Perfect Enough to Sleep?

Perfectionism and Markers of Poor Sleep

Susie Yen Peng Oh

ORCiD: 0009-0008-8145-9038

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“A ruffled mind makes a restless pillow.”

-Charlotte Bronte-

“If I waited for perfection … I would never write a word.”

-Margaret Atwood-

Abstract

Insomnia or poor sleep in the form of inadequate sleep either in duration or quality is a prevalent and costly health condition. Perfectionism, a multidimensional personality construct, has been theorised to be a risk factor of insomnia. Both insomnia and perfectionism are transdiagnostic risk factors in mental health disorders. While studies have investigated the relationship between perfectionism and an individual's subjective perceptions of sleep (such as duration, quality and so forth), there is a lack of research looking at the relationship between objective measures of sleep and perfectionism; and none based on actigraphy sleep study. Furthermore, no previous research has investigated whether perfectionism plays a role in the commonly experienced insomnia symptom of sleep-wake state discrepancy, and whether sleep can also impact on perfectionism.

This thesis aimed to investigate the potential relationships between sleep and perfectionism and explore the mediating influence of stress, arousal and sleep-related cognitions on these relationships. In study 1, a comprehensive study of the relationship between sleep and perfectionism was conducted using subjective and objective sleep measures obtained from sleep diary and actigraphy, respectively. This study found self-driven, higher levels of internalised perfectionistic concerns about making mistakes and having doubts about actions were associated with poorer subjective sleep. In comparison, externally driven perfectionistic concerns of perceived standards that others have for oneself (socially prescribed perfectionism), parental expectations and parental criticism related positively to objective measures of poor sleep and stress mediated those relationships.

In Study 2, the potential role that perfectionism may play in sleep-wake state discrepancy was explored. It was found that higher levels of perfectionistic concerns over mistakes and doubts about actions correlated with and predicted discrepancy in sleep onset

latency via the mediating effect of cognitive pre-sleep arousal. Study 3 then investigated the day-to-day bidirectional relationships between sleep and perfectionism at both interindividual and intraindividual levels. Bidirectional relationships between sleep and perfectionism were found at the interindividual level, but not at the interindividual level. However, stress mediated the relationship from perfectionism to sleep quality at the intraindividual level. Stress also mediated the relationship from sleep to perfectionism at the interindividual level.

Together, this thesis contributes new evidence to the existing literature that perfectionism is a risk factor of insomnia. It also highlights stress and pre-sleep arousal as underlying mediators in those relationships. These findings have important clinical and research implications in the assessment and treatment of poor sleep, suggesting that the different facets of perfectionism affect sleep differently and provide nuanced insights into how perfectionism affect sleep. In clinical practice, perfectionism should be assessed as a risk factor for insomnia. If perfectionism is identified as a potential driver of poor sleep, managing perfectionistic concerns, stress and pre-sleep arousal become important treatment considerations that can impact on the treatment process and therapy efficacy.

Declaration

This is to certify that:

i) The thesis comprises only my original work towards the degree of Doctor of Philosophy;

ii) Due acknowledgement has been made in the text to all other material used;

iii) The thesis is fewer than 100,000 words in length, exclusive of tables, figures, bibliographies and appendices.

I, Susie Yen Peng Oh, declare that the research reported in this thesis was conducted in accordance with the principles for the ethical treatment of human participants, as approved for this research by the University of Melbourne Human Ethics Committee (HREC ID 1955374).

Susie Yen Peng Oh Dated 06 May 2026

Preface

The author independently collected the data used in this research program. The author was solely responsible for collecting self-report and actigraphy data from all participants, which included adults with and without sleep difficulties. This included screening potential participants and co-ordinating the distribution, adherence and collection of actigraphy for 65 participants.

This thesis is presented with publication and includes three studies that were developed collaboratively with supervisors and other co-authors. The author was responsible for study conceptualisation and design, data collection and processing, statistical analyses, initial drafts and revisions of all manuscripts submitted for publication, while co-authors assisted with design, statistical analyses and revisions. All three studies are published or has been submitted for publication.

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To my family

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My mummy, sisters and extended family

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Publications & Submission

This thesis comprises three studies, including two published papers and one submitted manuscript.

Study	Status	Reference
1	Published on 24 May 2024	**Oh, S. Y.**, Meaklim, H., Nicholas, C. L., Cunnington, D., Schenker, M., Patrick, C. J., Windred, D., & Phillips, L. J. (2024). Perfect enough to sleep? Perfectionism and actigraphy-determined markers of insomnia. *Behavioral Sleep Medicine*, 1-16. https://doi.org/10.1080/15402002.2024.2355476
2	Published on 31 May 2026	**Oh, S. Y.**, Nicholas, C. L., Phillips, L. J., Cunnington, D., Schenker, M., Patrick, C. J., Windred, D., & Meaklim, H. (2026). Perfectionism contributes to sleep-wake state discrepancy: The mediating role of pre-sleep arousal. *Brain Sciences*, *16*(1), 600. https://doi.org/10.3390/brainsci16060600
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Abbreviations

Abbreviation	Meaning
AIE	Attention-Intention Effort Pathway
DASS-21	Depression, Anxiety and Stress Scale (21 item)
DBAS-16	Dysfunctional Beliefs and Attitudes about Sleep Scale Brief Version
DBAS-C	Dysfunctional Beliefs and Attitudes about Sleep Scale – Consequences of insomnia
DBAS-E	Dysfunctional Beliefs and Attitudes about Sleep Scale – Expectations about sleep
DBAS-M	Dysfunctional Beliefs and Attitudes about Sleep Scale – Beliefs about sleep medication
DBAS-W	Dysfunctional Beliefs and Attitudes about Sleep Scale – Worries about sleep
DSM-5-TR	Diagnostic and Statistical Manual (5th Ed, Text Revision)
CBT	Cognitive Behavioural Therapy
CBT-I	Cognitive Behavioural Therapy for Insomnia)
DPM	Daily Perfectionism Measures
DSI	Daily Stress Inventory
ECG	Electrocardiography
EEG	Electroencephalogram
EMA	Ecological Momentary Assessment
EMG	Electromyography

Abbreviation	Meaning
EOG	Electrooculography
FMPS	Frost Multidimensional Perfectionism Scale
GGIR	Raw Accelerator Data Analysis
HF-MPS	Hewitt-Flett Multidimensional Perfectionism Scale
ISI	Insomnia Severity Index
IIV	Intraindividual variability
LMM	Linear mixed-effects modelling
N1	Sleep stage 1
N2	Sleep stage 2
N3	Sleep stage 3
NOA	Number of awakenings
NREM	Non-Rapid Eye Movement
PSAS	Pre-Sleep Arousal Scale
PSAS-C	Pre-Sleep Arousal Scale – Cognitive arousal
PSAS-S	Pre-Sleep Arousal Scale – Somatic arousal
PSD	Pittsburgh Sleep Diary
PSG	Polysomnography
PSQI	Pittsburgh Sleep Quality Index
REM	Rapid-eye movement
REP	Melbourne University Research Experience Program
SE	Sleep efficiency
SEMA3	Smartphone Ecological Momentary Assessment app
SCN	Suprachiasmatic nucleus
SOL	Sleep onset latency

Abbreviation	Meaning
SOL_D	Discrepancy in sleep onset latency
SWS	Slow wave sleep
SWSD	Sleep-wake state discrepancy
TST	Total sleep time
TST_D	Discrepancy in total sleep time
WASO	Wake after sleep onset
WASO_D	Discrepancy in wake after sleep onset

INTRODUCTION

Chapter 1

Thesis Overview

"How blessed are some people, whose lives have no fears, no dreads; to whom sleep is a blessing that comes nightly, and brings nothing but sweet dreams."

-Bram Stoker, "Dracula" (1897, p. 110)-

The focus of this thesis is on the relationships between perfectionism and sleep.

1.1 Insomnia or Poor Sleep

Sleep quality is a broad, dimensional construct reflecting the level of satisfaction with quantitative and/or subjective aspects of sleep, including duration, latency, number of arousals, depth and restfulness (Buysse et al., 1988). Within this, insomnia symptoms that reflect poor sleep refer specifically to difficulties initiating or maintaining sleep or dissatisfaction with sleep quality, but do not necessarily meet criteria for insomnia disorder in terms of frequency, duration, or associated daytime impairment or distress. In contrast, insomnia disorder, as defined in the Diagnostic and Statistical Manual of Mental Disorders (5th ed., text rev.), is a clinically defined sleep–wake disorder characterised by persistent difficulties initiating or maintaining sleep or waking up earlier than expected, occurring at least three nights per week for a minimum of three months, and accompanied by clinically significant daytime impairment and/or distress, despite adequate opportunity for sleep (American Psychiatric Association, 2022). The focus of this thesis is on insomnia symptoms that reflect poor sleep. Therefore, insomnia and poor sleep are used interchangeably to refer to difficulties with initiating and/or maintaining sleep and/or dissatisfaction with sleep quality or quantity.

In Australia, 33-45% of adults reported experiencing adverse daytime consequences resulting from inadequate sleep, either in duration or quality (Adams et al., 2017). Such adverse daytime consequences include negative impact on mood, memory, energy level and general wellbeing, which negatively affect work performance, social activities, driving and general daytime functioning (Adams et al., 2017; Cunnington et al., 2013). Australians with clinically relevant poor sleep (i.e., insomnia, characterised by persistent difficulty initiating or maintaining sleep) report lower life satisfaction and higher use of medication and healthcare services than Australians without insomnia (Bin et al., 2012). This indicates poor sleep entails high personal, community and economic costs. In fact, poor sleep cost the Australian economy $14.4B in 2019/2020 alongside an estimated non-financial cost of $36.6B in the loss of wellbeing, which was equivalent to 3.2% of the total Australian burden of diseases (Sleep Health Foundation, 2021).

Poor sleep or insomnia is identified as a key variable and considered a transdiagnostic risk factor in mental health. This is because insomnia is often comorbid with, and contributes to the onset, maintenance and relapse of many mental health disorders, including depression, anxiety, bipolar disorder, alcohol use disorder, posttraumatic stress disorder, schizophrenia and psychosis (Dolsen et al., 2014; Harvey, 2008; Hertenstein et al., 2023). In the DSM-5-TR, insomnia is not only listed as a distinct condition named as insomnia disorder, but also as a diagnostic criterion for a variety of disorders (American Psychiatric Association, 2022). Given its high prevalence and transdiagnostic nature in mental health, the study of poor sleep remains important.

1.2 Perfectionism

Perfectionism is a personality construct that relates to the tendency to pursue flawlessness, having excessive high personal performance standards and being overly self-critical of one's performance and behaviours (Flett & Hewitt, 2002a; Frost et al., 1990).

Perfectionism is complex and multidimensional in nature (Shafran et al., 2002). Perfectionism is defined by cognitions and measured via self-reports with the Frost Multidimensional Perfectionism Scale (F-MPS; Frost et al., 1990) and the Hewitt-Flett Multidimensional Perfectionism Scale (HF-MPS; Hewitt et al., 1991), the two most cited scales in the study of perfectionism. For a detailed discussion on the multidimensional nature of perfectionism and its measurement, see Chapter 2.

Like insomnia, perfectionism has been identified as a transdiagnostic risk factor in mental health because of its associations and comorbidity with many mental health disorders (Callaghan et al., 2024; Egan et al., 2011; Gyori & Balazs, 2021; Limburg et al., 2017; Lunn et al., 2023; M. M. Smith et al., 2018). Transdiagnostic processes are described as the intersection points between personality and psychopathology (Rodriguez-Seijas et al., 2015). While they contribute to the onset, maintenance and relapse of multiple mental disorders; they also offer the potential to improve treatment efficacy across multiple mental disorders (Kothari et al., 2019; Lloyd et al., 2015). Therefore, the study of perfectionism has important clinical implications.

1.3 Perfectionism as a Risk Factor for Poor Sleep

Perfectionism was first observed to be a risk factor for insomnia more than 30 years ago and is thought to play a role in the sleep-interfering and sleep interpreting processes in insomnia which is particularly salient given that insomnia is diagnosed based on self-report (Lundh & Broman, 2000). Current models of insomnia suggest perfectionism contributes to insomnia in various by disrupting the automaticity of sleep normalcy via hyperarousal (Besser et al., 2008; Espie et al., 2006; Perlis et al., 1997; Riemann et al., 2010). A discussion of the various models is presented in Chapter 4.

So far, research has found evidence to support perfectionism as a risk factor for insomnia. Previous studies have demonstrated correlations and longitudinal associations

between higher levels of perfectionism and higher levels of sleep disturbances (e.g., Akram et al., 2015; Azevedo et al., 2009; Johann et al., 2017; Lundh et al., 1994). However, inconsistencies in those associations exist in the current literature due to the complexity of perfectionism as a multidimensional construct. (Akram et al., 2017; Azevedo et al., 2010; Azevedo et al., 2009; Brand et al., 2015; Lundh et al., 1994; Schmidt et al., 2018; Vincent & Walker, 2000). Furthermore, the relationships between perfectionism and insomnia are found to be affected by other factors, such as, anxiety, stress, rumination and dysfunctional sleep-related cognitions (Akram et al., 2015; Akram et al., 2017; Akram et al., 2020; Brand et al., 2015; Jansson-Frojmark & Linton, 2007; Lin et al., 2017). A more in-depth review of existing research evidence can be found in Chapter 4.

1.4 Key Gaps in Existing Research

Given that the diagnosis of insomnia is dependent on patients' self-assessment and report of their own sleep, evidence from existing research studies had predominantly been based on self-reported subjective sleep measures (American Psychiatric Association, 2022). However, it is known that objective and subjective measures of sleep can differ, particularly amongst poor sleepers (Fernandez-Mendoza et al., 2011; Harvey & Tang, 2012). Therefore, it remains unknown if known relationships between perfectionism and sleep that is based on subjective sleep measures will hold when objective sleep measures are used to assess sleep. It is also unclear whether poor sleep in individuals with high perfectionism relates only to their perception of sleep or whether there are indeed objective markers of poor sleep that relate to high levels of perfectionism. Furthermore, no study has utilised actigraphy sleep study to study the relationships between perfectionism and sleep. Actigraphy sleep study requires participants to wear a watch-like device to continuously capture activity and rest. Actigraphy offers the advantage of being carried out ecologically in the participants' natural sleep environment to provide valid characterisation of participants' habitual sleep, usually over a

period of 10-14 days (Martin & Hakim, 2011). This will provide day-to-day data over the study period to allow for more in-depth intraindividual analysis. Therefore, the focus of this PhD project is to measure sleep using actigraphy to capture objective sleep measures in addition to subjective self-reports of sleep to study the relationships between perfectionism and sleep.

1.5 Thesis Aims and Outline

The overall aim of this thesis was to investigate potential relationships between sleep and perfectionism by including both objective and subjective measures of sleep.

Part I aimed to introduce the topic of sleep and perfectionism. Chapter 2 presents an introduction to sleep - what is sleep, how is sleep measured, the processes that govern sleep, some functions of sleep and the consequences of poor sleep. Chapter 3 provides an overview of perfectionism – what is perfectionism, how is perfectionism measured and the consequences of perfectionism. Part 1 concludes with Chapter 4 introducing the theoretical relationships between sleep and perfectionism, summarising existing studies of those relationships then identifying the gaps in the literature.

Part II aimed to further study the relationships between sleep and perfectionism beyond existing literature findings. Chapter 5 presents study 1, the first, comprehensive study of objective sleep using actigraphy in investigating the relationship between sleep and perfectionism. This is followed by Chapter 6, which includes study 2 exploring the potential role perfectionism might play in the insomnia symptom of sleep-wake state discrepancy (SWSD). Finally, chapter 7 includes study 3, a novel investigation into the role of intraindividual variations in subjective sleep and perfectionism. All 3 studies were conducted based on the same sample of 65 participants. Studies 1 and 2 utilised both self-reported and actigraphy-derived data from 60 participants while Study 3 was based on only self-reported

sleep data from 63 participants. Studies 1 and 2 had fewer participants due to actigraphy errors and/or inadequate wear of actigraphy watch by participants.

In Part III, the general discussion and conclusion are presented in chapter 8, which integrates the key findings of this thesis into the current literature. This chapter concludes with the strengths and limitations of this thesis, research and clinical implications of the findings from this thesis, and directions for future research in the study of sleep and perfectionism.

PART I

Chapter 2

Sleep

"Sleep is the best meditation."

-Dalai Lama-

Sleep is a complex, unique and reversible physiological state produced by the body. During sleep, the brain goes into a state of rest, disengaging from and becoming unresponsive to external cues yet remains reactive to internal stimulus of neuronal activity (Aserinksy & Kleitman, 1953; Brinkman et al., 2023). At the same time, the body goes into an unconscious state, typically characterised by closed eyes, recumbent posture and behavioural inactivity. While the full function of sleep remains to be explored, having adequate and good quality sleep is vital in maintaining physical and mental health and optimal functioning.

2.1 Sleep Architecture

Normal human sleep is divided into two alternating phases of sleep, non-rapid eye movement (NREM) sleep and REM (rapid eye movement) sleep at a macrolevel based on a constellation of physiologic parameters. NREM sleep is further divided into three stages from N1 to N3. Each phase and stage of sleep is characterised by specific variations in brain wave patterns, skeletal muscle tone, respiratory patterns and eye movements. The human brain enters sleep through NREM sleep, progressing from N1 through to N3 sleep before entering REM sleep over a period of approximately 90 mins. This cycle is repeated around 4 to 6 times each night.

As sleep progresses from N1 through to N3 sleep, sleep depth increases, which is observable via electroencephalogram (EEG) of brain wave patterns that increase in amplitude and decrease in frequency. See Figure 2.2 for sleep stages and frequency bands of brain wave

patterns during sleep. Stage N1 sleep is characterised by theta EEG activity, slow eye movements and the lowest arousal threshold, which means it is easy to be awoken from sleep (Carskadon & Dement, 2017; Deatherage et al., 2009). Stage N2 sleep is indicated by sleep spindles of high small bursts of higher frequency sigma activity and K-complexes (Carskadon & Dement, 2017). Stage N3 sleep is characterised by high amplitude slow-wave delta activity, which is often referred to as slow-wave sleep (SWS), delta sleep or deep sleep (Carskadon & Dement, 2017; Deatherage et al., 2009). Consequently, stage N3 sleep has the highest arousal threshold, making it much harder for sleep to be discontinued compared to other stages and phases of sleep (Carskadon & Dement, 2017).

Upon completion of stage N3 sleep, the brain usually progresses to REM sleep, which is characterised by low amplitude and high frequency beta, theta and alpha EEG waves similar to brain wave patterns during wakefulness. Other distinguishing features of REM sleep include bursts of rapid eye movements, vivid dreaming, muscle atonia, twitches and irregular breathing (Carskadon & Dement, 2017; Deatherage et al., 2009). NREM and REM sleep alternate throughout the night in cycles with REM sleep episodes becoming longer as the night progresses. Early sleep in the first half of the night is dominated by SWS whereas REM sleep dominates sleep in the second half of the night. See Figure 2.3 for illustration. This distribution of SWS towards the beginning of the night and REM sleep towards the second half of the night is linked to the homeostatic Process S and the circadian oscillation of Process C respectively (Borbély, 1982). See section 2.4 on the two processes of sleep regulation.

Figure 2.1

EEG examples of sleep stages including frequency bands. Adapted from Chan and Nicholas (2018)

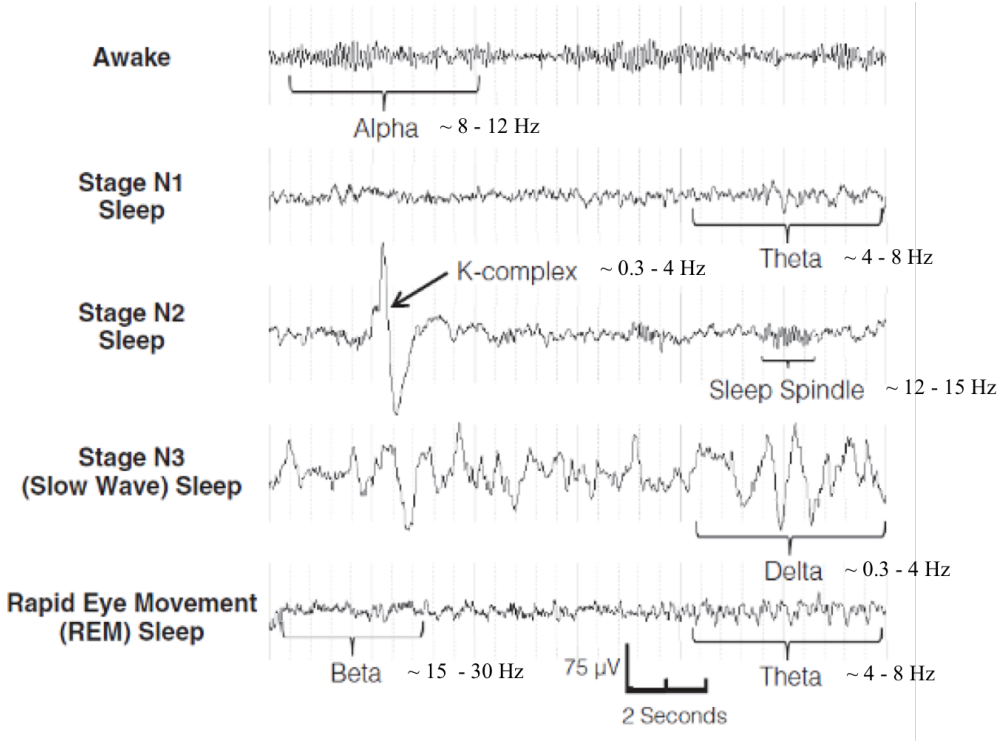
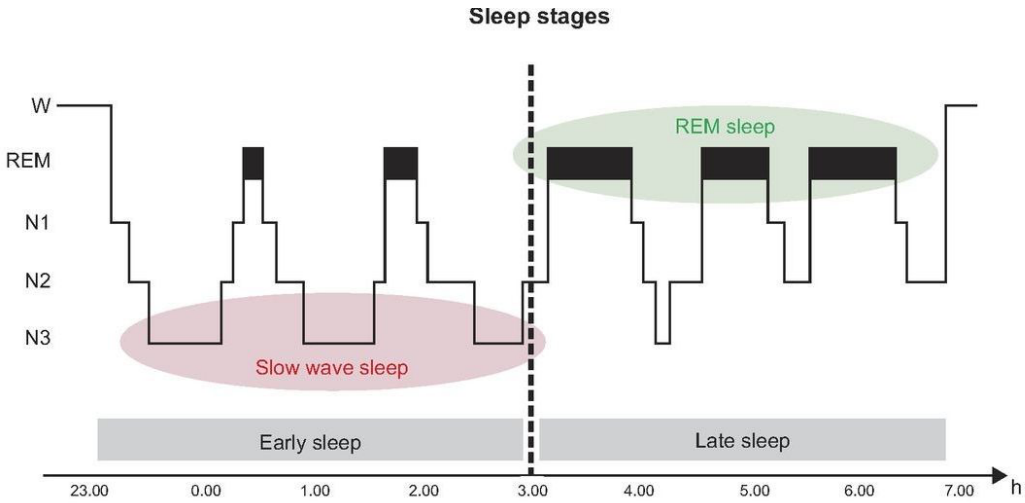


Figure 2.2

Hypnogram illustrating sleep architecture of typical human sleep throughout a nocturnal period of sleep including NREM and REM cycles (Rasch & Born, 2013)



2.2 Measuring Sleep

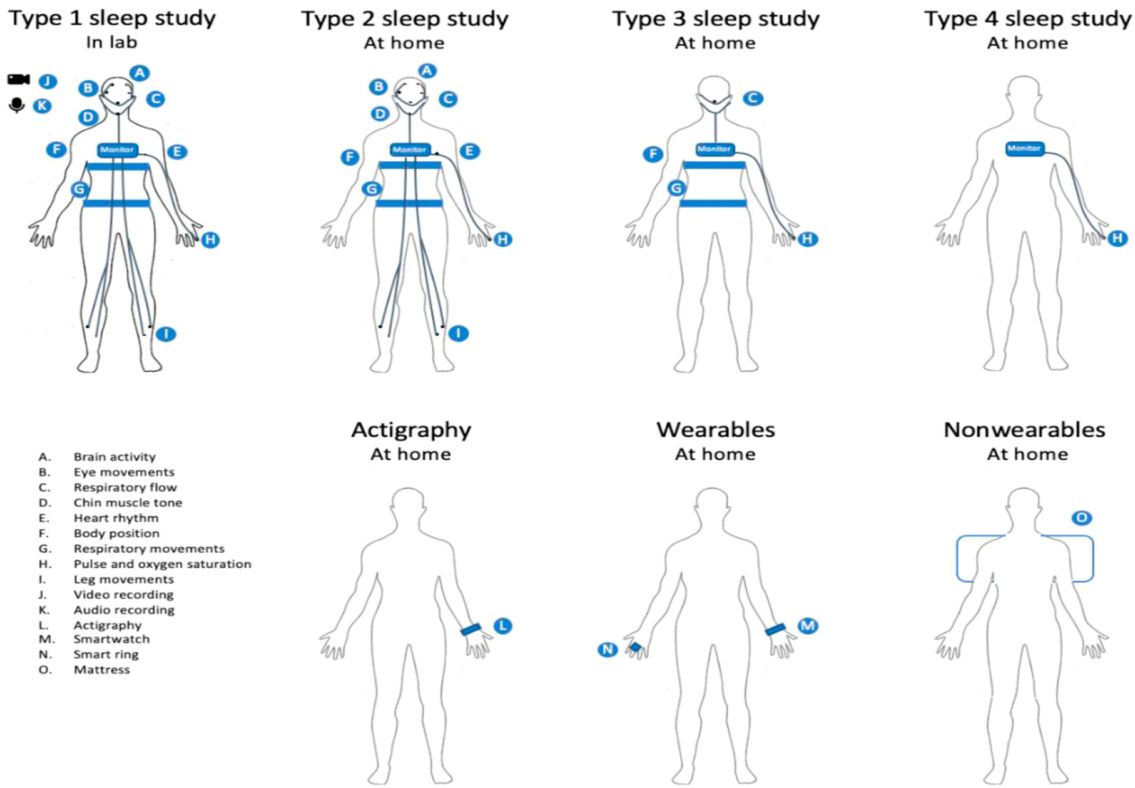
Sleep can be assessed objectively and subjectively in various ways. Objective sleep measures are typically collected through an overnight sleep study or over several nights using wearables or nonwearable devices, while subjective sleep measures are typically reported by participating subjects upon wake. These different types of data represent different sides of the same sleep coin.

2.2.1 Objective Measures

Sleep can be objectively assessed via a polysomnography (PSG), actigraphy or other wearable and non-wearable (i.e., nearable) devices. See Figure 2.3 for the various types of objective sleep assessment methods and measures. Objective sleep assessment can capture measures to reflect sleep architecture and record sleep disturbances to provide further insights which might or might not be captured by self-reported subjective sleep measures.

Figure 2.3

Various types of objective sleep measures and methods (Arnardottir et al., 2021)

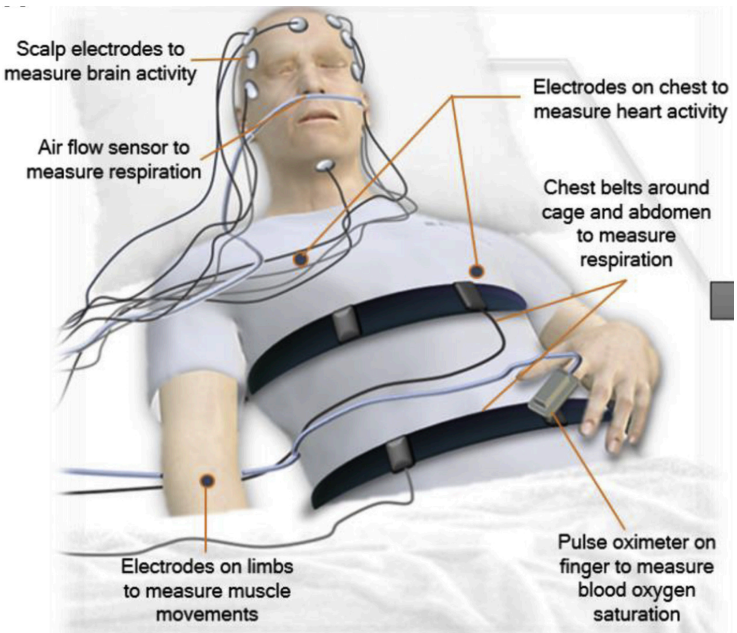


2.2.1.1 Polysomnography

The gold standard diagnostic method for sleep assessment is the PSG, which is normally done in a hospital or laboratory setting with staff monitoring sleep throughout the night. It involves electrophysiological measures of brain activity via electroencephalography (EEG), eye movements via electrooculography (EOG), and muscle tone via chin electromyography (EMG). Together, these electrophysiological data are measured in 30-second epochs throughout the night to allow the determination of different sleep stages (wake, N1, N2, N3 and REM), arousals from sleep and wake periods to provide the sleep architecture for the night. PSG also includes respiratory flow monitoring to assess breathing and obstruction of the upper airways, electrocardiography (ECG) test, leg EMG to assess leg movement, blood oxygen measure and assessment of body position. Together, these allow PSG to record respiratory events and periodic leg movements, on which the diagnosis of certain sleep disorders is based (e.g., obstructive sleep apnoea, restless leg syndrome, REM sleep behaviour disorder). See Figure 2.4 for an example set-up for a PSG.

Figure 2.4

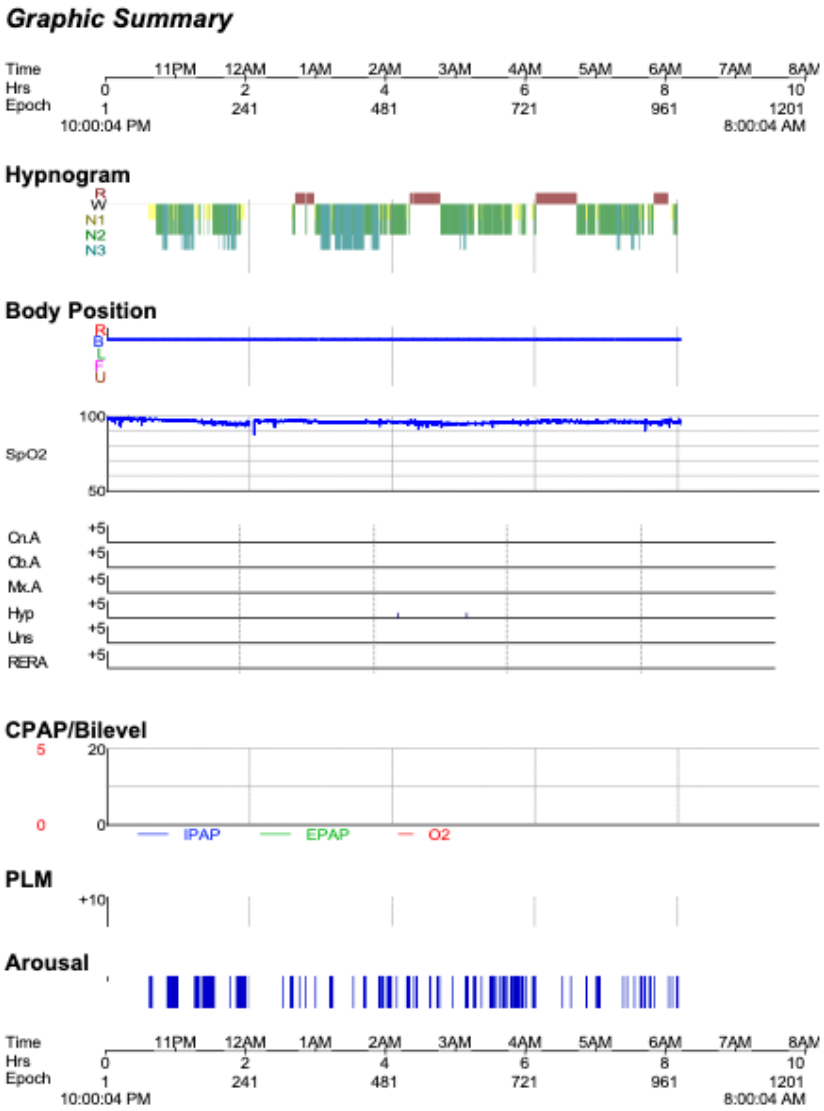
PSG requires multiple wired sensors and transducers (Kwon et al., 2021)



Although PSG is the gold standard for sleep assessment, it has several limitations. Due to its high costs, time consuming and intrusive nature because of the number of wires attached, it is usually limited to a single night, which does not allow for the measurement of night-to-night variability of sleep parameters. Furthermore, PSG conducted in hospital or sleep laboratory introduces an artificial sleep environment to potentially raise first-night effect (Agnew et al., 1966). First night effect refers to sleep being worse than usual on the first night of recording. This includes longer sleep onset latency, more awakenings, lower total sleep time, increased light sleep stages, decreased percentage of REM sleep and longer REM latency in both good sleepers and those with insomnia (Hu et al., 2024; Leger et al., 2025). To minimise some of these effects, PSG may be carried out at home to avoid environment unfamiliarity and conducted over two nights. The first night is referred to as an 'adaptation' night and only data from the second night is considered, a standard recommendation by the United States Food and Drug Administration and the European Medicines Agency (European Medicines Agency, 2011; Food and Drug Administration, 1997). This practice further increases the costs of a PSG sleep study. Example of a part of a PSG report can be found in Figure 2.5, which captured the time the sleep study commenced and ended, showed the various sleep stages through the night via a hypnogram, and recorded body position, oxygen saturation level, periodic leg movement and arousals during sleep throughout the night.

Figure 2.5

PSG graphic report of my own data recorded at a sleep laboratory



2.2.1.2 Actigraphy

Actigraphy is an alternative method to measure sleep objectively in sleep research (e.g., GENEActiv®, Actiwatch®). Typically, an actigraphy is an actimetry sensor contained in a watch-like device that is worn on an individual's non-dominant wrist 24 hours a day over days or even weeks to continuously capture movement/activity and rest. Some devices in addition capture temperature and light data to provide further information about circadian "Zeitgebers". Sleep is inferred from a lack of physical activity or motion because there is

little movement during sleep whereas periodic increases in movement occur during wake (Stone & Ancoli-Israel, 2017; Tryon, 1991). The device records physical movements via a sampling of activity count that is stored for each epoch, which is typically set to 60-seconds. Each epoch is then classified as either wake or sleep based on a pre-determined algorithm, which then calculates estimates of total sleep time (TST), sleep onset latency (SOL), wake after sleep onset (WASO), number of awakenings (NOA) and sleep efficiency (SE, the percentage of time spent asleep while in bed) (Martin & Hakim, 2011; Sadeh & Acebo, 2002; Stone & Ancoli-Israel, 2017). Sleep logs to document waketime, bedtime, periods of not wearing the device, times of external motion or unusual events are recommended for use with actigraphy for data corroboration to improve validity of sleep estimates (Sadeh, 2011; Sadeh & Acebo, 2002).

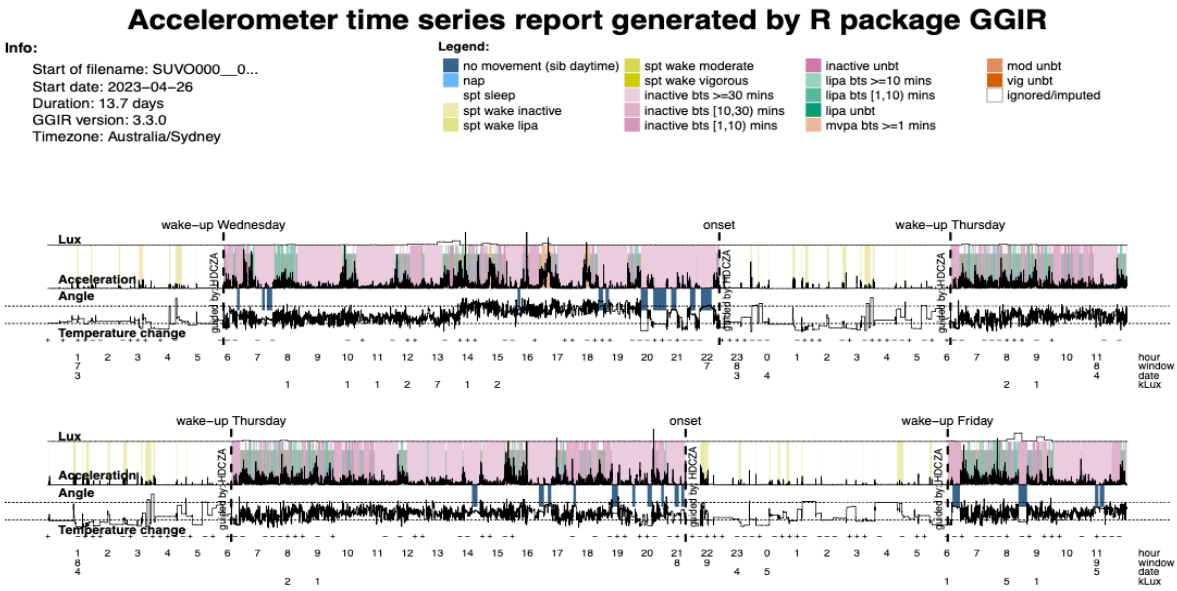
Although actigraphy cannot provide information on sleep architecture and is less sensitive than PSG, it is generally considered a valid and useful alternative objective sleep measure to the gold standard (Marino et al., 2013). Compared to a PSG, actigraphy is a more convenient and less invasive method of collecting objective sleep data, which offers significant cost advantages (Martin & Hakim, 2011). Furthermore, actigraphy facilitates the collection of ecological sleep data from an individual's natural sleep environment and can be used for extended monitoring over days and weeks to allow the study of sleep variability objectively (Martin & Hakim, 2011; Samson et al., 2016; Stone & Ancoli-Israel, 2017). It is also recognized as valid tool in diagnosis and validation of various sleep disorders, including insomnia, circadian sleep disorders and narcolepsy (Banfi et al., 2021; Gillett et al., 2021; Leger et al., 2018; Natale et al., 2014).

Actigraphy also offers an advantage in tracking sleep/wake sleep behaviours on a 24-hour basis because it can capture daytime naps and/or unintentional sleep (Samson et al., 2016). While sleep detection via actigraphy is reliable and valid in normal population,

actigraphy is known to become less accurate and reliable in disturbed sleep as it tends to overestimate sleep and underestimate wake (Sadeh, 2011; Sadeh & Acebo, 2002; Stone & Ancoli-Israel, 2017). As actigraphy proxies sleep with the lack of movement, it can falsely classify resting while being awake as sleep or restless sleep as wake. For example, misclassification may occur in individuals with insomnia who lay motionless in bed for extended periods of time while attempting to initiate sleep or individuals with periodic limb movements while sleeping (Sadeh, 2011). Lastly, sleep estimates from actigraphy can also vary and differ across different devices and algorithms. Therefore, it is good practice to ensure any chosen actigraphy device, scoring algorithm and variables measured are validated with populations or conditions that are specific to the individual whose sleep is being assessed (Sadeh, 2011; Sadeh & Acebo, 2002). Figure 2.6 provides an example of an actigraphy output.

Figure 2.6

Screenshot of my own raw data recorded with a GENEActive actigraphy watch (ActivInsights Ltd, Cambridge, UK) and processed by the GGIR algorithm (van Hees et al., 2022)



2.2.1.3 Other objective measures of sleep

New technologies have led to a proliferation of both research and consumer products in sleep assessment and monitoring. EEG-based sleep monitoring devices make up a type of new based on wearable technology that utilises electrodes on forehead (in the form of headbands), ear or neck sleep monitoring system [e.g., Zeo (Zeo Inc., Newton, MA, USA), Dreem (Beacon Biosignals, Inc., Boston, MA, USA), Somfit (Compumedics Limited, Melbourne, Australia), cEEGrid (Twente Medical Systems Internationa, Oldenzaal, Netherlands), Zmachine® Insight+ (General Sleep Corporation, Euclid, OH, USA)]. These user-friendly devices offer a cost-effective alternative to the PSG as such sleep monitoring devices do not require physical presence of a researcher or clinician and can be use at home on a long-term basis (Markov et al., 2024). However, most devices have yet to be validated against PSG; and challenges around regulatory constraints and data privacy impede their clinical adoption (Markov et al., 2024). Other sleep measuring technologies include non-EEG-based wearables, such as, smartwatches or rings, nearables which depend on sensors placed near the sleeper; and in-bed sensors placed on or under the mattress. Some of these devices measure breathing rate, skin temperature, heart rate, etc. to proxy sleep stages and identify cardiopulmonary sleep-related events, such as, oxygen desaturation. While they may be more convenient as most do not require setup support from a trained technician and have been widely adopted, most of these devices were designed specifically for consumer use and generally limited in research or clinical use. As such, most have not been clinically validated and lacked transparency in data collection and analysis with undisclosed algorithms as they are considered business secrets although some are in the process of being validated (Arnardottir et al., 2021; de Zambotti et al., 2024).

2.2.2 Subjective measures of sleep

Sleep can also be assessed based on the subjective experience of the individual, which cannot be captured by objective sleep measures. One way to assess sleep subjectively is through questionnaires, which are designed to assess many aspects of the sleep experience, including sleep habits, sleep quality, beliefs about sleep, chronotype, etc. They can also be used as a screen for specific sleep disorders; to identify sleep problems and assess how sleep is impacting on daytime functioning.

One commonly used instrument to screen for insomnia is the Insomnia Severity Index (ISI), which assesses sleep disturbance, sleep dissatisfaction and sleep-related impairment (Bastien et al., 2001). The Dysfunctional Beliefs and Attitudes about Sleep Scale Brief Version (DBAS-16) is a questionnaire used to evaluate an individual's sleep-related worry and expectations, medication use and perceived consequences of insomnia (Morin et al., 2007). Another questionnaire, the Pre-Sleep Arousal Scale (PSAS) is designed to help individual identify experiences of cognitive arousal (e.g., worry, racing thoughts) and somatic arousal (e.g., tight muscles, pounding heart) which can disrupt the process of initiating sleep to fuel insomnia (Nicassio et al., 1985). Screening for obstructive sleep apnea is commonly conducted with the STOP-BANG questionnaire, which stands for Snoring, Tiredness, Observed apnea, blood Pressure, Body mass index, Age, Neck circumference and Gender (Chung et al., 2008) while screening for excess daytime sleepiness is commonly conducted using the Epworth Sleepiness Scale (Johns, 1991).

A major limitation of questionnaires relates to the lack of validation studies across different sleep populations as sensitivity and specificity in detecting a sleep problem using the same questionnaire can differ across clinical and general populations (Arnardottir et al., 2021). A clinical interview with a sleep physician or somnologist, including a review of patient history and questionnaires and a physical examination, is considered the gold standard

of subjective sleep assessment (Fischer et al., 2012; Grote & Puertas, 2021). It can, however, be difficult to access a qualified sleep physician (Arnardottir et al., 2021).

Another method to assess sleep subjectively is through sleep diaries. Sleep diaries play an important role in the diagnosis and treatment of sleep disorders as part of a multi-method multi-trait approach of sleep assessment (Buysse et al., 2006; Perlis et al., 2025). Sleep diaries are typically completed in the morning immediately upon wake from a sleep period. They capture the subjective accounts of sleep timing, duration and quality; as well as behaviours that may affect sleep. As sleep diaries are often completed for at least one to two weeks, they capture night-to-night variability in sleep and is more representative of an individual's sleep compared to a one-time questionnaire that usually asks for the average report of an individual's sleep over the past one or two weeks or one or two nights of PSG (Buysse et al., 2006; Perlis et al., 2025). An example of a sleep diary is the Pittsburgh Sleep Diary (PSD), consisting of a bedtime diary and a waketime diary. The bedtime diary documents waking behaviours during the day before a sleep period, such as, mealtimes, number and timing of caffeinated and alcoholic drinks, use of sleeping medications, timing and duration of daytime naps and exercise, etc. The waketime diary is designed to quantify and assess the sleep period just completed, including bedtime, sleep time, sleep onset latency, number of awakenings, total duration of nighttime awakenings, time of final awakening, and ratings on sleep quality and mood and alertness upon wake. Timely compliance and recall bias are major limitations of sleep diaries (Arnardottir et al., 2021).

2.2.3 Sleep-Wake State Discrepancy

Measuring sleep can be complex due to a lack of biomarkers for sleep quality and disturbances and the various ways in which sleep can be quantified. Furthermore, discrepancy between individuals' subjective reports and objective measurements of sleep is commonly present in all sleep disorders and even reported by good sleepers (Cudney et al.,

2022; Schinkelshoek et al., 2020; Stephan & Siclari, 2023; Valko et al., 2021). While such discrepancy is often associated with an underestimation of sleep, the overestimation of sleep has also been reported by individuals who did not report but were objectively assessed to have moderate daytime sleepiness (Castelnovo et al., 2019; Herzog et al., 2025; Trajanovic et al., 2007). This phenomenon is referred to by many terms, such as, sleep-state misperception, sleep misestimation, subjective-objective sleep discrepancy and sleep-wake state discrepancy. In this thesis, this phenomenon will be referred to as sleep-wake state discrepancy (SWSD). This neutral term is recommended because it does not imply error or inaccuracy in an individual's subjective sleep report since the underlying mechanisms of SWSD is currently unknown (Bensen-Boakes et al., 2022; Harvey & Tang, 2012).

2.3 Two-Process Model of Sleep Regulation

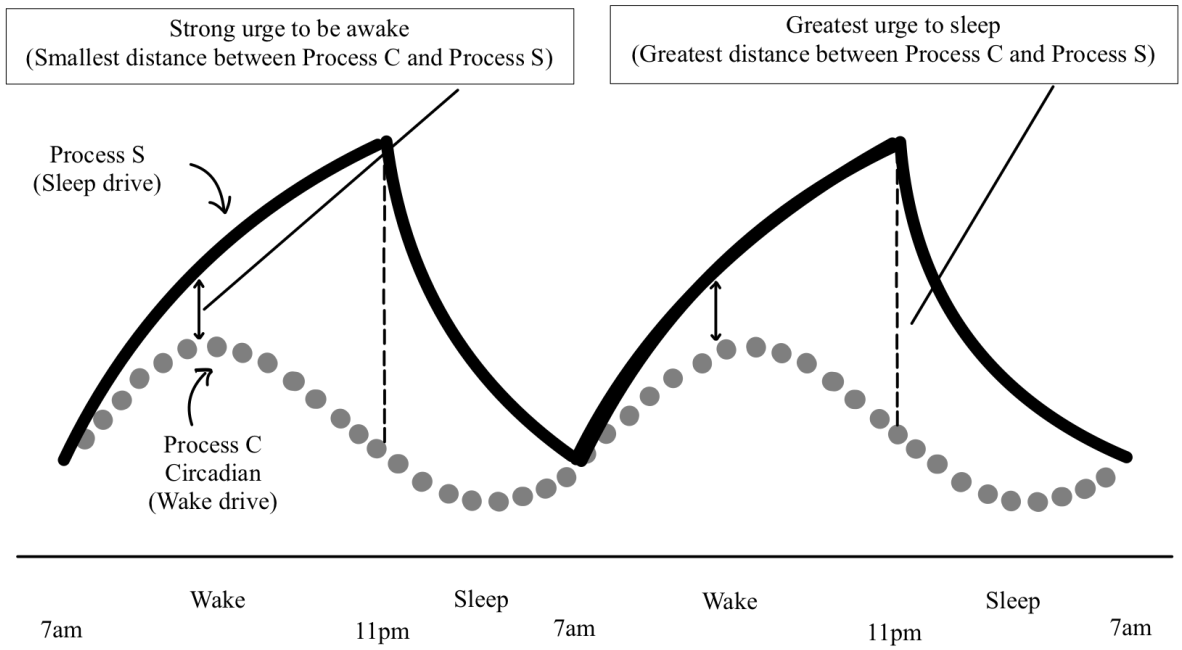
Since its introduction by Borbély in 1982, the two-process model of sleep regulation has been a major conceptual framework in sleep science. The model proposes that sleep is regulated by two processes, Process S which is sleep-dependent and Process C which is sleep-independent (Borbély, 1982). Sleep propensity, timing, duration and the cyclical alternation between NREM sleep and REM sleep are determined by these two processes and their reciprocal interaction with each other.

The sleep-dependent Process S represents the homeostatic sleep drive or sleep debt, which increases during wake and exponentially declines across NREM SWS (Borbély, 1982). Process S is determined by the duration of the antecedent waking period and reflected in SOL or the time it takes to initiate sleep. The time course of Process S is derived from the values of SWS activity during sleep and the SWS propensity during waking. Borbély et al. (2016) suggests that SWS represents the decay rate of Process S, which is a function of prior wake time and an indicator of sleep homeostasis. The sleep-independent Process C represents the predictable rhythmic variation of sleep propensity and is controlled by the hypothalamic

suprachiasmatic nucleus (SCN), which is the endogenous circadian pacemaker responsible for generating circadian rhythms in sleep and activity (Borbély, 1982; Moore, 2001). The SCN regulates core body temperature, hormone release (including melatonin secretion) and other behavioural and physiological processes, which actively promote both sleep and wake at different phases of the circadian cycle to influence sleep timing (Harvey et al., 2011; Moore, 2007; Redfern et al., 1991). Borbély (1982) postulated that REM sleep propensity is less influenced by sleep or waking but is more dependent on Process C as it is inversely associated with body temperature, demonstrating circadian rhythm.

Figure 2.7

Illustration of the Two-Process of Sleep Regulation. Adapted from Walker (2017)



Healthy sleep results from the synchronous reciprocal interaction between homeostatic Process S and circadian Process C to maintain daytime wakefulness and consolidate nighttime sleep of alternating cycles between NREM and REM sleep (Beersma, 1998; Borbély, 1982). Process C acts as an arousing drive that increases with wake, rising progressively to overcome the increasing sleep drive from Process S to promote and maintain

wakefulness throughout the day. The arousal drive from Process C peaks in the late afternoon then gradually falls until it is absent. This results in peak sleep propensity by late evening as sleep drive from Process S reaches its peak when the discrepancy between Process S and Process C is at its maximum (Mistlberger, 2005; Moore, 2007). See Figure 2.7. At sleep onset, Process S is at its peak causing the sleep cycle to be dominated by SWS and as the night progresses, SWS sleep progressively decreases due to the declining Process S (Borbély, 1982).

2.4 Day-to-Day Intraindividual Sleep Variability

The biological bases of sleep wake patterns, which are determined by the homeostatic sleep drive and circadian clock, are relatively stable across days (Borbély, 1982). However, day-to-day variation in sleep wake patterns beyond this stable biological regulation exists and is referred to as intraindividual variation (IIV) of sleep (Bei et al., 2016). Personality traits, psychopathology and adverse health outcomes can affect IIV in sleep wake patterns, which is further exacerbated by increasing social and economic demands of the current 24-hour society (Chaput et al., 2020; Križan & Hisler, 2019; Mead et al., 2021; Phillips et al., 2025; Rajaratnam & Arendt, 2001; Sperry & Kwapil, 2022; Taub & Hawkins, 1979). More specifically, higher IIV has been found to be associated with insomnia symptoms, poor daytime functioning; and physiological dysregulation, while sleep interventions can reduce levels of IIV in sleep (Bei et al., 2017; Bredeli et al., 2022; Suh et al., 2012; Sun et al., 2024). The measurement and study of IIV of sleep is an additional aspect of sleep research that can help further the understanding of sleep, sleep wake patterns and poor sleep (Bei et al., 2016; Bredeli et al., 2022).

2.5 Some Functions of Sleep

In this section, the importance of getting adequate quantity and quality of sleep for optimal physical and mental health is highlighted through a brief review of the proposed functions of sleep.

Sleep is vital for survival and ubiquitous among all animals and on average, humans spend over a third of our lifetime sleeping (Brinkman et al., 2023). Sleep has persisted through evolution despite limiting other survival functions, such as procreation, food gathering and predation defense, which indicates sleep must serve important functions (Joiner, 2016; Rechtschaffen, 1998). While many theories on why we sleep have been proposed, no single theory can parsimoniously explain the essential function of sleep (Rechtschaffen, 1998).

2.5.1 Slow-wave Sleep

SWS plays a pivotal role in health by fulfilling several functions. One important function of SWS sleep is suggested to be the consolidation of declarative and procedural memory, particularly motor skills acquisition, into long-term storage. Newly acquired memories during wakefulness are initially encoded within the hippocampus before being transferred to the neocortical storage during slow-wave sleep (Cox et al., 2020). A second function of SWS is proposed by the synaptic homeostasis hypothesis. It states that SWS down-regulates synaptic potentiation that increases during wakefulness to maintain synaptic homeostasis, which preserves energy and improves efficiency of grey matter to benefit learning, memory and brain plasticity (Tononi & Cirelli, 2003). SWS also serves other bodily functions. It plays a role in the endocrine system to affect hormone regulation, insulin sensitivity and weight gain and has a positive bidirectional relationship with immunity (Feuth, 2024; Ishii et al., 2024; Kianersi et al., 2023; Reither et al., 2021). In terms of sleep physiology, higher duration of SWS is associated with higher subjective sleep quality and

feeling of being refreshed and well-rested (Cudney et al., 2022; Keklund & Akerstedt, 1997; Shirota et al., 2023). Overall, SWS is pivotal for physical and brain health as well as essential to facilitate learning and memory.

2.5.2 Rapid Eye Movement (REM) Sleep

The functional role of REM sleep and dream continues to remain unknown (Kennedy & Norman, 2005; Peever & Fuller, 2017). REM sleep is important for brain development and neurogenesis because the highest proportion of REM sleep occurs in early childhood (Marks et al., 1995; Roffwarg et al., 1966). Some known physical functions of REM sleep include the regulation of body temperature, feeding behaviour, autonomic nervous system, the brain as an organ and its glymphatic system, and the structure of sleep itself in terms of modulating subsequent NREM sleep (Mukai & Yamanaka, 2023). REM sleep is theorised to play an important role in memory consolidation alongside SWS (Ackermann & Rasch, 2014; Diekelmann & Born, 2010). Firstly, REM sleep facilitates the consolidation of procedural memory via selective pruning and maintenance of new synapses in a process of synaptic regulation (Li et al., 2017). Secondly, memory representational transformation, modification or distortion and integration into the existing knowledge base to form memory schemas occur during REM sleep (Kaida et al., 2023; Liu et al., 2025; Paller et al., 2021; Tamminen et al., 2017). Thirdly, REM sleep is crucial for processing emotional memory by strengthening the content of the emotional memory and reducing its affective tone, making it critical for emotion regulation, mental well-being and emotional resilience (Rasch & Born, 2013; Wagner et al., 2006); (Walker, 2024; Walker & van der Helm, 2009). REM sleep clearly plays a significant role in learning, memory and brain and mental health.

2.6 Consequences of Poor or Inadequate Sleep

Sleep is a biological process that is vital for life, and inadequate or poor sleep are detrimental to physical, cognitive and emotional health (Hirshkowitz et al., 2015). The

characteristics of normal healthy sleep include adequate duration, good quality, appropriate timing, regularity and the lack of sleep disturbances and disorders (Watson et al., 2015). The lack of adequate duration or quality of sleep is commonly described as sleep deprivation while a lack of sleep continuity is commonly termed sleep fragmentation or disruption. Despite Australasian Sleep Association's endorsement of the recommendation by the United States National Sleep Foundation not to sleep less than 6 10 hours, 15% of Australian adults reported sleeping less than 6 hours per night (Metse & Bowman, 2020). In fact, the 2016 Sleep Health Foundation national survey indicated that 33-45% of Australian adults do not get adequate sleep, either in duration or quality, and is affected by its daytime consequences (Adams et al., 2017). Poor sleep not only affects the individual but also the community and entails economic costs. Poor sleep cost the Australian economy $14.4B in the 2019/20 financial year, equivalent to 0.73% of the Australian Gross Domestic Product; and the estimated non-financial costs of the loss of wellbeing was $36.6B, representing 3.2% of the total Australian burden of disease for the year (Sleep Health Foundation, 2021). This section will discuss the consequences of inadequate or poor sleep on performance, cognition, mood and health with a particular focus on insomnia disorder and poor sleep as a transdiagnostic factor in mental health disorders.

2.6.1 Somatic

Disrupted, poor or insufficient sleep is detrimental to physical health and has been linked to a range of health issues. Research indicates that total or partial sleep deprivation or sleep fragmentation increases pain perception in both healthy individuals and people with chronic pain (Chang et al., 2022). Furthermore, many immune functions are related to and regulated by the circadian rhythm and sleep although the exact mechanisms and their relationships remain unknown (Singh et al., 2025). What is known is that chronic insufficiency of sleep increases the production of pro-inflammatory cytokines to cause low-

grade inflammation and produce immunodeficiency that can exacerbate health conditions, including cardiovascular, metabolic, neoplastic, autoimmune and neurodegenerative diseases (Garbarino et al., 2021; Poluektov, 2021; Singh et al., 2025). For example, short sleep duration is a known risk factor for, and poor sleep quality was associated with developing obesity and type 2 diabetes mellitus (Antza et al., 2021; Henson et al., 2024) In a large cross-sectional population survey in the USA, it was found that individuals with sleep problems or a diagnosis of sleep disorder were more likely to have been diagnosed with cancer (Porcacchia et al., 2024). In another eight-year study tracking a large cohort of elderly in England, poor sleep quality was associated with the long-term risk of developing cancer (Song et al., 2021). In fact, poor sleep quality has been associated with increased mortality risk (Del Brutto et al., 2024).

2.6.2 Behaviour

Inadequate or poor sleep can adversely affect motor skills and behaviours. Even a night of mild sleep loss has been shown to significantly increase sleepiness and reduce vigilance to negatively impact on performance (Gibbings et al., 2021). There is also strong research evidence to suggest that sleep-deprived individuals make more errors in cognitive tasks and exhibit higher impairment in inhibitory control, which is important in regulating everyday behaviour (Choong et al., 2025). Unsurprisingly, studies have also shown that poorer sleep quality and shorter sleep duration are associated with higher aggression, manifesting as aggressive behaviour, anger, irritability, hostility and aggression control (Demichelis et al., 2022; Van Veen et al., 2021; Van Veen et al., 2022). There is also increasing evidence linking sleep deprivation to poor driving and higher risk of road traffic accidents; and poor sleep quality and/or duration to risky health behaviours, such as, alcohol consumption, drug seeking and use and binge-eating (Angarita et al., 2016; Cerolini, 2023; Mike et al., 2016;

Sprajcer et al., 2023). Consequently, it has been suggested that the negative impact of sleep deprivation on inhibitory control may underlie such risky behaviours (Choong et al., 2025).

2.6.3 Mental Health: Insomnia as a Transdiagnostic Risk Factor

Insomnia or disturbed sleep plays a significant role in mental health. A recently published umbrella review found that sleep deprivation was followed by elevated anxiety, aggression, depression and poor mood because it led to emotional instability and dysregulation and an inability to accurately process and respond to emotional stimuli (Shah et al., 2025). Likewise, sleep disruption was found to increase stress responsivity, emotional distress and mood disorders; as well as higher deficits in cognition, memory and performance to further confound the stress responsivity in bidirectional associations (Medic et al., 2017). Disturbed sleep or insomnia is identified as a risk factor, a comorbid condition and transdiagnostic factor for many mental health disorders, playing a significant role in their onset, maintenance, relapses and recurrences (Harvey, 2008; Palagini et al., 2022). Research has previously identified insomnia to significantly predict or is associated with depression, bipolar disorder, anxiety, alcohol abuse, schizophrenia, psychosis and posttraumatic stress disorder (Dolsen et al., 2014; Hertenstein et al., 2023; Nakajima et al., 2023).

Furthermore, sleep quality can impact on quality of life. Individuals who reported higher sleep quality reported greater life satisfaction in terms of feeling healthier and happier with higher levels of wellbeing and lower levels of work stress (Kudrnacova & Kudrnac, 2023). Conversely, individuals who reported poor sleep quality were more likely to report a lower quality of life as indicated by more problems with physical activity, self-control, daily activity and pain (Lee et al., 2021). More significantly, poor quality sleep, sleep deprivation and inadequate sleep duration have been found to significant associated with increased suicidal behaviour, suicide ideation and risk (Hedstrom et al., 2021; Palagini et al., 2024;

Porras-Segovia et al., 2019). These findings highlight the importance of the role sleep plays in maintaining mental health.

2.6.4 Insomnia and Insomnia Disorder

Due to the important role that sleep plays in mental health, the Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR) lists insomnia distinctly as a mental health disorder as well as using the presence of sleep problems as a diagnostic criterion in the assessment of various mental disorders (American Psychiatric Association, 2022). For example, insomnia, hypersomnia, sleep disturbance or distressing dreams are used to diagnose major depressive disorder, generalized anxiety disorder and posttraumatic stress disorder. The DSM-5-TR defines features of insomnia to include being dissatisfied by sleep quantity or quality associated with difficulties in the initiation or maintenance of sleep and/or waking up too early then being unable to return to sleep. For insomnia to be classified as insomnia disorder, the sleep disturbance must cause significant distress or impairment in daily functioning and be present for at least 3 nights per week for at least 3 months despite having adequate opportunity for sleep. Poor or inadequate sleep exists on a continuum from insomnia symptoms that are subthreshold through to meeting diagnostic threshold for insomnia disorder diagnosis.

Chapter 3

Perfectionism

"Perfectionism doesn't make you feel perfect; it makes you feel inadequate."

-Maria Shriver-

This chapter provides an overview of perfectionism as a personality construct. Personality dispositions play an important role in the determination of individual, interpersonal and social outcomes (Corr et al., 2017; Ozer & Benet-Martinez, 2006). Perfectionism is a personality construct or style that is associated with negative intrapersonal psychological and interpersonal outcomes, highlighting it as a vulnerability factor in the development and maintenance of maladjustment, relational difficulties, psychological diagnoses and physical health problems (Flett & Hewitt, 2019; Smith et al., 2022). Due to significant cultural and social changes including the rise of neoliberalism, competitive individualism, meritocracy and increasingly anxious and controlling parental practices, the prevalence of perfectionism has risen from 1989 to 2016 to coincide with and possibly contribute to rising rates of psychopathology (Curran & Hill, 2019). The rising prevalence rate of perfectionism underscores the importance of studying perfectionism as a personality construct.

3.1 Key Characteristics of Perfectionism

The main characteristics of perfectionism relate to the pursuit of flawlessness and the coupling of having excessive high personal standards for performance with the propensity of being overly critical of one's own behaviour (Flett & Hewitt, 2002a; Frost et al., 1990). Perfectionists over-emphasise how others evaluate them, so place pressure on themselves to meet high standards to avoid disappointing and disapproval by significant others (Frost et al.,

1990; Hewitt et al., 1991). While extreme perfectionists have been theorised to aim for perfection across all facets of their lives, most people with perfectionistic tendencies report being perfectionistic across multiple, but not all domains of life, including work and studies (Flett & Hewitt, 2002a; Stoeber & Stoeber, 2009). Being perfectionistic in more domains is associated with higher levels of perfectionism (Stoeber & Stoeber, 2009).

3.2 Measuring Perfectionism

Perfectionism is described as a unique and complex personality construct that is relational and paradoxical in nature, is experienced globally across countries and cultures, and can create a "problem in living" when striving for perfectionism becomes a burden (Flett & Hewitt, 2019). As such, perfectionism has been conceptualised as a multidimensional construct and is measured via self-reports as it is a construct that is defined by cognitions. The two most cited and oldest scales in the study of perfectionism are the Frost Multidimensional Perfectionism Scale (FMPS; Frost et al., 1990) and the Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS; Hewitt et al., 1991).

3.2.1 Frost Multidimensional Perfectionism Scale (FMPS)

The Frost Multidimensional Perfectionism Scale (FMPS; Frost et al., 1990) measures six components of perfectionism. Four dimensions (concern over mistakes, doubts about actions, personal standards and organisation) are directed towards the self, while the remaining two dimensions (parental expectations and parental criticism) relate to perceived parental demands on the self. Concern over mistakes relates to perfectionists being overly concerned about making mistakes such that even minor mistakes will lead to a perception of not meeting their standards and a fear of failure such that any imperfect performance will be deemed a failure or worthless. Doubts about actions refers to the perfectionists' feelings of uncertainty about a task being unsatisfactorily completed. Parental expectations and parental criticism refer to the value perfectionists place on their parents' high expectations and critical

evaluations of them to avoid the potential loss of parental acceptance and love. Personal standards refer to the excessive high standards for performance that perfectionists set for themselves. Organisation is used to characterise the perfectionists' tendency for accuracy, neatness, order and organisation. See Table 3.1 for brief definition of subscales.

The FMPS is one of the two most widely cited measures of perfectionism (Flett & Hewitt, 2019). The FMPS and its subscales were found to have good reliability and internal consistency, and perfectionism as measured by the FMPS was found to correlate with reported procrastination and compulsivity (Frost et al., 1990). The FMPS showed good discriminant group validity across nonpsychiatric groups and patients with depression, social anxiety disorder, panic disorder, agoraphobia and obsessive-compulsive disorder, anorexia (Bastiani et al., 1995; Wheeler et al., 2011). The FMPS was also found to have moderate to good test-retest stability (e.g., Rice & Dellwo, 2001; Gelabert et al., 2011). However, several criticisms of the FMPS exist. Several factor analyses suggested the FMPS likely comprises less than six factors with the most notable evidence provided by Stober (1998) suggesting concerns over mistakes and doubts about actions can be combined into one factor while parental criticism and parental expectations can be combined into another factor. Furthermore, there is no published norms for the FMPS. Despite these shortcomings, the FMPS has been translated into many languages, e.g., Spanish, Portuguese, Chinese, Polish, etc. and validation studies have reported good validity and reliability and continues to be widely used (Correia et al., 2017; Gavino et al., 2019; Liu et al., 2022; Piotrowski & Bojanowska, 2019).

Table 3.1

Definition of subscales of FMPS and HFMPS

Scale Subscale	Definition
Frost Multidimensional Perfectionism (FMPS)	
Concern over Mistakes	Overly concerned about making mistakes
Doubts about Actions	Feeling uncertain about a task being unsatisfactorily completed
Parental Criticism	Perceived critical evaluations by parents
Parental Expectation	Perceived high expectations from parents
Organisation	Tendency for accuracy, neatness, order and organization
Personal Standards	Set excessive standards for one's own performance
Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS)	
Self-oriented Perfectionism	Set excessive standards and evaluation of one's own performance and behaviours
Other-oriented Perfectionism	Set excessive standards and evaluation of others' performance and behaviours
Socially Prescribed Perfectionism	Belief that others set excessive standards for them and evaluate them against those standards

3.2.2 Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS)

The Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS; Hewitt & Flett, 1991) measures three dimensions of perfectionism that reflect both personal and interpersonal traits. The first dimension, self-oriented perfectionism, is directed inwardly at the self with the setting exacting standards for and strict evaluation of one's own performance and behaviours to avoid failures. The second dimension, other-oriented perfectionism, is directed outwardly through the setting of unrealistic standards for and the strict evaluation of others' performance and behaviours. The third dimension, socially prescribed perfectionism, refers to the belief or perception that significant others set unrealistic and exacting standards which they are strictly evaluated against, leading to a fear of negative evaluation and avoidance of disapproval by others. See Table 3.1 for brief definition of subscales.

The HFMPS, along with the FMPS, is the most commonly used measure in perfectionism research (Flett & Hewitt, 2019). The HFMPS and its subscales have adequate validity and reliability (Hewitt, 1991). Self-oriented perfectionism correlated with high self-standards, self-criticism, perseveration, overgeneralisation, and concerns over mistakes, personal standards and parental expectations subscales of the FMPS (Hewitt et al., 1991). Socially prescribed perfectionism correlated with self-punitiveness, parental expectations and parental criticism subscales of the FMPS (Hewitt et al., 1991). The HFMPS has also demonstrated moderate to good temporal stability (Cox & Enns', 2003; Hewitt et al., 1991; Maia et al., 2011). A key criticism of the HFMPS relates to negatively worded items designed to minimise response biases (mainly in the others-oriented perfectionism subscale) but can cause additional variance in its factor structure and lower internal consistency compared to the other two subscales with lower number of negatively worded items (Cox et al., 2022; De Cuyper et al., 2015; Hewitt & Flett, 1991). However, when a method factor that considers negatively worded items was included, a three-factor structure was confirmed (De Cyuper et al., 2015). To date, the HFMPS has also been translated into several languages, e.g., Dutch, Spanish, Chinese, German, etc. with good validity and reliability and continues to be widely used in research (De Cuyper et al., 2015; Hewitt & Flett, n.d.; Rodriguez-Campayo et al., 2009; Yang et al., 2023).

3.3 The Debate between Clinical Perfectionism and Multidimensional Perfectionism

The multidimensional construct of perfectionism has been criticised by Shafran et al. (2002) for being too broad and lacking clinical utility. The authors pointed out that the multidimensional measures of perfectionism, as captured by the FMPS and the HFMPS, exceed the characteristics of perfectionism as described by clinicians and early theorists. For example, items relating to the negative reactions to and effects on other people when making mistakes (e.g., "other people will think less of me if I make a mistake", "I should be upset if I

make a mistake") assess variables related to perfectionism but do not assess the perfectionism construct itself (Shafran et al., 2002). Moreover, while the multidimensional scales work well in mapping personality traits and are useful in descriptive research, they do not provide specific treatment targets and lack clinical utility (Shafran et al., 2002). The authors then introduced clinical perfectionism as a cognitive-behavioural definition of perfectionism that emphasises the overreliance of self-evaluation as the key feature of perfectionism with identifiable and specific treatment targets.

On the other hand, proponents of the multidimensional construct of perfectionism argued that clinical perfectionism is self-focused and unidimensional and has failed to consider the rumination about failure to attain perfectionism, and the incorporation of interpersonal facets of perfectionism increases the understanding of perfectionism and has significant clinical value (Hewitt et al., 2003). Further criticism of Shafran et al. (2002)'s conceptualisation of clinical perfectionism (e.g., Dunkley et al., 2006) that personal standards were maladaptive had been disputed by Egan et al. (2011) who stated that striving for excellence in itself is not maladaptive but becomes maladaptive when one's sense of self-worth is based on attaining those unrealistic standards.

For the purpose of this thesis, which is in line with existing research in sleep and perfectionism, the multidimensional measures of perfectionism were used to understand the drivers of perfectionism, and the effects of clinical perfectionism were considered when exploring clinical implications.

3.4 State vs Trait Perfectionism

Perfectionism is conceived to have dynamic state-like variations in addition to its traditional conceptualisation as a stable trait or personality disposition (Flett & Hewitt, 2002a; Stoeber, 2018). As a state-dependent cognitive affective construct, the level of perfectionism expressed by an individual can fluctuate and change beyond trait-level

perfectionism and is dependent on contextual or situational cues and interpersonal interactions (Boone & Soenens, 2015; Boone, Soenens, Vansteenkiste, et al., 2012; Cattell & Kline, 1977; Flett & Hewitt, 2002a; Saboonchi & Lundh, 2010; Ståhlberg et al., 2020; Vecchione & Marsicano, 2023). This conceptualisation is supported by research findings of day-to-day and week-to-week fluctuations in different components of perfectionism, including perfectionistic cognitions, perfectionistic concerns, perfectionistic strivings and perfectionistic self-presentations (Boone & Soenens, 2015; Boone, Soenens, Vansteenkiste, et al., 2012; Mackinnon et al., 2014; Mackinnon et al., 2017; Mackinnon et al., 2019). Furthermore, such state-like perfectionism fluctuations can predict and are associated with social anxiety, psychological distress, perceived stress, subjective well-being, alcohol-related problems, binge eating behaviours and eating disorder symptoms (Boone & Soenens, 2015; Boone, Soenens, Vansteenkiste, et al., 2012; Mackinnon et al., 2014; Mackinnon et al., 2017; Mackinnon et al., 2019; Merwin et al., 2022; Molnar et al., 2023). Research has also shown that higher perfectionism levels can be induced in adults when they are explicitly instructed to set and strive for high standards for the next 24 hours (Boone & Soenens, 2015; Boone, Soenens, Vansteenkiste, et al., 2012; Jean et al., 2025). Additionally, levels of clinical perfectionism, defined as dysfunctional self-evaluation that is dependent on striving for excessive high standards despite adverse consequences, can be significantly and reliably reduced through psychological interventions (Galloway et al., 2022; Ip, 2025; Shafran et al., 2002; Suh et al., 2019; Wegerer, 2024). Together, these findings support the concept that perfectionism levels can vary and be changed, and perfectionism has dynamic state-like situational features in addition to its stable trait-like personality disposition.

3.5 Consequences of Perfectionism

Perfectionism is considered a personality trait that is closely related to mental health (Shafran et al., 2002; Simon et al., 2025). Two superordinate factors, perfectionistic strivings

and perfectionistic concerns, can be formed by combining various facets of multidimensional perfectionism (Frost et al., 1993; Stoeber & Gaudreau, 2017; Stoeber & Otto, 2006). Perfectionistic strivings reflect self-directed striving for perfection and excellence and is made up of perfectionism dimensions of high personal standards, organization, self-oriented perfectionism and other-oriented perfectionism and were previously conceptualised to be an adaptive and positive influence (Frost et al., 1993; Stoeber & Gaudreau, 2017; Stoeber & Otto, 2006). However, the model of clinical perfectionism proposes that when one's self-worth is tied to meeting and striving for high standards, perfectionistic strivings can become maladaptive and a clinical problem (Egan et al., 2011).

Perfectionistic concerns reflect fear of making mistakes, critical self-evaluation and worry about judgement by others; and comprise of perfectionism dimensions of concerns over mistakes, doubts about actions, parental expectations, parental criticism, socially prescribed perfectionism, perception of actual performance failing to meet one's high standards and reacting negatively to imperfections (Frost et al., 1993; Stoeber & Gaudreau, 2017; Stoeber & Otto, 2006). Further research in perfectionism suggests that when perfectionism is distinguished from excellencism, perfectionism is unnecessary and/or harmful because it was not associated with any positive outcomes or lower risks of negative outcomes and was negatively associated with academic achievement (Gaudrea et al., 2022). The remaining of this chapter will focus on the consequences of clinical perfectionism, which refers to unrelenting or overdependent self-evaluation against standards that are self-determined and excessive despite adverse outcomes (Shafran et al., 2002).

3.5.1 Adverse Behavioural, Emotional and Social Consequences

Driven by the fear of imperfection and failure, adverse behaviours associated with perfectionism include excessive commitment manifesting as making lists, checking and rechecking, avoidance of difficult tasks and procrastination (Goswami & Baksi, 2025; Rice et

al., 2012; Riley & Shafran, 2005). Being overly concerned about being perfect and needing to maintain order and control also results in cognitive biases leading to inflexibility, a lack of openness and inefficiency in task completion due to excessive rigidity and arbitrary standards that focus on rules and unimportant details (Egan et al., 2014). In fact, perfectionism serves as a risk factor for school burnout, perceived employment stress, inaction, procrastination and bedtime procrastination behaviours (Jiang & Jiang, 2025; Nguyen & Morris, 2024; Sirois et al., 2017; Zhang et al., 2025).

Perfectionism can also affect social and emotional responses with grave risks. A positive association was found between perfectionism and loneliness, suggesting a propensity to sacrifice social relationships and community engagements in the pursuit of perfection and goals (Chen, 2024; Pétrin-Pomerleau, 2025). Such pursuits may hinder genuine connections and lead to low social support, frustrations arising from social disconnection and the need for relatedness (Chen et al., 2024; Pétrin-Pomerleau et al., 2025). Individuals with high clinical perfectionism were also found have rigid responses to their perfectionistic thoughts such that they tend to avoid uncomfortable emotions and disengage in actions that are consistent with their values, which leads to lower wellbeing and higher distress (Nguyen & Morris, 2024). Maladaptive perfectionistic behaviours, cognitions and emotional responses coupled with self-criticism can adversely affect mental and physical health to cause sleep problems, fatigue, anxiety and depression (Goswami & Baksi, 2025).

The resulting psychological distress associated with high levels of perfectionism can be so severe that suicide may be contemplated or attempted as an option to escape the unbearable life by individuals with high perfectionism (Baumeister, 1990; M. M. Smith et al., 2018). A meta-analysis identified perfectionism as a personality trait of individuals susceptible to suicide ideation and attempts, and highlighted that even perfectionistic striving, which was previously considered adaptive, is associated with suicide ideation (M. M. Smith

et al., 2018). Another systematic review identified non-suicidal self-injury and perfectionism to be positively related and serious risk factors for suicide ideation and behaviour (Gyori & Balazs, 2021). These findings have led to calls for perfectionism to be the focus of suicide assessment, intervention and prevention (Flett & Heald, 2024; Gyori & Balazs, 2021).

3.5.2 Perfectionism as another Transdiagnostic Risk Factor

When considering mental health disorders, a transdiagnostic process is defined as attention, memory, reasoning, thought and/or behaviour that acts as a mechanism to trigger and maintain multiple mental health disorders (Harvey et al., 2004). Perfectionism meets the definition of a transdiagnostic process because it is associated with and/or a common a risk factor across affective disorders, anxiety disorders, eating disorders and obsessive-compulsive disorder; contributes to comorbidity and is related to psychopathological behaviours and outcomes, such as non-suicidal self-harm, suicide ideation and psychological distress (Callaghan et al., 2024; Egan et al., 2011; Gyori & Balazs, 2021; Limburg et al., 2017; Lunn et al., 2023; M. M. Smith et al., 2018). As highlighted in the previous chapter, poor sleep is identified as another transdiagnostic factor for mental health disorders (Harvey, 2008). Described as the intersection where personality meets psychopathology, transdiagnostic processes are highly relevant in case assessment and conceptualization, and comorbidity clarification, which can facilitate and improve treatment (Rodriguez-Seijas et al., 2015). Consequently, the study of transdiagnostic processes of sleep and perfectionism may have important implications for clinical practice. In the next chapter, the role that perfectionism may play in sleep will be explore.

Chapter 4

Sleep and Perfectionism

"But I have promises to keep, and miles to go before I sleep, and miles to go before I sleep."

-Robert Frost-

Perfectionism was first hypothesised to be a predisposing and maintaining factor in the development of insomnia by Lundh et al. (1994), who observed insomnia patients tend to have excessive levels of perfectionism in the form of elevated personal standards and perfectionistic attitudes. Their hypothesis was supported with initial evidence that found Concerns over Mistakes, Doubts about Actions and Personal Standards, which are subscales from the FMPS, to correlate with sleeping problems in a control sample and significantly higher perfectionism levels in a clinical sample with insomnia disorder compared to a normal sample. Since then, several theoretical models of insomnia that consider perfectionism as a risk factor for poor sleep have been proposed. These will be briefly discussed next.

4.1 Theoretical Background

4.1.1 Interaction between Sleep-Interfering and Sleep-Interpreting Processes in Insomnia

In the integrative model of insomnia, which theorised insomnia as an interaction between two psychological processes in sleep-interfering and sleep-interpreting, perfectionism was included as a possible risk factor (Lundh & Broman, 2000). It is argued that because the diagnosis of insomnia relies on subjective reporting of negative daytime consequences of poor sleep leading to significant impairment, individuals with high personal standards may be less tolerant of the negative impact of bad sleep. As such, they have a lower threshold for daytime dysfunction and significant impairment to define their sleep as

insufficient and meet the diagnostic threshold of insomnia. Therefore, personal standards may have an important role in appraising daytime functioning and sleep.

The authors postulated that individuals with high levels of perfectionism can become overly concerned about adverse daytime effects of tiredness, poor mood and impaired performance in the sleep-interpreting process when experiencing common transient sleeping problems brought about by life stressors. Furthermore, when perfectionistic standards co-exist with worries about sleeplessness, such worries drive negative sleep expectations and frustrations about sleep difficulties, which becoming cognitively and emotionally arousing to objectively interfere with sleep and perpetuate sleep problems (Lundh et al., 1991). The authors also suggested that individuals with high perfectionism levels also tend to push themselves when fatigued and that can disrupt rhythms of activity and rest to interfere with sleep. Therefore, perfectionism may contribute to poor sleep progressing to chronic insomnia by influencing both sleep-interpreting and sleep-interfering processes in the development of insomnia.

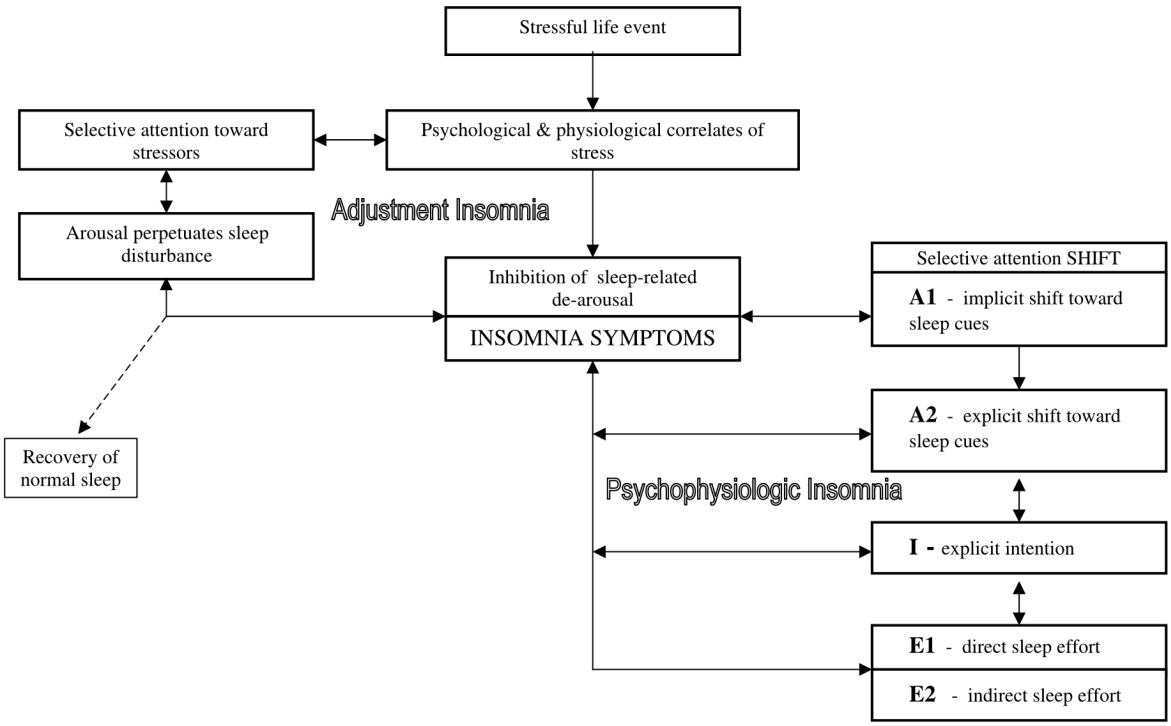
4.1.2 Attention-Intention Effort (AIE) Pathway

In the attention-intention-effort pathway (AIE) model of insomnia, Espie et al. (2006) suggested that sleep is a passive and automatic process and insomnia develops when the automaticity of sleep normalcy is disrupted through a failure to de-arouse. The inhibition of the sleep-wake automaticity occurs when individuals selectively attend to sleep, explicitly intend to sleep and actively engage in sleep effort, see Figure 4.1. When sleep is disrupted and/or perceived to be inadequate, the distress from sleeplessness and craving for sleep may lead to an abnormally high preoccupation with sleep and pre-sleep worries, rumination and attention bias towards sleep cues, which cause pre-sleep arousal that disrupt the automatic process of sleep. The attentional focus on sleep and sleeplessness then lead to sleep intention and engagement of sleep effort, further inhibiting normal sleep automaticity (Espie et al.,

2006). In line with this model, the authors' early works found paradoxical intention therapy, i.e., "give up trying to sleep" or "try to remain awake" effective in treating insomnia (Espie et al., 2006). However, it was ineffective for individuals who became anxious about their sleep performance and adherence to therapeutic demands. They drew parallels of this finding to Lundh et al. (1994)'s theoretical suggestion that perfectionism is a predisposing vulnerability factor for insomnia. Together, these theories suggest that insomnia can develop from the disruption to sleep normalcy and may be exacerbated by perfectionistic tendency focusing on sleep performance.

Figure 4.1

Proposed evolution of insomnia following the Attention-Intention-Effort pathway (Espie et al., 2006)



4.1.3 Hyperarousal Model

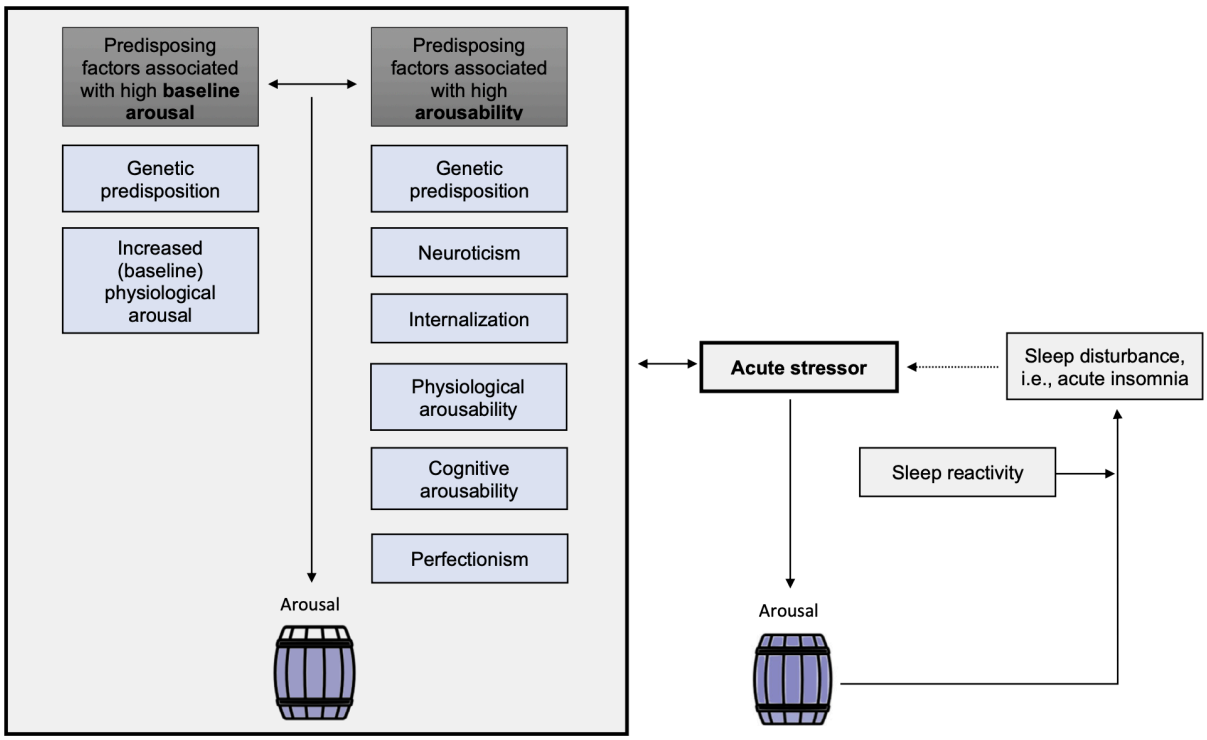
In the hyperarousal model of insomnia by Riemann et al. (2010), insomnia is conceptualised as a psychobiological disorder as indicated by neuroendocrine,

neuroimmunological, electro and neurophysiological, structural and functional changes in the brain. The authors emphasized that there are cortical and physiological levels of hyperarousal in addition to cognitive and emotional hyperarousal as previously presented in cognitive models of insomnia, such as the AIE pathway by Espie et al. (2006) (discussed above); and adding to the neurocognitive perspective of psychophysiological insomnia by Perlis et al. (1997). Perlis et al. (1997) proposed that physiological cortical arousals induced during transient insomnia from worry and/or rumination induced by stress can turn chronic via classical conditioning and that such physiological hyperarousal experienced during sleep onset and sleep-wake transitions can explain sleep-wake state discrepancy experienced in insomnia. Hyperarousal has also been identified as a state marker and a predisposing factor of insomnia and part of pathophysiological processes that leads to insomnia symptoms in a review of hyperarousal in insomnia (Dressle & Riemann, 2023, see Figure 4.2).

On the basis that perfectionism was associated with increased physiological arousal levels, it has been identified as a contributing risk factor in various hyperarousal models of insomnia (Besser et al., 2008). In a review of personality traits in insomnia, van de Laar et al. (2010) found individuals with insomnia tend to display traits of perfectionism. The authors suggested that when facing “failure to sleep”, perfectionistic individuals exert excessive effort in initiating sleep, which inadvertently causes increased physiological arousal that prevents sleep onset in a vicious cycle leading to chronic insomnia. Dressle and Riemann (2023) postulated that while those vulnerable to insomnia tend to have a higher baseline level of arousal, perfectionism exacerbates that vulnerability because their stress response operate at a higher level of cognitive-emotional and physiological arousals that boost their baseline arousal level. When confronted with acute stressor and sleep disturbance, their stress response in the form of sleep reactivity becomes another stressor that is dysfunctionally processed at high arousal levels and leads to chronic hyperarousal and insomnia.

Figure 4.2

The role of hyperarousal in predisposition to insomnia (Dressle & Riemann, 2023)



4.1.4 Summary of Theoretical Background

Based on the above theoretical considerations, perfectionism has been identified as a predisposing vulnerability in insomnia. Perfectionism has been theorised to contribute to the adverse interaction of sleep-interpreting and sleep-interfering processes by causing excessive concerns about transient sleeping problems, disrupting the automaticity and normalcy of the passive sleep process through focused attention, intention and effort in sleep and exacerbating hyperarousal, all of which can contribute to the development of chronic insomnia. However, the mechanisms of how perfectionism contributes to insomnia development have not yet been fully elucidated. As such, perfectionism continues to be a personality variable relevant to sleep and insomnia research.

4.2 Review of Existing Literature

This section will focus on reviewing some existing studies that had explored the relationships between perfectionism and sleep since Lundh et al. (1994)'s identification of perfectionism as a potential risk factor for insomnia.

4.2.1 Subjective Sleep and Perfectionism

Initial evidence of the relationship between sleep and perfectionism was found by Lundh et al. (1994). In their study of 383 adults, Concerns over Mistakes and Doubts about Actions were positively correlated to self-reported sleeping problems (e.g., difficulties initiating or maintaining sleep, wake after sleep onset, etc.) and their study of 70 insomnia patients demonstrated higher perfectionism levels compared to control participants. Since then, the evidence is largely consistent in identifying specific dimensions of perfectionism to be associated with self-reported markers of poor sleep. In a large sample of 1163 undergraduates, Azevedo et al. (2009) showed Socially Prescribed Perfectionism to be the only dimension from the Hewitt Flett Multi-Perfectionism Scale to be positively correlated to difficulties in sleep initiation and maintenance and sleep disturbance. In the female subsample, a small positive correlation was observed between Self-Oriented Perfectionism and difficulties in sleep initiation and maintenance and sleep disturbances. In contrast, Self-Oriented Perfectionism was reported to be associated with good sleep quality in another large study of 335 university students and 296 community adults (Molnar et al., 2020). In the same study, Molnar et al. (2020) confirmed Socially Prescribed Perfectionism to be associated with poor sleep quality, which was consistent with Azevedo et al. (2009)'s finding.

In a study comparing 32 adults with insomnia and 26 controls, Vincent and Walker (2000) found the clinical insomnia group to score higher in Concerns over Mistakes, Doubts about Actions and Parental Criticism compared to the controls. The insomnia group also demonstrated positive association between Parental Criticism and sleep onset latency.

However, there were no differences between groups on perfectionism scores using the Hewitt-Flett Multidimensional Perfectionism Scale, nor were there any significant correlations between those perfectionism measures from the Hewitt-Flett Multidimensional Perfectionism Scale and sleep measures. Relatedly, correlations between Concerns over Mistakes and Doubts about Actions and poor sleep as measured by the Insomnia Severity Index was also reported in a study of 256 patients with tinnitus (Andersson et al., 2005). Together, existing research findings have consistently identified Concerns over Mistakes, Doubts about Actions and Socially Prescribed Perfectionism to be related to self-reported subjective markers of poor sleep. The evidence for Self-Oriented Perfectionism and Parental Criticism, on the other hand, appears to be less consistent.

Longitudinal studies also provided evidence to support the relationships between perfectionism and poor sleep. In a study of 870 university students, those with insomnia reported a higher level of Socially Prescribed Perfectionism at baseline, and Socially Prescribed Perfectionism at baseline predicted difficulties in sleep initiation and maintenance over a two-year period (Azevedo et al., 2010). In a similar study of 870 university students, consistent, modest and significant correlations between Socially Prescribed Perfectionism and difficulties initiating and maintaining sleep and sleep disturbances were found over a two-year study period (Maia et al., 2011). Compared to the consistent patterns found between Socially Prescribed Perfectionism, a less consistent pattern with small correlations between Self-Oriented Perfectionism and these sleep measures were also reported in the same study. Another study involving 819 community adults studied over a three-month period revealed Concerns over Mistakes, Doubts about Actions, Parental Criticisms and Parental Expectations were positively associated with current and future insomnia symptoms (Lombardo et al., 2013). Bidirectional predictive relationships between Socially Prescribed Perfectionism and insomnia had also been reported in a sample of 434 adolescents over a

two-year period (Richardson et al., 2024). Together, the evidence suggests perfectionism can be predictive of sleep disturbances over time.

4.2.2 Objective Sleep and Perfectionism

To date, there has been one study that has utilized objective sleep measure in the study of the relationships between sleep and perfectionism. Johann et al. (2017) studied 334 attendees at a sleep laboratory for two consecutive nights using polysomnography. The authors found significant associations between Concern over Mistakes and Personal Standards and nocturnal awakenings, Concern over Mistakes and arousal index (i.e., number of arousals per hour), and Personal Standards and wake after sleep onset. However, these associations were reported only on the first night but not on the second night of study. Consequently, the authors concluded that perfectionism may predispose individuals to sleep disturbances when facing acute stressors, further adding evidence to support perfectionism as a predisposing factor for poor sleep and insomnia, catalysed by stress.

4.2.3 Mediating Factors in the Relationships between Sleep and Perfectionism

Despite the clear relationships between perfectionism and insomnia symptoms, research suggests that those associations operate through other affective and cognitive factors. In a 12-month study involving 1936 adult participants from the general population, Jansson-Frojmark and Linton (2007) identified Concern over Mistakes to be significantly associated to pre-existing and future insomnia, but those relationships were mediated by emotional distress. In another study, significant associations between Concern over Mistakes and Doubts about Actions, Parental Expectations and Criticisms, and Personal Standards with markers of poor sleep (e.g., sleep onset latency, sleep disturbances, awakenings after sleep onset) were found to be mediated by stress, poor coping and emotion regulation (Brand et al., 2015). Similarly, Akram et al. (2015) reported that depression and anxiety mediated the positive associations between Doubts about Action and Parental Criticisms with insomnia; and while baseline

insomnia predicted future Doubts about Action, that relationship also attenuated to non-significance after controlling for baseline anxiety and current insomnia. When comparing 39 patients with insomnia and 39 controls, Akram et al. (2017) also found that anxiety mediated the relationship between Concern over Mistakes and Doubts about Action with insomnia between the groups. Likewise, the associations between perfectionism and poor sleep were replicated in adolescent samples, but mediated by vulnerability to stress, worry and rumination (Lin et al., 2017; Richardson & Gradisar, 2020).

Other factors appear to also affect the relationship between perfectionism and sleep. Akram et al. (2020) found that the positive associations and predictions of insomnia by Doubts about Actions, Parental Criticism and Parental Expectations were explained by anxiety and dysfunctional beliefs in a large study involving 624 community adults and university students. Similarly, counterfactual processing played a mediating role in the positive associations with and predictions of insomnia severity by Concerns over Mistakes, Doubts about Action and Organisation in a study of 180 university students (Schmidt et al., 2018). In a study of 853 cancer patients, arousability was identified as a mediating factor in the positive association between Parental Criticism and insomnia (Trudel-Fitzgerald et al., 2017). Taken together, these findings suggest that perfectionism may affect sleep through the effects of other affective and cognitive factors.

4.2.4 Gaps in the Literature

Since Lundh et al. (1994) first identified perfectionism to be a risk factor for insomnia, research has been limited and is methodologically heterogeneous. Firstly, only a few studies used both the Frost Multidimensional Perfectionism Scale and the Hewitt-Flett Multidimensional Perfectionism Scale (see Akram et al., 2015; Akram et al., 2017; Vincent & Walker, 2000). Even though both scales are closely related and there is considerable overlap between the two scales, they bring across distinct features of perfectionism: the Frost

Multidimensional Perfectionism Scale focuses more on self-criticisms and self-evaluation while the Hewitt-Flett Multidimensional Perfectionism Scale focuses on interpersonal expectations (Frost et al., 1993; Frost et al., 1990; Hewitt & Flett, 1991). Therefore, using both scales to study the relationships between perfectionism and sleep may be more insightful than relying on only one of them.

Secondly, all studies except for the polysomnography study conducted in-laboratory by Johann et al. (2017), relied on self-reported subjective measures of sleep. This is because insomnia diagnosis relies on the patients' self-assessment of their own sleep according to the DSM-5-TR (American Psychiatric Association, 2022). Therefore, how perfectionism affects sleep that is objectively measured in the individual's natural environment has not yet been investigated. This is despite research showing that individuals with insomnia tend to perceive their sleep to be worse compared to objective measures of sleep, a phenomenon often referred to as sleep misperception or more recently as sleep-wake state discrepancy (Bensen-Boakes et al., 2022; Fernandez-Mendoza et al., 2011; Harvey & Tang, 2012). Whether perfectionism affects sleep beyond one's self-perception to relate to objective physiological and sleep measures remains unknown. It is unclear if perfectionism affects only the perception of sleep or whether it also affects other physiological and physical markers of poor sleep. It is also unknown if and how perfectionism contributes to the progression from poor sleep perception to poor objective sleep markers.

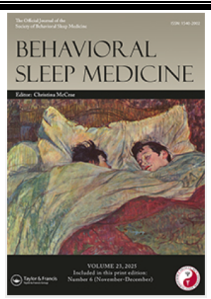
Thirdly, it remains unclear if perfectionism plays a role in sleep-wake discrepancy in insomnia due to limited inclusion of both objective and subjective sleep measures. Therefore, the study of the potential relationships between perfectionism and both objectively and subjectively measured sleep may provide further insights into how perfectionism predisposes individuals to sleep problems.

Fourthly, existing research into the relationship between perfectionism and poor sleep has been based on mean levels of sleep parameters and not at the intraindividual variability basis to account for night-to-night fluctuations. Research has shown that intraindividual variability in sleep can impact on how sleep is experienced to affect the perception of sleep and insomnia severity (Bei et al., 2016; Bredeli et al., 2022; Morin & Espie, 2007). Conceived as a cognitive-affective construct, perfectionism can also fluctuate dynamically from day-to-day or week-to-week and change over time in addition to its trait-like stability (Boone, Soenens, Mouratidis, et al., 2012; Mackinnon et al., 2019; Ståhlberg et al., 2020; Vecchione & Marsicano, 2023). Yet to date, no study has investigated potential day-to-day fluctuations in the relationships between perfectionism and sleep. As such, research is possibly missing out on identifying nuanced patterns that may provide insights into whether and how perfectionism can act as a risk factor for sleep problems on an intraindividual basis or in reverse, whether and how daily sleep can influence fluctuations in perfectionism (Bei et al., 2016; Bredeli et al., 2022).

PART II

Chapter 5

Study 1 - Perfect Enough to Sleep? Perfectionism and Actigraphy-Determined Markers of Insomnia



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Perfect Enough to Sleep? Perfectionism and Actigraphy-Determined Markers of Insomnia

Susie Y. Oh [a,b], Hailey Meaklim [a,c], Christian L. Nicholas [a], David Cunnington [d], Maya Schenker [a], Cameron J. Patrick [e], Daniel Windred [b], and Lisa J. Phillips [a]

This chapter contains an original research article which was published in *Behavioral Sleep Medicine* on 24 May 2024 and has been formatted to conform with the format of this thesis. The references cited in this manuscript can be found at the end of this chapter. Abbreviations used in this chapter are introduced again in line with the accepted manuscript. Supplementary tables, figures and material are included in appendix A.

5.1 Abstract

Objectives: Perfectionism is an important factor in insomnia development and maintenance. Previous studies exploring the relationship between perfectionism and insomnia have predominantly relied on self-reported sleep measures. Therefore, this study sought to assess whether actigraphy-measured sleep parameters were associated with perfectionism using actigraphy-derived sleep parameters. **Methods:** Sixty adults (85% females, mean age 30.18 ± 11.01 years) were sampled from the Australian general population. Actigraphy-derived objective sleep measures, subjective sleep diary measures, the Frost Multidimensional Perfectionism Scale (FMPS) and Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS) were collected. **Results:** High perfectionism levels were associated with poor sleep, but these relationships differed between objective and subjective measures. Perfectionism via FMPS-total, subscales of Concern over Mistakes, Doubts about Actions, Personal Standards and Self-oriented Perfectionism correlated with subjective sleep onset latency and sleep efficiency with moderate effects (*r = .26 to .88*). In contrast, perfectionism via HFMPS subscales of Socially Prescribed Perfectionism and Parental Expectations predicted objective sleep onset latency and sleep efficiency. Additionally, stress mediated the relationships between objective sleep efficiency and Concern over Mistakes and Doubts about Actions. **Conclusions:** Perfectionism demonstrated stronger associations with subjective than objective sleep measures. Higher Parental Expectations and Socially Prescribed Perfectionism may increase one's vulnerability to objectively measured poor sleep. Therefore, perfectionism may be important in preventing and treating insomnia.

Keywords: perfectionism, insomnia, sleep, actigraphy, sleep health

5.2 Introduction

Insomnia is a prevalent and significant sleep disorder. Insomnia and inadequate sleep affect almost 15% and 45% of Australians respectively (Adams et al., 2016; Appleton et al., 2022). Sleep problems can affect mood, memory, energy level and general wellbeing, leading to increased use of healthcare services, higher personal and economic costs (Attard et al., 2019; Bin et al., 2012; Deloitte Access Economics, 2017). Insomnia symptoms include difficulty initiating and/or maintaining sleep, and/or early morning awakening despite adequate sleep opportunity. Insomnia symptoms are listed as a diagnostic criterion for a variety of disorders (e.g., depression, post-traumatic stress disorder) in the Diagnostic and Statistical Manual of Mental Disorders; however, insomnia can also be classified as a sleep-wake disorder in its own right (American Psychiatric Association, 2022). Furthermore, insomnia is identified as a transdiagnostic factor in mental health given its bidirectional relationship and high comorbidity with disorders (*e.g.*, depression, anxiety, bipolar disorder, alcohol use disorder, posttraumatic stress disorder, schizophrenia and psychosis), contributing to their onset, maintenance and relapse (Dolsen et al., 2014; Harvey, 2008; Hertenstein et al., 2019).

Perfectionism is an important factor in various etiological models of insomnia that propose cognitive, emotional and physiological arousals disrupt the automatic process of sleep onset (Espie et al., 2006; Harvey, 2002; Harvey et al., 2014; Riemann et al., 2010; van de Laar et al., 2010). Perfectionism, a multidimensional construct defined by excessive high standards and self-criticism, is commonly measured by the Frost Multidimensional Perfectionism Scale (FMPS, Frost et al., 1990) and/or the Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS, Hewitt & Flett, 1991). The FMPS measures six dimensions of perfectionism: Concern over Mistakes (reacting negatively to and viewing mistakes as failures), Doubts about Actions (doubting one's own performance), Parental Expectations

(perceiving parents as setting very high goals), Parental Criticism (perceiving parents as being highly critical), Personal Standards (setting high standards for self-evaluation) and Organisation (preferring order and organisation). The HFMPS measures three dimensions of perfectionism: Self-oriented Perfectionism (setting high standards for oneself), Socially Prescribed Perfectionism (perceiving others set high standards for oneself), and Other-oriented Perfectionism (setting high standards for others).

Evidence for cross-sectional and longitudinal relationships between insomnia and dimensions of perfectionism is presented in Table 5.1. Notably, there is a paucity of research in this area in Australia. Lundh et al. (1994) found that Concern over Mistakes, Doubts about Actions and Personal Standards were higher in patients with insomnia and were positively correlated with sleep problems in a general population sample. The authors theorised that perfectionism amplifies the negative mood and performance worries caused by common negative life events, which increases the risk of transient sleep problems. The impact of transient sleep problems on daytime performance subsequently becomes another source of worry. Subsequent rumination then drives dysfunctional sleep beliefs and perpetuates sleep initiation and maintenance difficulties in a vicious cycle that often results in chronic insomnia (Lundh & Broman, 2000). As a transdiagnostic process in the development and maintenance of psychopathology, treating perfectionism may be clinically relevant to improving the efficacy of cognitive-behavioural therapy for insomnia (CBT-I) in individuals who have insomnia and are highly perfectionistic (Akram et al., 2023; Egan et al., 2011; Johann et al., 2018; Limburg et al., 2017; Rodriguez-Seijas et al., 2015). Perfectionism may therefore play an important role in the sleep interpretation process relevant to both insomnia development and treatment. Furthermore, this relationship may be mediated by factors such as depression and/or anxiety, arousability, stress perception, emotional regulation and counterfactual thoughts (see Table 5.1).

Table 5.1

Overview of studies examining perfectionism and insomnia and/or sleep difficulties using subjective sleep measures

Study	Sample	Scale Used	Key Findings
Akram et al. (2020)	624 community adults and students in the United Kingdom	FMPS	DA, PC and PE: Positive association with and predict insomnia but mediated by anxiety and dysfunctional beliefs. O: Negative association and predicts insomnia.
Akram et al. (2017)	39 adults with insomnia and 39 normal sleepers in the United Kingdom	FMPS HFMPS	CM and DA: Insomnia group score higher than normal sleepers. Predict insomnia but mediated by anxiety. PC: Insomnia group score higher than normal sleepers. Predict insomnia, but partially mediated by anxiety.
Akram et al. (2015)	76 community adults in the United Kingdom	FMPS HFMPS	DA and PC: Positive association with insomnia but mediated by depression and anxiety. Baseline insomnia predicts future DA but mediated by baseline anxiety and current insomnia. Baseline insomnia predicts future PC.
Andersson et al. (2005)	256 tinnitus patients in Sweden	FMPS	CM and PC: Positive association with ISI.
Azevedo et al. (2010)	870 university students in Portugal	HFMPS	SPP: Insomnia group score higher than good sleepers group score at T1 and T2. Baseline SPP predicts difficulties initiating sleep and difficulties maintaining sleep at T1 and T2.
Azevedo et al. (2009)	1163 university students in Portugal	HFMPS	HFMPS, SOP and SPP: Positive association with difficulties initiating sleep, difficulties maintaining sleep and sleep disturbance index.
Brand et al. (2015)	346 university students in Switzerland	FMPS	CM: Positive association with ISI, SOL and NOA but mediated by stress and emotional regulation. DA and PS: Positive association with ISI and NOA but mediated by stress and emotional regulation.
Jansson-Frojmark & Linton (2007)	1936 community adults in Sweden	FMPS: CM and PS only	CM: Positive association with pre-existing insomnia and future insomnia but mediated by emotional distress.
Lombardo et al. (2013)	819 community adults in Italy	FMPS	CM, DA, PC and O: Positive association with current and future insomnia.
Lundh et al. (1994)	383 community adults and 70 insomnia patients in Sweden	FMPS: Only CM, DA and PS	CM and DA: Positive association with sleeping problems.
Maiai et al. (2011)	870 university students in Portugal	HFMPS	SOP: Inconsistent pattern found with small correlations. SPP: Positive association with difficulties initiating sleep and difficulties maintaining sleep across T1, T2 and T3.
Molnar et al. (2020)	335 university students in Canada 296 community adults in America	HFMPS	SOP: Positive associations with good sleep quality. SPP: Positive association with poor sleep quality.
Rirchardson & Gradisar (2020)	281 adolescents in Australia	Child Adolescent Perfectionism Scale	SOP: Positive association with insomnia but mediated by vulnerability to stress. SPP: Positive association with insomnia.
Schmidt et al. (2018)	180 university students in Switzerland	FMPS	CM and DA: Positive association with and predict insomnia severity but mediated by counterfactual processing. O: Negative association with and predicts insomnia severity but mediated by counterfactual processing.
Trudel-Fitzgerald et al. (2017)	853 cancer patients in Canada	FMPS	CM and DA: Positive association with insomnia in men. PC: Positive association with insomnia in women and men but mediated by arousability.
Vincent & Walker (2000)	32 community adults with insomnia and 26 as healthy controls in Canada	FMPS HFMPS	CM and DA: Clinical group score higher than healthy control group score. PC: Clinical group score higher than healthy control group score. Positive association with SOL in clinical group. PC: Positive association with sleep quality in healthy control group.

Notes. ISI, Insomnia Severity Index; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; FMPS, Frost Multidimensional Perfectionism Scale; CM, Concern over Mistakes; DA, Doubts about Actions; PE, Parental Expectations; PC, Parental Criticism; O, Organisation; PS, Personal Standards; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; SOP, Self-oriented Perfectionism; OOP, Other-oriented Perfectionism; SPP, Socially Prescribed Perfectionism.

Most studies examining the relationship between perfectionism and insomnia rely on self-reported sleep measures. Notable exceptions include three studies that assessed perfectionism and insomnia measures using polysomnography. Using punctuality as a proxy for perfectionism in a sample of clinical patients, (Spiegelhalder et al., 2012) found shorter total sleep time, lower sleep efficiency and higher wake after sleep onset were associated with arriving early at a sleep laboratory. (Johann et al., 2017) found significant associations between perfectionism (e.g., FMPS-total, Concern over Mistakes and Personal Standards) and markers of poor sleep (e.g., nocturnal awakenings, arousal index; and wake after sleep onset) in the first but not second sleep laboratory night in a sample of clinical patients. The authors explained the unpleasantness of spending the first night in a sleep laboratory as an acute stressor, and suggested perfectionistic individuals may be predisposed to developing insomnia when facing acute stressors. In contrast, a recent study by Johann et al. (2023) found FMPS-total, Concern over Mistakes and Personal Standards to be negatively associated with wake after sleep onset while total sleep time and sleep efficiency were positively associated with Personal Standards. These findings indicate that perfectionism may play a role in the aetiology of objectively measured sleep disturbances, but further investigation with objective sleep measures is required.

Actigraphy allows for the estimation of sleep in participants' natural sleep environment for extended periods of time and is an economical alternative to polysomnography (Martin & Hakim, 2011). Actigraphy-derived longitudinal objective sleep measures may aid in understanding of the relationship between perfectionism and parameters of insomnia and sleep continuity, and may have clinical implications since actigraphy is recommended for insomnia monitoring and treatment evaluation (Akram, 2018; Liguori et al., 2023; M. T. Smith et al., 2018). It is currently unknown whether it is the perception of poor sleep or actual physiological and physical markers of poor sleep that are related to perfectionism. It is

also unknown if and how the perception of poor sleep progresses into physical markers of poor sleep in the development of insomnia in highly perfectionistic individuals. To our knowledge, no actigraphy study in this research area exists despite potential theoretical and clinical significance.

The aim of this study is to investigate the association between perfectionism and sleep disturbances by: 1) replicating and extending previous findings between perfectionism and subjective sleep measures with an Australian general population sample, 2) exploring if relationships between each dimension of perfectionism and subjective sleep are replicated using actigraphy-derived objective sleep measures, and 3) exploring if depression, anxiety and stress mediate the relationships between perfectionism and actigraphy-derived objective sleep measures. It is hypothesised that high levels of perfectionism will be associated with subjective measures of sleep. No *a priori* hypothesis is made relating to objective sleep measures given limited past research findings.

5.3 Materials and Methods

5.3.1 Participants

Adult participants, aged 18 years and above, were recruited from the Research Experience Program (REP) at the University of Melbourne, via social media and word-of-mouth or referred by their treating sleep physician at the Melbourne Sleep Disorder Centre with diagnosis of insomnia. REP participants were undergraduate psychology students, who received course credit for participation and self-selected to the study in response to an online advertisement at the University of Melbourne, Australia. All potential participants regardless of recruitment pathway completed an online screening survey via Qualtrics (https://www.qualtrics.com) to determine eligibility. Exclusion criteria include: (a) current diagnosis of mental illness; (b) central nervous disorder (c) prior head injury; (d) shift work, defined as paid work starting before 7:00AM or after 2:00PM, rotating or including work

outside of 7:00AM to 6:00PM; (e) symptoms indicative of sleep disorders other than insomnia (*e.g.*, obstructive sleep apnoea, narcolepsy). In this study, no clinical insomnia diagnosis was required, and participants included both clinical and general population participants who were assessed for their insomnia symptomology.

A total of 1132 screening responses were obtained. There were 243 eligible participants after removing incomplete and duplicate responses, and those who declined to participate. 65 participants agreed to participate in the two-week actigraphy sleep component. A final sample of 60 participants were included in this study, after exclusions of participants with incomplete questionnaires and/or actigraphy recording errors.

All participants provided informed written consent online; and received an online gift voucher worth $25 upon completion of the actigraphy sleep component. Approval for this research study was granted by the Human Research Ethics Committee at the University of Melbourne.

5.3.2 Sleep Measures

Throughout the 14-day actigraphy period, participants completed the Pittsburgh Sleep Diary (PSD; Monk et al., 1994), which was delivered daily to participants' smart phones via the Smartphone Ecological Momentary Assessment app (SEMA3, Koval et al., 2019). The PSD captured self-reported daily bedtime, lights out time, minutes to sleep, waketime, etc. Subjective total sleep time (TST), sleep onset latency (SOL), wake after sleep onset (WASO), number of awakenings (NOA) and sleep efficiency (SE) were calculated from diary data. Objective daily sleep was assessed using a wrist worn GENEActiv accelerometer (Activinsights, Cambridge, United Kingdom). The accelerometer was set to a sample frequency of 40Hz. Accelerometer data was extracted using GENEActiv PC Software (version 3.3) and processed with GGIR (version 2.6.0) using R (version 4.0.5). Sleep recordings were extracted using GGIR parameters set to T3A10 where a period of sustained

inactivity, as measured by a lack of change in arm angle above 10-degrees for at least 3-minutes, was detected as sleep. This setting was chosen based on GGIR's validation study against polysomnography showing that shorter time window and higher angle threshold provided better sensitivity in detecting sleep when compared to its default setting (van Hees et al., 2015).

Sleep recordings were evaluated to derive objective WASO, TST, NOA and SE. Objective SOL was derived using a combination of subjective information supplied by participants' sleep diaries (*e.g.*, lights out time) and objective data extracted from GENEActiv. While data collection was scheduled for 14 days, some participants had missing or unusable data. Therefore, the average score for each variable for each participant was calculated over the number of nights where usable sleep data were recorded. Participants also completed the Insomnia Severity Index (ISI) at the end of the two-week actigraphy sleep study (Bastien et al., 2001; Morin, 1993). The ISI is a self-reported questionnaire that measures the nature, severity, and impact of insomnia over the past fortnight. It consists of 7 items that are rated on a 5-point Likert scale from 0 (no problem) to 4 (very severe problem) with a total score range of 0 to 28. These items assess sleep onset and maintenance difficulties, early morning awakenings, sleep satisfaction; and distress, daytime dysfunction and noticeability by others resulting from sleep problem. The ISI has excellent internal consistency with Cronbach alphas of .90 for community sample and .91 for clinical sample, and an optimal cut-off score of 10 for detecting insomnia in community sample with sensitivity at 86.1% and specificity at 87.7% (Morin et al., 2011).

5.3.3 Assessment

To assess the different dimensions of perfectionism, both the Frost Multidimensional Perfectionism Scale (FMPS; Frost et al., 1990) and Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS; Hewitt & Flett, 1991) were utilised. The FMPS consists of 35

items, each rated on a Likert scale from 1 (disagree strongly) to 5 (agree strongly). There are 6 subscales in the FMPS, each with maximum scores as follows: Concern over Mistakes 45, Doubts about Actions 20, Parental Expectations 25, Parental Criticism 20, Personal Standards 35 and Organisation 30. Total FMPS score ranges from 29 to 145 as it excludes the Organisation subscale which comprises 6 items. Higher levels of perfectionism are reflected by higher scores. Internal consistency for each subscale of the FMPS was good with Cronbach's alphas ranging .77 to .93 and reliability coefficients ranging .77 to .94 (Frost et al., 1990).

The HFMPS consists of 45 items, each rated on a Likert scale from 1 (disagree) to 7 (agree). There are three subscales in the HFMPS: Self-oriented Perfectionism, Other-oriented Perfectionism and Socially Prescribed Perfectionism. The maximum total score of each subscale is 105 with higher scores representing higher levels of perfectionism. Internal consistency for each subscale of the HFMPS was good with Cronbach's alphas ranging from .74 to .88 (Hewitt et al., 1991).

Participants also completed the Depression, Anxiety and Stress Scale 21 (DASS-21; Lovibond & Lovibond, 1995). The DASS-21 consists of 3 scales with each comprising of 7 items measuring levels of Depression, Anxiety, and Stress and rated on a 4-point Likert-type scale from 0 (Did not apply to me at all) to 3 (Applied to me very much or most of the time). Internal consistency is high with Cronbach's alphas reported as: .91 for Depression, .80 for Anxiety and .84 for Stress (Sinclair et al., 2012).

5.3.4 Study Protocol

Prior to the start of the actigraphy component, participants attended a consent meeting with the lead researcher (S.O.) either in-person or online via Zoom (https://zoom.us). During this meeting, explanations about the actigraphy watch and study protocol were provided, and participants completed the FMPS and HFMPS. Over the 14-day actigraphy study period,

participants wore the accelerometer on their non-dominant wrist 24 hours a day, but removal was permitted during contact sports, swimming or if required by work. Actigraphy watches were distributed during the in-person consent meeting, or via post prior to the online consent meeting.

Participants also completed the PSD daily when prompted by SEMA3, which sent out reminders via notifications within each data collection input timeframes. At the end of the 14-day actigraphy study period, participants attended a debrief to return the actigraphy watch, complete the DASS-21 and ISI, and received remuneration.

5.3.5 Statistical Analysis

The statistical software package R (version 4.3.0; http://www.R-project.org/) was used for all analyses. The relationships between perfectionism and sleep were assessed with correlation, regression, and mediation analyses. Firstly, the associations between perfectionism and ISI, subjective and objective sleep parameters were analysed using Pearson correlations, which is consistent with past research (Akram et al., 2015; Brand et al., 2015; Lundh et al., 1994; Schmidt et al., 2018). Correlations of .10 indicate small effect, .30 medium effect and .50 large effect (Cohen, 1988).

Prior to further analysis, SOL, WASO and NOA were log transformed due to data skewness. Since SE was a proportion between 0 and 1, a logit transform was applied to stabilise the variance of residuals (Warton & Hui, 2011). A series of regression models were then conducted for each combination of perfectionism variable (FMPS-total and HFMPS-total and subscale scores as independent variable) and actigraphy derived objective sleep parameter (TST, logSOL, logWASO, logNOA and logitSE as dependent variable) with age and gender as covariates.

Finally, using Depression, Anxiety and Stress scores obtained from DASS-21 as mediators, a series of mediation analyses were conducted for each selected combination of

perfectionism subscale (Concern over Mistakes, Doubts about Actions, Parental Criticism, Personal Standards and Socially Prescribed Perfectionism) and actigraphy derived objective sleep parameters. Notably, all mediation analyses were conducted even in the absence of a significant total effect as per O'Rourke and MacKinnon (2018).

The alpha level for the two-tailed analyses was set at $p < .05$. Model assumptions and effects, which included and excluded outliers, were visually inspected and compared. Overall, model assumptions were met and there was no meaningful change in model effects with or without outliers, so outliers were included in the current analyses (see Tables A3 to A10 in the Appendix for models excluding outliers).

5.4 Results

5.4.1 Descriptive Data

The final sample included 60 participants aged 18-66 years ($M = 30.18$, $SD = 11.01$), of whom 85.0% identified as female. Participants reported ISI scores ranging from 0 to 25 ($M = 7.48$, $SD = 5.92$). Just over a third of the sample ($n = 23$, 38.3%) were categorised as a 'poor sleeper', with an ISI score exceeding 9 (Morin et al., 2011). Mean and standard deviations of subjective and objective sleep measures, and perfectionism and DASS-21 are presented in Tables 5.2 and 5.3 respectively. As shown in Table 5.2, there were significant differences between all subjective and objective sleep measures, except for NOA.

Table 5.2

Mean scores and standard deviations for objective and subjective sleep measures

	Objective		Subjective		Paired t-Test		Effect Size
	M	SD	M	SD	t	p	Cohen's d
TST, mins	424.30	72.65	447.90	59.43	-2.58	.012*	-0.35 (small)
SOL, mins	7.36	8.23.	22.97	21.74	-5.24	<.001**	-0.95 (large)
WASO, mins	49.02	34.00	18.65	22.69	5.50	<.001**	1.05 (large)
NOA, no.	1.25	1.48	1.43	0.97	-0.72	.474	-0.14 (negligible)
SE, %	87.52	9.50	91.49	7.45	-2.51	.015*	-0.46 (small)

Notes. TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency. *$p < .05$, **$p < .01$.

Table 5.3

Mean scores, standard deviations, and sample range for measures of perfectionism, depression, anxiety, and stress

	M	SD	Sample Range (Score Range)
FMPS	86.9	19.69	41-141 (29-145)
Concern over Mistakes	26.92	8.18	11-45 (9-45)
Doubts about Actions	11.87	3.77	5-20 (4-20)
Parental Criticism	9.37	4.04	4-20 (4-20)
Parental Expectation	13.2	4.54	6-25 (5-25)
Organisation	24.58	3.43	15-30 (6-30)
Personal Standards	25.58	5.65	9-35 (7-35)
HFMPS	177.2	29.85	100-238 (45-315)
Self-oriented Perfectionism	72.3	14.9	33-105 (15-105)
Other-oriented Perfectionism	52.48	13.36	23-81 (15-105)
Socially Prescribed Perfectionism	52.47	13.37	28-105 (15-105)
Depression	4.37	4.74	0-21 (0-21)
Anxiety	3.35	3.57	0-18 (0-21)
Stress	6.47	4.75	0-19 (0-21)

Notes. FMPS, Frost Multidimensional Perfectionism Scale; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale.

5.4.2 Correlation Analyses between Sleep Measures and Perfectionism

There were significant positive correlations of medium to large effects between ISI and all subscales of perfectionism, except for Parental Expectations, Organisation and Other-oriented Perfectionism (Cohen, 1988). Results in Tables 5.4 and 5.5 showed the number and strength of significant correlations between subjective sleep and perfectionism measures were generally higher than those found between objective sleep and perfectionism measures. Specifically, significant positive correlations were found between subjective logSOL and FMPS-total (p = .006), Concern over Mistakes (p = .008), Doubts about Actions (p = .012), Personal Standards (p = .004) and Self-oriented Perfectionism (p = .020); and between objective logSOL and Parental Expectations (p = .029). Significant negative correlations were found between subjective logistSE and FMPS-total (p = .016), Personal Standards (p = .006) and Self-oriented Perfectionism (p = .042); and between objective logitSE and Parental Expectations (p = .047) and Socially Prescribed Perfectionism (p = .009). Overall, these relationships were considered to have medium effects (Cohen, 1988).

5.4.3 Regression Analyses of Objective Sleep Measures and Perfectionism

Regression analyses indicated that Parental Expectations predicted TST, logSOL and logit SE, while HFMPS-total predicted logSOL; and Socially Prescribed Perfectionism predicted logitSE as shown in Table 5.6. No other perfectionism scale or subscales were significant predictors of the various objective sleep measures.

Table 5.4

Correlations between log transformed subjective sleep measures and perfectionism

n = 60	L1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. TST #															
2. logSOL	-.15*														
3. logWASO	-.27	.50**													
4. logNOA	-.04	.16	.68**												
5. logitSE	.36**	-.87**	-.80**	-.31*											
6. FMPS	-.08	.35**	.17	-.02	-.31*										
7. CM	-.02	.34**	.11	.01	-.25	.88**									
8. DA	-.09	.32*	-.02	-.17	-.21	.71**	.62**								
9. PC	-.16	.15	.15	.12	-.18	.71**	.48**	.42**							
10. PE	-.15	.04	.13	.00	-.12	.62**	.30*	.19	.72**						
11. O	.03	.13	-.05	-.07	-.03	.09	.07	.08	-.16	.03					
12. PS	.06	.37**	.22	-.04	-.35**	.74**	.62**	.44**	.20	.29*	.26*				
13. HFMPS	-.07	.20	.14	.03	-.20	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.			
14. SOP	.03	.30*	.13	-.03	-.26*	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.76**		
15. OOP	-.01	-.14	.03	.11	.08	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.56**	.02	
16. SPP	-.17	.25	.13	-.02	-.23	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.83**	.57**	.22

Notes. log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; FMPS, Frost Multidimensional Perfectionism Scale; CM, Concern over Mistakes; DA, Doubts about Actions; PE, Parental Expectations; PC, Parental Criticism; O, Organisation; PS, Personal Standards; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; SOP, Self-oriented Perfectionism; OOP, Other-oriented Perfectionism; SPP, Socially Prescribed Perfectionism, N.A., not available. *$p < .05$, **$p < .01$, # TST was the only sleep variable that was not log-transformed.

Table 5.5

Correlations between log transformed objective sleep measures and perfectionism

n = 60	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. TST #															
2. logSOL	-.36**														
3. logWASO	-.46**	.57**													
4. logNOA	.-.37**	.43**	0.80**												
5. logitSE	.61**	-.32**	-.80**	-.74**											
6. FMPS	.04	.23	.14	.07	-.16										
7. CM	.13	.13	.11	.04	-.08	.88**									
8. DA	.15	.03	.19	.05	-.07	.71**	.62**								
9. PC	-.23	.15	.14	.09	-.19	.71**	.48**	.42**							
10. PE	-.24	.28*	.13	.08	-.26*	.62**	.30*	.19	.72**						
11. O	.09	.25	-.07	-.09	.16	.09	.07	.08	-.16	.03					
12. PS	.21	.25	.07	.02	-.04	.74**	.62**	.44**	.20	.29*	.26*				
13. HFMPS	.01	.23	.18	.02	-.20	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.			
14. SOP	.13	.25	.12	.01	-.07	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.76**		
15. OOP	-.01	.02	-.03	-.09	-.03	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.56**	.02	
16. SPP	-.12	.21	.28	.12	-.33**	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.83**	.57**	.22

Notes. log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; FMPS, Frost Multidimensional Perfectionism Scale; CM, Concern over Mistakes; DA, Doubts about Actions; PE, Parental Expectations; PC, Parental Criticism; O, Organisation; PS, Personal Standards; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; SOP, Self-oriented Perfectionism; OOP, Other-oriented Perfectionism; SPP, Socially Prescribed Perfectionism, N.A., not available. *$p < .05$, **$p < .01$, # TST was the only sleep variable that was not log-transformed.

Table 5.6

Regression coefficients between objective sleep measures and perfectionism

n = 60	TST #			logSOL			logWASO			logNOA			LogitSE		
	β	CI	p	exp β	CI	p	exp β	CI	p	exp β	CI	p	exp β	CI	p
FMPS	0.06	-0.92 - 1.05	.90	1.31	0.96 - 1.79	.09	1.06	0.91 - 1.23	.44	1.06	0.70 - 1.59	.78	0.88	0.72 - 1.08	.23
CM	1.07	-1.32 - 3.45	.37	1.19	0.86 - 1.64	.29	1.04	0.89 - 1.20	.63	1.01	0.66 - 1.52	.98	0.95	0.78 - 1.17	.66
DA	2.39	-2.72 - 7.50	.35	1.02	0.74 - 1.40	.91	1.03	0.89 - 1.19	.70	1.03	0.68 - 1.55	.89	0.95	0.77 - 1.16	.59
PC	-4.30	-0.88 – 0.28	.07	1.19	0.87 - 1.63	.26	1.07	0.93 - 1.24	.33	1.13	0.76 - 1.69	.53	0.87	0.71 - 1.05	.15
PE	-4.18	-8.27 – -0.10	.05*	1.39	1.03 - 1.89	.033*	1.06	0.92 -1.23	.43	1.10	0.73 -1.64	.65	0.82	0.67 - 0.99	.043*
O	1.04	-4.66 – 6.74	.72	1.32	0.97 - 1.80	.07	0.95	0.82 - 1.10	.50	0.84	0.56 - 1.26	.39	1.09	0.89 - 1.34	.40
PS	2.48	-0.84 – 5.81	.14	1.32	0.97 - 1.80	.07	1.03	0.89 - 1.19	.69	1.00	0.67 - 1.50	.99	0.95	0.78 - 1.16	.63
HFMPS	0.05	-0.61 – 0.71	.88	1.38	1.01 - 1.88	.043*	1.09	0.94 - 1.26	.27	1.00	0.66 - 1.52	.98	0.89	0.73 -1.09	.25
SOP	0.50	-0.79 - 1.79	.44	1.32	0.97 - 1.80	.08	1.05	0.91 - 1.22	.48	0.98	0.65 - 1.47	.90	0.94	0.77 - 1.15	.53
OOP	0.21	-1.26 - 1.68	.78	0.10	-0.23 - 0.42	.55	0.98	0.85 - 1.14	.82	0.88	0.58 - 1.33	.53	1.03	0.84 - 1.27	.75
SPP	-0.62	-2.09 - 0.85	.40	1.36	1.00 - 1.87	.05	1.16	1.00 - 1.34	.05	1.18	0.78 - 1.79	.42	0.80	0.65 - 0.97	.027*

Notes. exp, standardised exponentiated regression coefficient, for example, a 1.00 standard deviation increase in PE leads to a ratio change of 1.39 or a 39% increase in logSOL, and a 1.00 standard deviation increase in HFMPS leads to a ratio change of 1.38 or a 38% increase in logSOL. log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; FMPS, Frost Multidimensional Perfectionism Scale; CM, Concern over Mistakes; DA, Doubts about Actions; PE, Parental Expectations; PC, Parental Criticism; O, Organisation; PS, Personal Standards; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; SOP, Self-oriented Perfectionism; OOP, Other-oriented Perfectionism; SPP, Socially Prescribed Perfectionism. *$p < .05$, # TST was the only sleep variable that was not log-transformed.

5.4.4 Mediation Analyses Using Depression, Anxiety and Stress as Mediators in the Relationships between Objective Sleep Measures and selected Measures of Perfectionism

Results in the mediation analyses were broadly consistent with results from the regression analyses. None of the mediation analyses using Depression and Anxiety as mediators were significant (see Tables A5 and A6 in Appendix). Significant results presented in Table 5.7 indicated that while the total effect of Concern over Mistakes on logitSE was not significant, the mediation effect of stress on the relationship between Concern over Mistakes and logitSE was significant, such that an increase in Concern over Mistakes led to a decrease in sleep efficiency via stress as a mediator. A similar pattern was found in the relationship between Doubts about Actions and sleep efficiency. However, when outliers were removed, this result was no longer significant, suggesting they were driven by the outliers (for full results of mediation analyses using stress as a mediator with and without outliers, see Tables A7 and A12 in Appendix). Furthermore, considering the number of analyses involved in the current study, which could give rise to spurious findings, there was little evidence to support these relationships. Therefore, these results were likely inconclusive.

Table 5.7

Significant results from exponentiated regression coefficients of mediation analysis using stress as a mediator in the relationship between selected log transformed objective sleep measures and selected subscales of perfectionism (n = 60, simulations = 10,000)

Sleep Measure	logitSE		
Perfectionism	Estimate	CI	P
Concern over Mistakes			
- Average causal mediated effect	0.86	0.71 - 0.99	.036*
- Average direct effect	1.12	0.87 - 1.43	.40
- Total effect	0.95	0.77 - 1.20	.68
Doubts about Actions			
- Average causal mediated effect	0.90	0.77 – 1.00	.042*
- Average direct effect	1.06	0.84 - 1.32	.61
- Total effect	0.95	0.76 - 1.19	.63

Notes. *$p < .05$. Only significant results presented above. For full results, see Table A9 in Appendix.

5.5 Discussion

This study explored the relationship between facets of multidimensional perfectionism and insomnia as measured by self-reported subjective and actigraphy-derived objective sleep measures. It also explored whether this relationship is mediated by depression, anxiety and stress. Results showed individuals who self-reported higher levels of insomnia also reported higher levels of perfectionism. Specifically, those who reported longer sleep onset latency and lower sleep efficiency also tend to report higher total perfectionism (via FMPS-total), Concern over Mistakes, Doubts about Actions, Personal Standards and Self-oriented Perfectionism. These results support the hypothesis that higher level of perfectionism is associated with self-reported sleep measures of poor sleep. Notably, the relationship between perfectionism and insomnia differed between objective and subjective sleep measures. Participants who reported higher levels of Parental Expectations had longer objective sleep

onset latency and those who reported higher levels of Parental Expectations and Socially Prescribed Perfectionism had lower objective sleep efficiency. Furthermore, Parental Expectations and total score on the HFMPS were significant predictors of objective sleep onset latency while Parental Expectations and Socially Prescribed Perfectionism were significant predictors of objective sleep efficiency. Finally, there is inconclusive evidence to indicate that the associations between Concern over Mistakes and Doubts about Actions with objective sleep efficiency were mediated by stress. Overall, these results suggest certain aspects of perfectionism relate to markers of poor sleep, but some of those relationships differ across objective and subjective markers of poor sleep.

5.5.1 Subjective Measures of Sleep

Evidence for subjective measures of insomnia being related to perfectionism is further supported by this study with an Australian general population sample. The finding of relationships between subjective measures of insomnia and perfectionism dimensions of Concern over Mistakes, Doubts about Actions, Parental Criticism and Personal Standards is consistent with past literature (Akram et al., 2015; Akram et al., 2017; Akram et al., 2020; Andersson et al., 2005; Brand et al., 2015; Jansson-Frojmark & Linton, 2007; Lombardo et al., 2013; Lundh et al., 1994; Richardson & Gradisar, 2020; Trudel-Fitzgerald et al., 2017; Vincent & Walker, 2000). The current findings relating self-reported insomnia measures to Self-oriented Perfectionism and Socially Prescribed Perfectionism add evidence to support similar findings by Azevedo et al. (2010), (Azevedo et al., 2009), Maia et al. (2011) and Molnar et al. (2020) but contradict findings by Akram et al. (2017), Akram et al. (2015) and Vincent and Walker (2000). Notably, these relationships were previously found in large samples (e.g., 335 students by Molnar et al. (2020)) yet they were significant in the current study with a sample size of 60. Overall, this study adds to evidence in the literature

supporting theoretical suggestions that perfectionism plays an aetiological role in the development of insomnia.

5.5.2 Objective Measures of Sleep Derived from Actigraphy

The current study extends the literature as it examined objective measures of sleep using actigraphy over two weeks. Results suggest Parental Expectations is associated with longer sleep onset latency and lower sleep efficiency while Socially Prescribed Perfectionism is associated with lower sleep efficiency. These results are largely in line with findings by Johann et al. (2017) where higher levels of total perfectionism (via FMPS-total), Concern over Mistakes and Personal Standards were associated with higher levels of nocturnal awakenings and wake after sleep onset. However, the current results differ from the negative associations of total perfectionism (via FMPS-total), Concern over Mistakes and Personal Standards with wake after sleep onset; and positive associations of total sleep time and sleep efficiency with Personal Standards found by Johann et al. (2023). These discrepancies may be due to sampling and methodological differences. The current sample was assessed using actigraphy and comprised of members of the general population with or without insomnia, but without other sleep disorders. In contrast, Johann et al. (2017) sampled clinical patients of various sleep disorders and Johann et al. (2023) sampled clinical patients with insomnia disorder and both assessed sleep using polysomnography. While Johann et al. (2017) suggested that perfectionism may predispose one to objective sleep disturbances in the context of acute stressors, current findings suggest perfectionism may also be a contributing factor to objective sleep disturbances in the context of ongoing stressors arising from the perceived expectations from others.

Both Parental Expectations and Socially Prescribed Perfectionism relate to the perception of meeting others' expectations of perfectionism, and Socially Prescribed Perfectionism has also been associated with Parental Expectations and Parental Criticism

(Frost et al., 1990). Furthermore, the perception of these external demands of high standards in Socially Prescribed Perfectionism extends beyond demands from family and friends to those from acquaintances and society at large (Hewitt, 2020). One possible explanation for the current findings is that individuals with such perfectionistic tendencies attempt to meet those external sleep expectations by spending more time in bed, which inadvertently causes longer sleep onset latency and lower sleep efficiency to worsen sleep in a vicious cycle.

There have been recent calls to increase awareness about the importance of sleep and encourage ways to reduce inadequate sleep to improve sleep health in Australia (Adams et al., 2016; Attard et al., 2019; Australian Government, 2023; Deloitte Access Economics, 2017). However, media messaging about sleep is complex, often presenting good sleep as an ideal to strive for and is ironically, overly idealistic (Breheny et al., 2023). Furthermore, the proliferation of messages about sleep in the media may promote and perpetuate common dysfunctional sleep beliefs and myths (Katz & Lazersfeld, 1955; Robbins et al., 2019). Consequently, increasing awareness about the impact of inadequate sleep through public health messaging combined with a low level of sleep health education can be detrimental to those who have unrealistic expectations about needing to have "perfect" sleep as it can cause some level of distress leading to insomnia (Ekirch, 2015; Meaklim et al., 2020). The current findings suggest this process may be exacerbated in those who are highly perfectionistic, particularly those high in Socially Prescribed Perfectionism. This is because such individuals may be more vulnerable to the perceived demands at societal levels, particularly with excessive exposure to social media, which is increasingly a part of digital technologies employed in public health promotion (Flett et al., 2022b; Stark et al., 2022).

In contrast to previous research (Akram et al., 2015; Akram et al., 2017; Akram et al., 2020; Jansson-Frojmark & Linton, 2007), neither depression nor anxiety mediated relationships between perfectionism and sleep in this study. These differences may be

explained by the different measures used to assess depression and anxiety measures between this study and earlier studies. Furthermore, the exclusion criterion of a current mental illness diagnosis excluded participants with comorbid depression and anxiety disorders. Given the divergent severity in symptoms between general and clinical populations, this could have contributed to the lack of a mediation effect in the current study, which could indicate a conservative finding. Although the current evidence is inconclusive, the mediation effect of stress on the relationship between sleep difficulties and perfection, specifically in Concern about Mistakes and Doubts about Actions, suggest stress may play a role in the relationship between perfectionism and insomnia. This is in line with finding by Brand et al. (2015) that perceived stress, as measured by the Perceived Stress Scale, may be an underlying psychological mechanism in the relationship between poor sleep and perfectionism. The current finding strengthens that line of thinking because the same relationships were found despite using different measures of stress and sleep.

5.5.3 Theoretical and Clinical Implications

Results from the current study support theoretical conceptualisations and empirical literature that perfectionism may increase one's vulnerability to insomnia. Perfectionism is suggested to amplify common negative life events and cause arousals to disrupt the automatic sleep process, which becomes another source of stress and/or worry that leads to insomnia development (Akram et al., 2023; Lundh & Broman, 2000). The current study builds upon past research by replicating previous findings of the relationship between insomnia and perfectionism using subjective sleep measures obtained from an Australian general population sample, adding to preliminary evidence that perfectionism may also play a role in the aetiology of objectively measured sleep disturbances. Specifically, we suggest individuals who have high Socially Prescribed Perfectionism and Parental Expectations may be more prone to developing chronic insomnia as they increase sleep efforts to try to meet sleep

expectations prescribed by others and perceived to be important, even if overly idealistic. Moreover, stress may be an underlying mechanism linking perfectionism to poor sleep such that individuals high on Concern for Mistakes and Doubts about Actions may be more prone to experiencing poor sleep when stressed, which then can lead to the development of dysfunctional sleep beliefs and unhelpful behaviours that cause insomnia (Espie et al., 2006; Morin, 1993).

Consequently, modifications to CBT-I to incorporate both perfectionism and stress reactivity as therapy targets should be considered in future trials. A recent CBT-I trial of clinical sample with perfectionism by Johann et al. (2023) indicated both perfectionism and insomnia were positively related to sleep efforts, pre-sleep arousal and dysfunctional beliefs about sleep, and that upon completion of CBT-I, levels of Organisation and Parental Expectations were elevated. Although the treatment was successful, the authors noted perfectionism may undermine sleep restriction therapy, a core component of CBT-I, because it can initially cause excessive daytime sleepiness, fatigue, and low mood and lead to dropouts. The current study findings suggest it may be important to address stress reactivity, Concern about Mistakes and Doubts about Actions prior to sleep restriction therapy to minimize the risk of dropout from CBT-I. Efficacy and impact of incorporating techniques from CBT for perfectionism into CBT-I could be explored in future research.

The current study findings also highlight the importance of improving sleep health education in Australia and taking a nuanced approach in public health messaging about sleep to prevent the proliferation of misperception, dysfunctional beliefs and myths about sleep. Applying the suggestions relevant to public health messaging for Socially Prescribed Perfectionism by Flett et al. (2022a), it may help to shift the focus from average to a range of sleep duration guidelines and normalise the occasional experiences of poor sleep to reduce the likelihood of overaction when one falls short of those expectations. For example,

emphasising that 6 to 10 hours of sleep may be appropriate for adults aged 26 to 64 to feel good and function well in addition to or even replacing the usual recommendation of 7 to 9 hours. Overall, public sleep health messaging should be developed with consideration of impact upon insomnia development and maintenance.

5.5.4 Strengths, Limitations and Future Directions

This is the first study to examine the relationships between perfectionism and markers of poor sleep relating to insomnia using actigraphy. Although actigraphy allowed the collection of ecological sleep data, it provides only binary sleep/wake detection and does not measure sleep architecture or capture physiological sleep data, such as, brain activity, eye movement, or muscle tone. With technological advances and the introduction of new wearable devices to measure sleep (e.g., Somfit by Compumedics, Melbourne, Australia), future studies could explore if there are ecological physiological markers of poor sleep related to perfectionism. While it was noted there were significant differences between objective and subjective sleep measures in the current sample, no further analysis was done. It remains unknown if sleep state discrepancy might explain for the differences found in those relationships between perfectionism and sleep; and whether dysfunctional beliefs play a role in those differences and interrelationships. Another key limitation of the current study relates to its cross-sectional data, which does not allow for causality to be determined and calls for future longitudinal studies. Additionally, the small sample size of the current study is a limitation, and confirmatory work will be required to investigate any specific hypotheses that were generated. Lastly, this study used an actigraphy setting optimised to detect sleep. Other actigraphy settings which may be more optimal for detecting wake can be investigated in future studies.

5.6 Conclusions

Research into perfectionism as an important factor in insomnia has been lacking. The current study indicates having high Parental Expectations and Socially Prescribed Perfectionism may increase one's vulnerability to objectively measured poor sleep and insomnia. Additionally, stress may be a mechanism linking perfectionism and insomnia for individuals with high levels of Concern for Mistakes and Doubts about Action. These findings indicate that perfectionism may be an important factor in preventing and treating insomnia.

5.7 References

Adams, R., Appleton, S., Taylor, A., McEvoy, D., & Antic, N. (2016). Report to the Sleep Health Foundation 2016 sleep health survey of Australian adults. https://www.sleephealthfoundation.org.au/pdfs/surveys/SleepHealthFoundation-Survey.pdf

Akram, U. (2018). Objective sleep and personality. *Journal of Clinical Sleep Medicine*, 14(3), 485-486. https://doi.org/10.5664/jcsm.7010

Akram, U., Ellis, J. G., & Barclay, N. L. (2015). Anxiety mediates the relationship between perfectionism and insomnia symptoms: A longitudinal study. *PLoS One*, 10(10), e0138865. https://doi.org/10.1371/journal.pone.0138865

Akram, U., Ellis, J. G., Myachykov, A., Chapman, A. J., & Barclay, N. L. (2017). Anxiety mediates the relationship between multidimensional perfectionism and insomnia disorder. *Personality and Individual Differences*, 104, 82-86. https://doi.org/10.1016/j.paid.2016.07.042

Akram, U., Gardani, M., Riemann, D., Akram, A., Allen, S. F., Lazuras, L., & Johann, A. F. (2020). Dysfunctional sleep-related cognition and anxiety mediate the relationship between multidimensional perfectionism and insomnia symptoms. *Cognitive Processing*, 21(1), 141-148. https://doi.org/10.1007/s10339-019-00937-8

Akram, U., Stevenson, J. C., Gardani, M., Allen, S., & Johann, A. F. (2023). Personality and insomnia: A systematic review and narrative synthesis. *Journal of Sleep Research*, e14031. https://doi.org/10.1111/jsr.14031

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders* (5th ed., text rev.). https://doi.org/https://doi.org/10.1176/appi.books.9780890425787

Andersson, G., Airikka, M.-L., Buhrman, M., & Kaldo, V. (2005). Dimensions of perfectionism and tinnitus distress. *Psychology, Health & Medicine*, 10(1), 78-87. https://doi.org/10.1080/13548500512331315389

Attard, K. P., Adams, R. J. T., Vakulin, A., & Reynolds, A. C. (2019). Sleep and help seeking behaviours in Australia: A narrative review. *OBM Neurobiology*, 3(2), 1-1. https://doi.org/10.21926/obm.neurobiol.1902029

Australian Government. (2023). *Australian Government response to the House of Representatives Standing Committee on health, aged care and sport report: Bedtime reading - Inquiry into sleep health awareness in Australia*. Australian Government. https://www.health.gov.au/resources/publications/bedtime-reading-inquiry-into-sleep-health-awareness-in-australia?language=en

Azevedo, M. H., Bos, S. C., Soares, M. J., Marques, M., Pereira, A. T., Maia, B., Gomes, A. A., & Macedo, A. (2010). Longitudinal study on perfectionism and sleep disturbance. *World Journal of Biological Psychiatry*, 11(2 Pt 2), 476-485. https://doi.org/10.3109/15622970903304467

Azevedo, M. H., Soares, M. J., Bos, S. C., Gomes, A. A., Maia, B., Marques, M., Pereira, A. T., & Macedo, A. (2009). Perfectionism and sleep disturbance. *World Journal of Biological Psychiatry*, 10(3), 225-233. https://doi.org/10.1080/15622970701367930

Bastien, C. H., Vallieres, A., & Morin, C. M. (2001). Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Medicine*, 2(4), 297-307. https://doi.org/https://doi.org/10.1016/s1389-9457(00)00065-4

Bin, Y. S., Marshall, N. S., & Glozier, N. (2012). The burden of insomnia on individual function and healthcare consumption in Australia. *Australian and New Zealand Journal of Public Health*, 36(5), 462-468. https://doi.org/10.1111/j.1753-6405.2012.00845.x

Brand, S., Kirov, R., Kalak, N., Gerber, M., Puhse, U., Lemola, S., Correll, C. U., Cortese, S., Meyer, T., & Holsboer-Trachsler, E. (2015). Perfectionism related to self-reported insomnia severity, but not when controlled for stress and emotion regulation. *Neuropsychiatric Disease and Treatment*, 11, 263-271. https://doi.org/10.2147/NDT.S74905

Breheny, M., Ross, I., Ladyman, C., Signal, L., Dew, K., & Gibson, R. (2023). "It's Just [Complicated] Sleep": Discourses of sleep and ageing in the media. *Gerontologist*. https://doi.org/10.1093/geront/gnad058

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd ed.). Routledge Academic.

Deloitte Access Economics. (2017). *Asleep on the job - Costs of inadequate sleep in Australia.* Sleep Health Foundation.

Dolsen, E. A., Asarnow, L. D., & Harvey, A. G. (2014). Insomnia as a transdiagnostic process in psychiatric disorders. *Current Psychiatry Reports*, 16(9), 471. https://doi.org/10.1007/s11920-014-0471-y

Egan, S. J., Wade, T. D., & Shafran, R. (2011). Perfectionism as a transdiagnostic process: A clinical review. *Clinical Psychology Review*, 31(2), 203-212. https://doi.org/10.1016/j.cpr.2010.04.009

Ekirch, A. R. (2015). The modernization of western sleep: Or, does insomnia have a history? *Past & Present*, 226(1), 149-192. https://doi.org/10.1093/pastj/gtu040

Espie, C. A., Broomfield, N. M., MacMahon, K. M., Macphee, L. M., & Taylor, L. M. (2006). The attention-intention-effort pathway in the development of psychophysiologic insomnia: A theoretical review. *Sleep Medicine Review*, 10(4), 215-245. https://doi.org/10.1016/j.smrv.2006.03.002

Flett, G. L., Hewitt, P. L., Nepon, T., Sherry, S. B., & Smith, M. (2022). The destructiveness and public health significance of socially prescribed perfectionism: A review, analysis, and conceptual extension. *Clinical Psychology Review*, 93, 102130. https://doi.org/10.1016/j.cpr.2022.102130

Frost, R. O., Marten, P., Lahart, C., & Rosenblate, R. (1990). The dimensions of perfectionism. *Cognitive Therapy and Research*, 14(5), 449-468. https://doi.org/https://doi.org/10.1007/BF01172967

Harvey, A. G. (2002). A cognitive model of insomnia. *Behaviour Research and Therapy*, 40, 869–893. https://doi.org/10.1016/S0005-7967(01)00061-4

Harvey, A. G. (2008). Insomnia, psychiatric disorders, and the transdiagnostic perspective. *Current Directions in Psychological Science*, 17(5), 299-303. https://doi.org/https://doi.org/10.1111/j.1467-8721.2008.00594.x

Harvey, C. J., Gehrman, P., & Espie, C. A. (2014). Who is predisposed to insomnia: A review of familial aggregation, stress-reactivity, personality and coping style. *Sleep Medicine Review*, 18(3), 237-247. https://doi.org/10.1016/j.smrv.2013.11.004

Hertenstein, E., Feige, B., Gmeiner, T., Kienzler, C., Spiegelhalder, K., Johann, A., Jansson-Frojmark, M., Palagini, L., Rucker, G., Riemann, D., & Baglioni, C. (2019). Insomnia as a predictor of mental disorders: A systematic review and meta-analysis. *Sleep Medicine Review*, 43, 96-105. https://doi.org/10.1016/j.smrv.2018.10.006

Hewitt, P. L. (2020). Perfecting, belonging, and repairing: A dynamic-relational approach to perfectionism. *Canadian Psychology / Psychologie Canadienne*, 61(2), 101-110. https://doi.org/10.1037/cap0000209

Hewitt, P. L., & Flett, G. L. (1991). Perfectionism in the self and social contexts: Conceptualisation, assessment, and association with psychopathology. *Journal of*

Personality and Social Psychology, 60(3), 456-470. https://doi.org/https://doi.org/10.1037/0022-3514.60.3.456

Hewitt, P. L., Flett, G. L., Turnbull-Donovan, W., & Mikail, S. F. (1991). The Multidimensional Perfectionism Scale: Reliability, validity, and psychometric properties in psychiatric samples. *Psychological Assessment: A Journal of Consulting Clinical Psychology*, 3(3), 464-468. https://doi.org/https://doi.org/10.1037/1040-3590.3.3.464

Jansson-Frojmark, M., & Linton, S. J. (2007). Is perfectionism related to pre-existing and future insomnia? A prospective study. *British Journal of Clinical Psychology*, 46(1), 119-124. https://doi.org/https://doi.org/10.1348/014466506x158824

Johann, A. F., Feige, B., Hertenstein, E., Nissen, C., Benz, F., Steinmetz, L., Baglioni, C., Riemann, D., Spiegelhalder, K., & Akram, U. (2023). The effects of cognitive behavioral therapy for insomnia on multidimensional perfectionism. *Behaviour Therapy*, 54(2), 386-399. https://doi.org/10.1016/j.beth.2022.10.001

Johann, A. F., Hertenstein, E., Kyle, S. D., Baglioni, C., Feige, B., Nissen, C., Riemann, D., & Spiegelhalder, K. (2017). Perfectionism and polysomnography-determined markers of poor sleep. *Journal of Clinical Sleep Medicine*, 13(11), 1319-1326. https://doi.org/10.5664/jcsm.6806

Johann, A. F., Riemann, D., & Spiegelhalder, K. (2018). Does perfectionism increase the risk for dropout from Cognitive Behavioral Therapy for Insomnia? *Journal of Clinical Sleep Medicine*, 14(3), 487-488. https://doi.org/10.5664/jcsm.7012

Katz, E., & Lazersfeld, F. (1955). Personal influence. The part played by people in the flow of mass communication. *Free Press.* https://doi.org/10.1007/978-3-658-21742-6_67

Koval, P., Hinton, J., Dozo, N., Gellson, J., Alvarez, M., Harrison, A., Vu, D., Susanto, R., Jayaputera, G., & Sinnott, R. (2019). SEMA3: Smartphone Ecological Momentary Assessment, version 3. In http://www.sema3.com

Liguori, C., Mombelli, S., Fernandes, M., Zucconi, M., Plazzi, G., Ferini-Strambi, L., Logroscino, G., Mercuri, N. B., & Filardi, M. (2023). The evolving role of quantitative actigraphy in clinical sleep medicine. *Sleep Medicine Review*, 68, 101762. https://doi.org/10.1016/j.smrv.2023.101762

Limburg, K., Watson, H. J., Hagger, M. S., & Egan, S. J. (2017). The relationship between perfectionism and psychopathology: A meta-analysis. *Journal of Clinical Psychology*, 73(10), 1301-1326. https://doi.org/10.1002/jclp.22435

Lombardo, C., Mallia, L., Battagliese, G., Grano, C., & Violani, C. (2013). Perfectionism mediates the relationship between insomnia and depressive symptoms. *Sleep and Biological Rhythms*, 11(2), 90-98. https://doi.org/10.1111/sbr.12009

Lovibond, S. H., & Lovibond, P. F. (1995). Manual for the Depression Anxiety Stress Scales (2nd ed. ed.). *Psychology Foundation*. https://doi.org/https://doi.org/10.1037/t01004-000

Lundh, L.-G., & Broman, J.-E. (2000). Insomnia as an interaction between sleep-interfering and sleep-interpreting processes. *Journal of Psychosomatic Research*, 49, 299-310. https://doi.org/https://doi.org/10.1016/s0022-3999(00)00150-1

Lundh, L.-G., Broman, J.-E., Hetta, J., & Saboonchi, F. (1994). Perfectionism and insomnia. *Scandinavian Journal of Behaviour Therapy*, 23(1), 3-18. https://doi.org/10.1080/16506079409455949

Maia, B. R., Soares, M. J., Pereira, A. T., Marques, M., Bos, S. C., Gomes, A., Valente, J., Azevedo, M. H., & Macedo, A. (2011). Affective state dependence and trait stability

of perfectionism in sleep disturbances. *Revista Brasileira de Psiquiatria*, 33(3), 252-260. https://doi.org/https://doi.org/10.1590/s1516-44462011005000014

Martin, J. L., & Hakim, A. D. (2011). Wrist actigraphy. *Chest*, 139(6), 1514-1527. https://doi.org/10.1378/chest.10-1872

Meaklim, H., Jackson, M. L., Bartlett, D., Saini, B., Falloon, K., Junge, M., Slater, J., Rehm, I. C., & Meltzer, L. J. (2020). Sleep education for healthcare providers: Addressing deficient sleep in Australia and New Zealand. *Sleep Health*, 6(5), 636-650. https://doi.org/10.1016/j.sleh.2020.01.012

Molnar, D. S., Janssen, W. F., & Sirois, F. M. (2020). Sleeping perfectly? Trait perfectionism, perceived stress, and sleep quality. *Personality and Individual Differences*, 167. https://doi.org/10.1016/j.paid.2020.110244

Monk, T. H., Reynolds III, C. F., Kupfer, D. J., Buysse, D. J., Coble, P. A., Hayes, A. J., Machen, M. A., Petrie, S. R., & Ritenour, A. M. (1994). The Pittsburgh Sleep Diary. *Journal of Sleep Research*, 3(2), 111-120. https://doi.org/https://doi.org/10.1111/j.1365-2869.1994.tb00114.x

Morin, C. M. (1993). *Insomnia: Psychological assessment and management*. Guilford Press.

Morin, C. M., Belleville, G., Belanger, L., & Ivers, H. (2011). The Insomnia Severity Index: Psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep*, 34(5), 601-608. https://doi.org/https://doi.org/10.1093/sleep/34.5.601

Morin, C. M., Stone, J., Trinkle, D., Mercer, J., & Remsberg, S. (1993). Dysfunctional beliefs and attitudes about sleep among older adults with and without insomnia complaints. *Psychology and Aging*, 8(3), 463 - 467. https://doi.org/https://doi.org/10.1037/0882-7974.8.3.463

O'Rourke, H. P., & MacKinnon, D. P. (2018). Reasons for testing mediation in the absence of an intervention effect: A research imperative in prevention and intervention

research. *Journal of Studies on Alcohol and Drugs*, 79(2), 171-181. https://doi.org/10.15288/jsad.2018.79.171

Reynolds, A. C., Appleton, S. I., Gill, T. K., & Adams, R. J. (2019). *Chronic insomnia disorder in Australia. A report to the Sleep Health Foundation*. F. V. Communication. https://www.sleephealthfoundation.org.au/special-sleep-reports/chronic-insomnia-disorder-in-australia#:~:text=More%20than%20half%20of%20adult,is%20across%20the%20adult%20population.

Richardson, C., & Gradisar, M. (2020). Perfectionism and insomnia in adolescents: The role of vulnerability to stress and gender. *Journal of Adolescence*, 85, 70-79. https://doi.org/10.1016/j.adolescence.2020.10.003

Riemann, D., Spiegelhalder, K., Feige, B., Voderholzer, U., Berger, M., Perlis, M., & Nissen, C. (2010). The hyperarousal model of insomnia: A review of the concept and its evidence. *Sleep Medicine Review*, 14(1), 19-31. https://doi.org/10.1016/j.smrv.2009.04.002

Robbins, R., Grandner, M. A., Buxton, O. M., Hale, L., Buysse, D. J., Knutson, K. L., Patel, S. R., Troxel, W. M., Youngstedt, S. D., Czeisler, C. A., & Jean-Louis, G. (2019). Sleep myths: An expert-led study to identify false beliefs about sleep that impinge upon population sleep health practices. *Sleep Health*, 5(4), 409-417. https://doi.org/10.1016/j.sleh.2019.02.002

Rodriguez-Seijas, C., Eaton, N. R., & Krueger, R. F. (2015). How transdiagnostic factors of personality and psychopathology can inform clinical assessment and intervention. *Journal of Personality Assessment*, 97(5), 425-435. https://doi.org/10.1080/00223891.2015.1055752

Schmidt, R. E., Courvoisier, D. S., Cullati, S., Kraehenmann, R., & der Linden, M. V. (2018). Too imperfect to fall asleep: Perfectionism, pre-sleep counterfactual processing, and insomnia. *Frontiers in Psychology*, 9, 1288. https://doi.org/10.3389/fpsyg.2018.01288

Sinclair, S. J., Siefert, C. J., Slavin-Mulford, J. M., Stein, M. B., Renna, M., & Blais, M. A. (2012). Psychometric evaluation and normative data for the depression, anxiety, and stress scales-21 (DASS-21) in a nonclinical sample of U.S. adults. *Evaluations & the Health Professions*, 35(3), 259-279. https://doi.org/10.1177/0163278711424282

Smith, M. T., McCrae, C. S., Cheung, J., Martin, J. L., Harrod, C. G., Heald, J. L., & Carden, K. A. (2018). Use of actigraphy for the evaluation of sleep disorders and circadian rhythm sleep-wake disorders: An American Academy of Sleep Medicine Clinical practice guideline. *Journal of Clinical Sleep Medicine*, 14(7), 1231-1237. https://doi.org/10.5664/jcsm.7230

Spiegelhalder, K., Regen, W., Kyle, S. D., Endres, D., Nissen, C., Feige, B., & Riemann, D. (2012). Time will tell: A retrospective study investigating the relationship between insomnia and objectively defined punctuality. *Journal of Sleep Research*, 21(3), 264-269. https://doi.org/10.1111/j.1365-2869.2011.00970.x

Stark, A. L., Geukes, C., & Dockweiler, C. (2022). Digital Health Promotion and Prevention in Settings: Scoping Review. J Med Internet Res, 24(1), e21063. https://doi.org/10.2196/21063

Trudel-Fitzgerald, C., Savard, J., Slim, L. M., Roy, R. C., Flett, G. L., Hewitt, P. L., & Ivers, H. (2017). The relationship of perfectionism with psychological symptoms in cancer patients and the contributing role of hyperarousability and coping. *Psychology & Health*, 32(4), 381-401. https://doi.org/10.1080/08870446.2016.1273354

van de Laar, M., Verbeek, I., Peveragie, D., Aldenkamp, A., & Overeem, S. (2010). The role of personality traits in insomnia. *Sleep Medicine Reviews*, 14, 61-68. https://doi.org/10.1016/j.smrv.20

van Hees, V. T., Sabia, S., Anderson, K. N., Denton, S. J., Oliver, J., Catt, M., Abell, J. G., Kivimaki, M., Trenell, M. I., & Singh-Manoux, A. (2015). A novel, open access method to assess sleep duration using a wrist-worn accelerometer. *PLoS One*, 10(11), e0142533. https://doi.org/10.1371/journal.pone.0142533

Vincent, N. K., & Walker, J. R. (2000). Perfectionism and chronic insomnia. *Journal of Psychosomatic Research*, 49, 349-354. https://doi.org/https://doi.org/10.1016/s0022-3999(00)00175-6

Warton, D. I., & Hui, F. K. C. (2011). The arcsine is asinine: The analysis of proportions in ecology. *Ecology*, 90(1), 3-10. https://doi.org/https://doi.org/10.1890/10-0340.1

Chapter 6

Study 2 - Perfectionism Contributes to Sleep-Wake State Discrepancy: The Mediating Role of Pre-Sleep Arousal

brain sciences

MDPI

Article

Perfectionism Contributes to Sleep-Wake State Discrepancy: The Mediating Role of Pre-Sleep Arousal

Susie Y. Oh [1,2], Christian L. Nicholas [1], Lisa J. Phillips [1], David Cunnington [3], Maya T. Schenker [1,2], Cameron J. Patrick [4], Daniel Windred [5] and Hailey Meaklim [1,5,*]

[1] Melbourne School of Psychological Sciences, The University of Melbourne, Parkville, VIC 3010, Australia; ohsy@student.unimelb.edu.au (S.Y.O.); cln@unimelb.edu.au (C.L.N.); lisajp@unimelb.edu.au (L.J.P.); m.schenker@unimelb.edu.au (M.T.S.)
[2] Monash University Healthy Sleep Clinic, Turner Institute for Brain and Mental Health, Monash University, Clayton, VIC 3168, Australia
[3] Thompson Institute, University of the Sunshine Coast, Birtinya, QLD 4575, Australia
[4] Statistical Consulting Centre, School of Mathematics and Statistics, The University of Melbourne, Parkville, VIC 3010, Australia; cameron.patrick@unimelb.edu.au
[5] Flagship Sleep Health Program, Flinders Health and Medical Research Institute (FHMRI), Flinders University, Adelaide, SA 5042, Australia
* Correspondence: hailey.meaklim@flinders.edu.au

This chapter contains an original research article which was published in *Brain Sciences* on 31 May 2026 and has been formatted to conform with the format of this thesis. The references cited in this manuscript can be found at the end of this chapter. Abbreviations used in this chapter are introduced again in line with the submitted manuscript. Supplementary tables, figures and material are included in appendix B.

6.1 Abstract

Objectives: Sleep-wake state discrepancy, the discrepancy between self-reported and objective sleep measures, is commonly experienced in poor sleep and insomnia. While perfectionism is implicated in insomnia, its relationship to sleep-wake state discrepancy has not been investigated. This study aimed to assess the association between sleep-wake state discrepancy and perfectionism and explore whether dysfunctional sleep beliefs and pre-sleep arousal mediate that relationship. **Methods:** Sixty adult participants from community and clinical populations were conveniently sampled (85% females, mean age 30.28 ± 11.13 years, 38% with insomnia symptoms). Sleep-wake state discrepancy measures were calculated using data from actigraphy and sleep diary collected over 14 days. The Frost Multidimensional Perfectionism Scale (FMPS), Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS), Dysfunctional Beliefs about Sleep (DBAS) and Pre-sleep Arousal Scale (PSAS) were also collected. **Results:** High perfectionism levels were associated with high levels of sleep-wake state discrepancy. Concern over Mistakes and Doubts about Actions correlated with sleep onset latency discrepancy with small effects (r = .26 and .29 respectively). Doubts about Action was associated with sleep onset latency discrepancy. Furthermore, pre-sleep arousal and cognitive pre-sleep arousal mediated relationships between sleep onset latency discrepancy and Concern over Mistakes and Doubts about Actions. **Conclusions:** Concern over Mistakes and Doubts about Actions relate to a poorer perception of sleep relative to objective sleep measures. During sleep onset, cognitive pre-sleep arousal appears to mediate relationships between perfectionism and sleep-wake state discrepancy. Therefore, perfectionism may be an important cognitive-emotional factor to consider when assessing and treating sleep-wake state discrepancy that commonly accompanies insomnia.

Keywords: perfectionism, sleep-wake state discrepancy, sleep misperception, insomnia, actigraphy, sleep health

6.2 Introduction

Poor sleep is a common and burdensome condition. Insomnia symptoms reflecting poor sleep can include difficulties initiating and/or maintaining sleep and/or dissatisfaction with sleep quality. While insomnia disorder is a formal diagnostic category requiring persistent sleep difficulties, significant daytime impairment, and occurring at least three times per week for a minimum of three months (American Psychiatric Association, 2022), the focus of this paper is on the broader experience of insomnia symptoms that reflect poor sleep, given their significant prevalence and impact even in the absence of a formal diagnosis. For example, in an Australian general population survey, 50% reported at least one insomnia symptom of difficulties initiating or maintaining sleep, while only 23% met diagnostic criteria for insomnia disorder (Appleton et al., 2022). Insomnia symptoms adversely affect general health and mental wellbeing, costing Australia an estimated US$13.3 billion in 2019-2020 in lost productivity and healthcare-related costs (Bin et al., 2012; Streatfeild et al., 2021). It is therefore critical to identify the behavioural, emotional, and cognitive processes that contribute to poor sleep quality and insomnia symptoms.

Sleep quality can be measured by subjective reports or objectively using tools, such as polysomnography (PSG) and actigraphy. Subjective reports of poor sleep and insomnia symptoms rely on an individual's self-reported perception of sleep and daytime functioning. Objective measures include PSG, which relies on multiple signals to measure sleep (e.g., electroencephalogram, electromyography), and actigraphy, which uses an accelerometer to infer sleep from physical activity in a simple, portable wrist-worn device (Edinger et al., 2004). Despite the benefits of capturing one night of comprehensive sleep data via PSG, actigraphy offers significant cost advantages and facilitates the collection of multiple nights

of ecological sleep data from participants' natural sleep environment (Martin & Hakim, 2011).

The outcomes from self-reported sleep measures can differ from those obtained via objective measurement. It is estimated that 8 to 66% of people with insomnia self-reported their sleep to be worse (i.e., reporting less sleep and more wakefulness during the same sleep opportunity) compared to objective sleep measures (Castelnovo et al., 2019). On the other hand, good sleepers have been found to exhibit the opposite pattern of overestimating their sleep compared to objective sleep measures (Maltezos et al., 2024). The discrepancy in sleep estimation between self-reported and objective measures of sleep is referred to by various names: sleep-state misperception, sleep misestimation, paradoxical insomnia, and subjective-objective sleep discrepancy. The term sleep-wake state discrepancy is used in this manuscript, adopting a recent recommendation that highlighted the importance of maintaining neutrality in the study of this discrepancy without implying the individual as inaccurate or incorrect since its underlying mechanisms remain unknown (Bensen-Boakes, Lovato, et al., 2022; Harvey & Tang, 2012). While sleep-wake state discrepancy is not always a symptom of poor sleep, it is found with both PSG and actigraphy studies across various insomnia population groups (Bianchi et al., 2013; Buysse et al., 2010; Carskadon et al., 1976; Castelnovo et al., 2021; Choi et al., 2016; Edinger & Krystal, 2003; Kudo et al., 2024; Maltezos et al., 2024; Manconi et al., 2010). Furthermore, compared to normal estimators, under- and over-estimators of sleeping time were found to report a lower quality of life (Cho et al., 2022). Therefore, it is important to further our understanding of sleep-wake state discrepancy and any factors that may worsen this phenomenon.

Cognitive-emotional factors play an important role in insomnia and sleep-wake state discrepancy. Personality traits, rumination, anxiety and pre-sleep arousal all influence an individual's perception of sleep and wakefulness, as well as sleep duration (Blanken et al.,

2019; Fernandez-Mendoza et al., 2011; Hermans et al., 2020; Kales et al., 1976; Liao et al., 2018; Means et al., 2003; Rezaie et al., 2020; Tang & Harvey, 2005). Specifically, perfectionism is a cognitive-emotional personality construct that has been suggested as a predisposing and possible perpetuating factor for insomnia (Lundh et al., 1994; van de Laar et al., 2010). An individual with heightened perfectionism is broadly characterised by having unrelenting standards and being excessively critical of one's own performance and behaviours (Frost et al., 1990; Hewitt & Flett, 1991). Past research has identified specific facets of perfectionism, including Concern over Mistakes (reacting adversely to and perceiving mistakes as failures), Doubts about Action (having doubts or feeling uncertain about one's own behaviours) and Socially Prescribed Perfectionism (believing others expect one to be perfect) to be associated with both objective and self-reported markers of poor sleep (Akram et al., 2015; Akram et al., 2017; Akram et al., 2020; Akram et al., 2023; Andersson et al., 2005; Azevedo et al., 2010; Azevedo et al., 2009; Brand et al., 2015; Jansson-Frojmark & Linton, 2007; Johann et al., 2023; Johann et al., 2017; Lombardo et al., 2013; Lundh et al., 1994; Maia et al., 2011; Molnar et al., 2023; Oh et al., 2026; Oh et al., 2024; Richardson & Gradisar, 2020; Schmidt et al., 2018; Trudel-Fitzgerald et al., 2017; Vincent & Walker, 2000). Notably, our previous study showed that perfectionism relates more strongly to self-reported than objective markers of poor sleep, and those who self-reported higher levels of sleep onset latency and lower sleep efficiency also reported higher levels of perfectionism (Oh et al., 2024). However, whether sleep-wake discrepancy exists in individuals with perfectionism and how perfectionism may play a role in sleep-wake state discrepancy remains unknown.

Poor sleep may be maintained by an interaction between cognitive sleep beliefs (e.g., "I must get eight hours of sleep to function properly") and hyperarousal with perfectionism. Riemann et al. (2010) indicated that hyperarousal is a key feature in cognitive and/or

neurobiological based insomnia models, some which attempt to account for the phenomenon of sleep-wake state discrepancy (Buysse et al., 2011; Espie et al., 2006; Harvey, 2002; Harvey & Tang, 2012; Lundh & Broman, 2000; Morin, 1993; Ong et al., 2012; Perlis et al., 1997). Pre-sleep arousal, a form of hyperarousal, can occur as somatic and/or cognitive activation during the transition to sleep, and is disruptive to sleep initiation and maintenance (Nicassio et al., 1985). Somatic or physiological arousals relate to physical sensations experienced from a racing heart, bodily tensions, jitteriness or nervousness, while cognitive arousals relate to worries or a racing mind that is difficult to control. Hyperarousal and pre-sleep cognitive arousal have been found to be associated with sleep-related metacognitive processes in insomnia which may contribute to sleep-wake state discrepancy (Harvey & Tang, 2012; Palagini et al., 2016). Furthermore, dysfunctional beliefs about sleep, worry and attentional bias have been suggested to perpetuate insomnia and are linked to sleep-wake state discrepancy (Harvey & Tang, 2012; Morin et al., 2007). Given that perfectionism is associated with higher physiological arousals and that individuals with perfectionistic concerns can become anxious about their sleep performance and subsequent effects of poor sleep to drive cognitive and emotional arousals, perfectionism is theorised to be a risk factor for poor sleep and may contribute to sleep-wake state discrepancy (Besser et al., 2008; Espie et al., 2006; Lundh et al., 1991; Riemann et al., 2010).

Additionally, anxiety and stress, dysfunctional beliefs about sleep, counterfactual processing and arousability have been identified as mediators in the relationship between perfectionism and poor sleep (Akram et al., 2017; Akram et al., 2020; Brand et al., 2015; Oh et al., 2026; Oh et al., 2024; Schmidt et al., 2018; Trudel-Fitzgerald et al., 2017). In a recent network analysis study, Zhao et al. (2024) found direct associations between insomnia severity, dysfunctional beliefs and attitudes about sleep and hyperarousal. Furthermore, hyperarousal was identified as a key node linking insomnia and perfectionism, whereby

Concern over Mistakes, Doubt about Actions, Parental Expectations and Personal Standards were positively associated with hyperarousal. In another study, it was suggested that potential interaction effects between perfectionism and pre-sleep arousal perpetuated insomnia symptoms based on the observation that individuals with high Concern over Mistakes and Doubts about Action experienced poorer sleep on days of higher pre-sleep arousal (Kuskens et al., 2023). To date, no study has explored whether and how perfectionism relates to hyperarousal or dysfunctional sleep beliefs and the impact this may have on sleep-wake state discrepancy.

This study extends our previous work which found stronger relationships between perfectionism and self-reported sleep measures compared to objective sleep measures (Oh et al., 2024). We aim to investigate whether sleep-wake state discrepancy plays a role in the relationships between perfectionism and poor sleep by 1) exploring the relationships between dimensions of perfectionism and measures of sleep-wake state discrepancy, and 2) investigating whether dysfunctional sleep beliefs and attitudes and pre-sleep arousal mediate the relationships between perfectionism and sleep-wake state discrepancy. No *a priori* hypothesis was made given a lack of past research findings, and these aims are considered explorative.

6.3 Materials and Methods

6.3.1 Participants

Participants, aged 18 years and above, were recruited from the University of Melbourne's Research Experience Program, through social media and word of mouth or referred from the Melbourne Sleep Disorder Centre by their sleep physician. Participants from the Research Experience Program were undergraduate psychology students, who responded to an online advertisement at the University of Melbourne, Australia to receive course credit for participation in the screening survey. Potential participants from all

recruitment pathways were assessed for study eligibility by completing an online screening survey via Qualtrics (https://www.qualtrics.com, URL accessed on 09 January 2021). A diagnosis of clinical insomnia was not required for participation, but participants were required to self-report levels of insomnia symptomology using the Insomnia Severity Index (ISI, Bastien et al., 2001). Therefore, the final sample consisted of participants from both clinical and general populations. Participants who reported the following were excluded: (a) current diagnosis of mental illness; (b) central nervous disorder; (c) prior head injury; (d) shift work, defined as paid employment with rotating shifts or including work hours outside of 7:00AM to 6:00PM, or starting work before 7:00AM or after 2:00PM; (e) symptoms consistent with sleep disorders other than insomnia (e.g., restless leg syndrome, obstructive sleep apnoea).

Initially, 1132 screening responses were obtained. After excluding duplicate or incomplete responses and those who declined to proceed with further study participation, 243 eligible participants were contacted for further study participation. Sixty-five participants agreed and participated in the two-week actigraphy sleep study, which resulted in a final sample of 60 after excluding participants with actigraphy recording errors (i.e., due to non-wear and/or data corruption) and/or incomplete survey responses. In the final sample, 7% were recruited from Melbourne Sleep Disorder Centre, 35% from Research Experience Program, and 58% from social media or by word of mouth. Objective and self-reported sleep data from this current sample were previously analysed and published (Oh et al., 2024). Using the same sample, the current study extends on this work by investigating sleep wake state discrepancy.

Informed written consent was obtained online from all participants. Upon completing the actigraphy sleep study, each participant received a $25 online gift voucher. The Human

Research Ethics Committee at the University of Melbourne granted approval of this research study (HREC ID 1955374).

6.3.2 Sleep and Sleep-Related Measures

Collection of both self-reported and objective sleep measures occurred throughout the 14-day actigraphy study. The Pittsburgh Sleep Diary (PSD; Monk et al., 1994) was delivered to participants' smartphones daily via the Smartphone Ecological Momentary Assessment app (SEMA3; Koval et al., 2019). The PSD facilitated calculation of self-reported total sleep time (TST), sleep onset latency (SOL) and wake after sleep onset (WASO) by capturing daily self-reports of bedtime, lights out time, minutes to sleep, waketime, etc. To measure objective sleep, participants wore GENEActiv devices (Activinsights, Cambridge, United Kingdom) on their non-dominant wrist, recording accelerometer data at 40Hz. GENEActiv PC Software (version 3.3) was used to extract the accelerometer data before being processed with GGIR (version 2.6.0) using R (version 4.0.5). Sleep recordings were extracted based on T3A10 GGIR parameters, which detected sleep by the absence of arm angle changes above 10-degrees for at least 3 minutes. This setting was chosen over its default T5A5 setting because GGIR's validation against polysomnography suggested that a reduced time window and increased angle threshold improved sensitivity in sleep detection (van Hees et al., 2015). Sleep recordings were evaluated and used to calculate objective TST and WASO. Objective SOL was calculated as the difference between participants' self-reported lights-out time and GGIR-defined sleep onset time.

6.3.2.1 Sleep-Wake State Discrepancy Calculations. Daily sleep-wake state discrepancies were calculated as the differences between self-reported and objective measures of SOL, WASO and TST as these arithmetic differences are most commonly used as measures of sleep discrepancy (Walton et al., 2024). Higher discrepancy values indicated higher self-reported estimates of each sleep measure compared to objective sleep. After

adjusting for missing or unusable data, the score for each sleep-wake state discrepancy variable for each participant was calculated as an average over the number of nights where usable data were recorded over the 14 days.

6.3.2.2 Insomnia Severity Index. At the end of the 14-day actigraphy sleep study, participants completed the Insomnia Severity Index (ISI; Bastien et al., 2001), which is a self-reported questionnaire measuring the nature, severity and impact of insomnia over the past two weeks. The ISI has 7 items, which are rated on a 5-point Likert scale from 0 (no problem) to 4 (very severe problem), with a total score ranging from 0 to 28. It has a good sensitivity of 86.1% and specificity at 87.7% for identifying insomnia in a community sample using a cut-off score of 10, and excellent internal consistency with Cronbach alphas of 0.90 and 0.91 for community and clinical samples, respectively (Morin et al., 2011).

6.3.2.3 Dysfunctional Beliefs and Attitudes about Sleep Scale and Pre-Sleep Arousal Scale. Other sleep-related measures collected at the start of the actigraphy sleep study period were the abbreviated version of the Dysfunctional Beliefs and Attitudes about Sleep Scale (DBAS; Morin et al., 2007) and the Pre-Sleep Arousal Scale (PSAS; Nicassio et al., 1985). The DBAS consists of 16 items assessing the degree of dysfunctional sleep/insomnia-related thoughts, where each item is rated on a Likert scale from 0 (strongly disagree) to 10 (strongly agree). The DBAS covers four subscales of sleep-related thoughts that includes two items on expectations about sleep (DBAS-E), six items on worries about sleep (DBAS-W), five items on consequences of insomnia (DBAS-C) and three items on beliefs about sleep medication (DBAS-M). All its subscales and total score range from 0 to 10 (average across the items) with a higher score indicating a higher level of dysfunctional beliefs and attitudes about sleep/insomnia. The DBAS is both internally consistent and stable over time with Cronbach alphas of .77 in the clinical sample and .79 in the research sample, and a test-retest correlation coefficient of .83 (Morin et al., 2007). The PSAS measures the

level of arousal experienced at bedtime when attempting to initiate sleep. It includes two subscales consisting of eight somatic arousal (PSAS-S) symptoms and eight cognitive arousal (PSAS-C) symptoms. Each item is rated on a 5-point Likert scale from 1 (not at all) to 5 (extremely), giving rise to subscale scores ranging from 8 to 40, where higher scores indicate higher levels of arousal before falling asleep. The PSAS has good internal consistency with Cronbach's alphas of PSAS-S and PSAS-C ranging from .79 to .84 and .67 to .88 in college students, normal sleepers and insomniacs respectively; as well as good temporal reliability with test-retest correlations of .76 for PSAS-S and .72 for PSAS-C (Nicassio et al., 1985).

6.3.3 Perfectionism Measures

The Frost Multidimensional Perfectionism Scale (FMPS; Frost et al., 1990) and Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS; Hewitt & Flett, 1991) were used to assess the multidimensions of perfectionism. The FMPS has 35 items, which are rated on a Likert scale from 1 (disagree strongly) to 5 (agree strongly). These items form 6 subscales: Concern over Mistakes (reacting adversely to and perceiving mistakes as failures), Doubts about Actions (having uncertainty about one's performance), Parental Expectations (perceiving parents to set high standards for oneself), Parental Criticism (perceiving parents as being highly critical of oneself), Personal Standards (having high self-evaluation standards) and Organisation (preferring order and structure). Refer to Table 6.1 for the score range of each subscale and total FMPS, which excludes the Organisation subscale. Higher scores indicate higher levels of perfectionism. Each subscale has good internal consistency with Cronbach's alphas and reliability coefficients ranging from .77 to .93 and .77 to .94, respectively (Frost et al., 1990). The HFMPS has 45 items, which are rated on a Likert scale from 1 (disagree) to 7 (agree), and three subscales: Self-oriented Perfectionism (expecting oneself to have high standards), Other-oriented Perfectionism (expecting others to have high standards) and Socially Prescribed Perfectionism (perceiving others to set high standards for

oneself). Each subscale has a score range of 7 to 105 with higher levels of perfectionism indicated by higher scores. Each subscale has good internal consistency with Cronbach's alphas ranging .74 to .88 (Hewitt & Flett, 1991).

6.3.4 Study Protocol

After initial screening and prior to beginning the actigraphy study, lead researcher (S.O.) met with each participant either in-person or online via Zoom (https://zoom.au, URL accessed on 21 April 2021). During this meeting, participants completed the FMPS, HFMPS, DBAS and PSAS; and were set up with or sent via post (prior to the online meeting) an actigraphy watch and given explanations about the actigraphy watch and study protocol. The accelerometer was worn by participants on their non-dominant wrist 24 hours a day over the 14-day actigraphy study period. Removal of the accelerometer was allowed during swimming, contact sports and/or to meet work requirements. Over the 14 days, participants received daily notifications and reminders via SEMA3 within specific data collection input timeframes to fill in the PSD (e.g., participants were prompted and allowed to fill in the morning diary between 7:30AM and 1:30PM and the bedtime diary between 8:30PM and 12:30AM). At the end of the actigraphy study period, participants completed the ISI, were debriefed and thanked in a meeting, and received remuneration.

6.3.5 Statistical Analysis

All analyses were conducted using the statistical software package R (version 4.3.0). Due to the exploratory nature of this study, the relationships between perfectionism and sleep were assessed by correlation, regression, and mediation analyses. Firstly, the associations between perfectionism and sleep-wake state discrepancy were analysed using Pearson correlations, which were deemed to have small effect at .10, medium effect at .30 or large effect at .50 (Cohen, 1988). Prior to further analysis, sleep-wake state discrepancy measures SOL_D (discrepancy in sleep onset latency), WASO_D (discrepancy in wake after sleep

onset) and TST_D (discrepancy in total sleep time), which were derived from diary-actigraphy differences (sleep diary minus actigraphy) were visually inspected. Overall, model assumptions of normality were met.

A series of regression models were conducted for each combination of perfectionism variable (FMPS-total, HFMPS-total and subscale scores as independent variables) and sleep-wake state discrepancy measure (SOL_D, WASO_D, TST_D) as dependent variable. Age and gender were included as covariates. Using DBAS and PSAS and subscale scores as mediators, a series of mediation analyses were conducted for each selected combination of perfectionism subscale (Concern over Mistakes, Doubts about Actions) and each sleep-wake state discrepancy measure (SOL_D, WASO_D and TST_D). As per O'Rourke and MacKinnon (2018), mediation analyses were conducted despite the absence of a significant total effect. The alpha level for the two-tailed analyses was set at $p < .05$.

6.4 Results

6.4.1 Descriptive Statistics

Sixty participants were aged 18-66 years ($M = 30.28$, $SD = 11.13$), with 85.0% identifying as female. Mean and standard deviations of FMPS, HFMPS, DBAS and PSAS scores are presented in Table 6.1. Participants' ISI scores ranged from 0 to 25 ($M = 7.48$, $SD = 5.92$), with 38.3% ($n = 23$) classed as a 'poor sleeper' based on an ISI score above 9, which classifies insomnia cases in community samples (Morin et al., 2011). For the remainder of this paper, a 'poor sleeper' refers to participants with insomnia symptoms reporting an ISI score of greater than 9. Mean and standard deviation of sleep and discrepancy measures for the total sample, poor sleepers and good sleepers are presented in Figure 6.1.

Results in Table 6.2 show that compared to actigraphy, participants classified as poor sleepers self-reported worse sleep than good sleepers. First, poor sleepers reported significantly higher SOL than good sleepers ($p < .01$) despite no significant difference in their

actigraphy-derived SOL. Second, good sleepers, but not poor sleepers, significantly underestimated WASO compared to actigraphy ($p < .01$) even though their objective measures of WASO were not statistically different. Third, good sleepers reported significantly lower WASO than poor sleepers ($p = .020$). Therefore, good sleepers perceived better sleep with much less WASO across the night than was measured by actigraphy and when compared to poor sleepers, even though their objective WASO was not different to that of poor sleepers. Furthermore, good sleepers overestimated TST relative to actigraphy ($p < .01$) and reported higher TST ($p = .049$) despite having no difference in objective TST compared to poor sleepers. Given the lack of power, no further analysis was conducted on group differences in sleep discrepancy measures. Mean and standard deviation of self-reported and objective sleep parameters for all participants as a group can be found in the Appendix Table B1.

Table 6.1

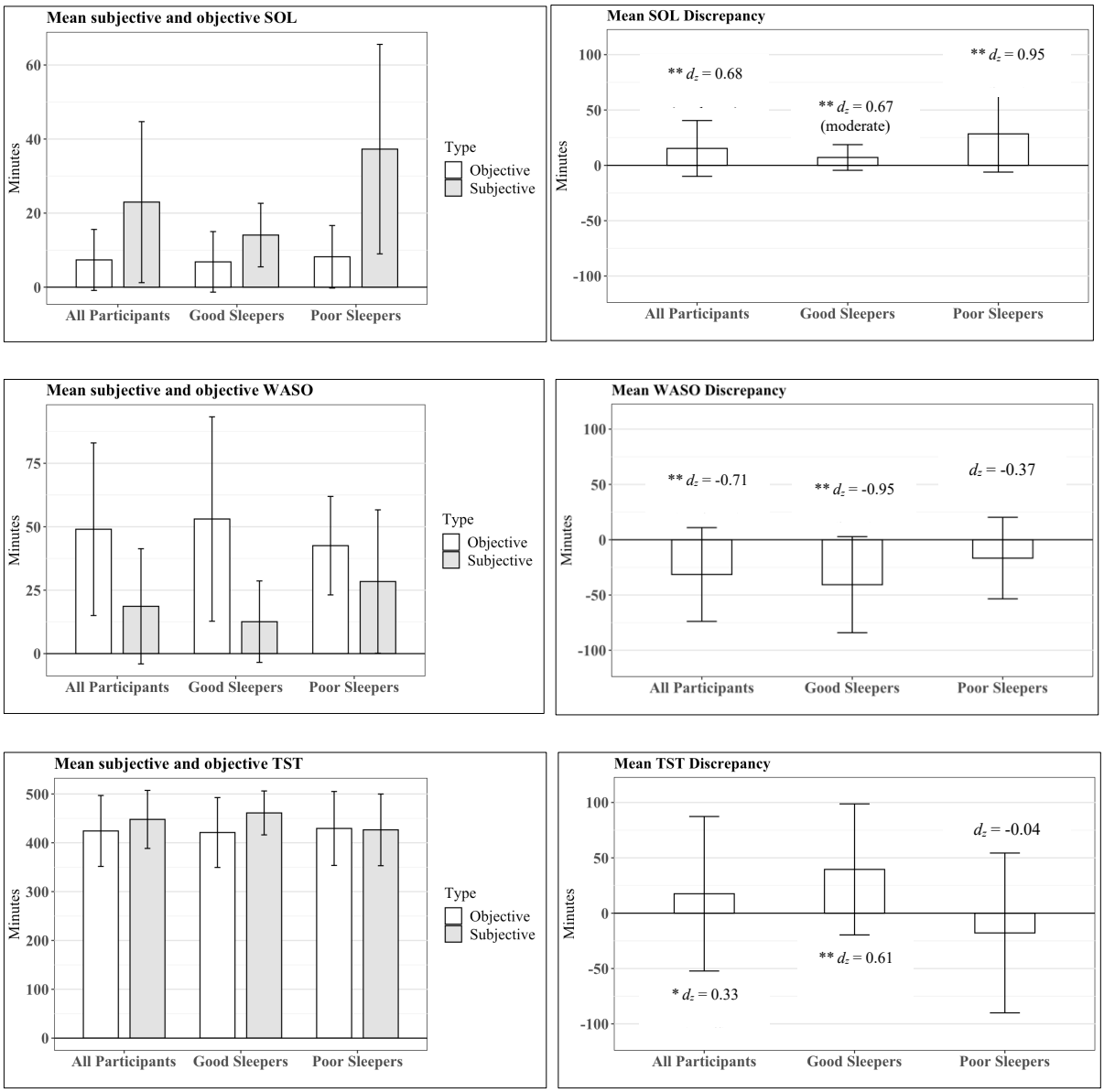
Mean scores, standard deviations, and sample range for measures of perfectionism, dysfunctional sleep beliefs and attitudes, and pre-sleep arousal for all participants

	M	*SD*	Sample Range (Score Range)
FMPS	86.9	19.69	41 – 141 (29 – 145)
Concern over Mistakes	26.92	8.18	11 – 45 (9 – 45)
Doubts about Actions	11.87	3.77	5 – 20 (4 – 20)
Parental Criticism	9.37	4.04	4 – 20 (4 – 20)
Parental Expectation	13.2	4.54	6 – 25 (5 – 25)
Organisation	24.58	3.43	15 – 30 (6 – 30)
Personal Standards	25.58	5.65	9 – 35 (7 – 35)
HFMPS	177.2	29.85	100 – 238 (45 – 315)
Self-oriented Perfectionism	72.3	14.9	33 – 105 (15 – 105)
Other-oriented Perfectionism	52.48	13.36	23 – 81 (15 – 105)
Socially Prescribed Perfectionism	52.47	13.37	28 – 105 (15 – 105)
DBAS	4.68	1.91	0.44 – 10 (0 – 10)
DBAS-Expectations	6.46	2.70	0 – 10 (0 – 10)
DBAS-Worries	4.23	2.37	0 – 10 (0 – 10)
DBAS-Consequences	5.59	2.19	0.40 – 10 (0 – 10)
DBAS-Medication	2.88	2.18	0 – 10 (0 – 10)
PSAS	34.93	12.60	17 – 79 (16 – 80)
PSAS-Somatic	14.05	5.35	8 – 39 (8 – 40)
PSAS-Cognitive	20.88	8.32	8 – 10 (8 – 40)

Notes. FMPS, Frost Multidimensional Perfectionism Scale; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; DBAS, Dysfunctional Beliefs and Attitudes about Sleep; PSAS, Pre-Sleep Arousal Scale.

Figure 6.1

Sleep-wake state discrepancy measures across groups (mean and standard deviation)



Notes. SOL = sleep onset latency; WASO = wake after sleep onset; TST = total sleep time. In discrepancy measures, a positive score denotes overestimation while a negative score denotes underestimation. Vertical lines depict standard deviation. Asterisk indicates significant difference between self-reported and objective measures of sleep parameter with Cohen's dz effect size presented. *p < .05, **p < .01.

Table 6.2

Mean scores and standard deviations of sleep measures by groups with within and between group differences

	Self-reported	Objective	Within group difference
	SOL_S	SOL_O	SOL (*t*-value)
Good sleepers	14.07 +/- 8.58	6.84 +/- 8.17	4.09**
Poor sleepers	37.28 +/- 28.29	8.20 +/- 8.44	4.57**
Between group difference (*t*-value)	3.83**	0.62	
	WASO_S	WASO_O	WASO (*t*-value)
Good sleepers	12.58 +/- 16.05	53.04 +/- 40.27	-5.76**
Poor sleepers	28.40 +/- 28.25	42.54 +/- 19.41	-1.77
Between group difference (*t*-value)	2.45*	-1.35	
	TST_S	TST_O	TST (*t*-value)
Good sleepers	461.20 +/- 44.96	421.07 +/- 71.53	3.68**
Poor sleepers	426.51 +/- 73.40	429.38 +/- 75.73	-0.19
Between group difference (*t*-value)	-2.04*	-0.43	

Notes. SOL = sleep onset latency; WASO = wake after sleep onset; TST = total sleep time.

*$p < .05$, **$p < .01$.

Table 6.3

Correlations between sleep discrepancy measures, perfectionism, sleep beliefs and attitude and pre-sleep arousal

n = 60	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. SOL_D																					
2. WASO_D	.32*																				
3. TST_D	-.66**	-.73**																			
4. FMPS	.23	.01	-.14																		
5. CM	.26*	.01	-.15	.88**																	
6. DA	.29*	.02	-.21	.71**	.62**																
7. PC	.08	-.06	-.02	.71**	.48**	.42**															
8. PE	-.05	-.05	.05	.62**	.30*	.19	.72**														
9. O	.01	.03	.03	.09	.07	.08	-.16	.03													
10. PS	.22	.11	-.18	.74**	.62**	.44**	.20	.29*	.26*												
11. HFMPS	.09	-.01	-.09	.79**	.70**	.52**	.46**	.45**	.13	.70**											
12. SOP	.14	-.01	-.09	.72**	.67**	.53**	.25	.23	.29*	.82**	.76**										
13. OOP	-.13	.08	-.07	.20	.13	.05	.20	.25	-.08	.13	.56**	.02									
14. SPP	.18	-.09	-.03	.76**	.67**	.53**	.55**	.50**	.05	.52**	.83**	.57**	.22								
15. DBAS	.10	-.03	.06	.47**	.39**	.36**	.34**	.33*	.32*	.31*	.42**	.37**	.03	.49**							
16. DBAS-E	-.20	.16	.20	.19	.06	.20	.22	.22	.40**	.10	.15	.19	-.01	.13	.60**						
17. DBAS-W	.13 13	.04	-.02	.46**	.42**	.30*	.31*	.30*	.21	.33**	.46**	.35**	.10	.53**	.92**	.37**					
18. DBAS-C	.13	-.09	.09	.41**	.33*	.43**	.29*	.23	.30*	.29*	.33*	.33**	.02	.34**	.86**	.57**	.66**				
19. DBAS-M	.12	.06	.02	.33**	.29*	.19	.25	.30*	.21	.18	.27*	.24	-.11	.45**	.74**	.19	.71**	.45**			
20. PSAS	.37**	.16	-.32*	.51**	.54**	.51**	.22	.13	.01	.39**	.48**	.49**	-.06	.59**	.57**	.09	.59**	.48**	.49**		
21. PSAS-S	.21	.08	-.19	.40**	.42**	.41**	.28*	.12	-.10	.22	.45**	.37**	.00	.58**55	.46**	.04	.48**	.37**	.42**	.88**	
22. PSAS-C	.42**	.18	-.36**	.51**	.54**	.51**	.16	.13	.08	.44**	.44**	.50**	-.09	.51**	.56**	.11	.57**	.48**	.47**	.95**	.68**

Notes. SOL_D = discrepancy in sleep onset latency; WASO_D = discrepancy in wake after sleep onset; TST_D = discrepancy in total sleep time; FMPS = Frost Multidimensional Perfectionism Scale; CM = Concern over Mistakes; DA = Doubts about Actions; PE = Parental Expectations; PC = Parental Criticism; O = Organisation; PS = Personal Standards; HFMPS = Hewitt-Flett Multidimensional Perfectionism Scale; SOP = Self-oriented Perfectionism; OOP = Other-oriented Perfectionism; SPP = Socially Prescribed Perfectionism; DBAS = Dysfunctional Beliefs and Attitudes about Sleep; DBAS-E = DBAS subscale Sleep Expectations; DBAS-W = DBAS subscale Worry about Sleep; DBAS-C = DBAS subscale Consequences of Insomnia; DBAS-M = DBAS subscale Medication; PSAS = Pre-sleep Arousal Scale; PSAS-S = Somatic subscale of the Pre-sleep Arousal Scale; PSAS-C = Cognitive subscale of the Pre-sleep Arousal Scale. *$p < .05$, **$p < .01$.

Table 6.4

Regression coefficients between sleep discrepancy measures and perfectionism

n = 60	SOL_D			WASO_D			TST_D		
	β	*95% CI*	*p*	*β*	*95% CI*	*p*	*β*	*95% CI*	*p*
FMPS	0.28	-0.06, 0.62	.11	0.08	-0.50, 0.66	.78	-0.51	-1.45, 0.44	.29
CM	0.75	-0.06, 1.57	.07	0.23	-1.19, 1.64	.75	-1.36	-3.66, 0.94	.24
DA	1.87	0.14, 3.61	.03*	0.42	-2.60, 3.45	.78	-3.87	-8.74, 1.00	.12
PC	0.44	-1.22, 2.09	.60	-0.58	-3.36, 2.19	.67	-0.29	-4.86, 4.28	.90
PE	-0.40	-1.88, 1.09	.59	-0.35	-2.84, 2.14	.78	0.90	-3.20, 5.00	.66
O	0.07	-1.93, 2.07	.95	0.23	-3.13, 3.59	.89	1.38	-4.13, 6.90	.62
PS	0.97	-0.19, 2.13	.10	0.83	-1.16, 2.81	.41	-2.01	-5.25, 1.23	.22
HFMPS	0.06	-0.17, 0.29	.60	0.04	-0.35, 0.42	.85	-0.27	-0.90, 0.36	.39
SOP	0.21	-0.24, 0.66	.35	0.21	-0.24, 0.66	.35	-0.37	-1.62, 0.88	.56
OOP	-0.28	-0.79, 0.23	.28	0.35	-0.51, 1.21	.41	-0.57	-1.98, 0.85	.43
SPP	0.31	-0.20, 0.82	.23	-0.18	-1.04, 0.69	.68	-0.34	-1.77, 1.08	.63

Notes. SOL_D = discrepancy in sleep onset latency; WASO_D = discrepancy in wake after sleep onset; TST_D = discrepancy in total sleep time; FMPS = Frost Multidimensional Perfectionism Scale; CM = Concern over Mistakes; DA = Doubts about Actions; PE = Parental Expectations; PC = Parental Criticism; O = Organisation; PS = Personal Standards; HFMPS = Hewitt-Flett Multidimensional Perfectionism Scale; SOP = Self-oriented Perfectionism; OOP = Other-oriented Perfectionism; SPP = Socially Prescribed Perfectionism. *$p < .05$.

6.4.2 Correlation and Regression Analyses of Sleep-Wake State Discrepancy Measures and Perfectionism

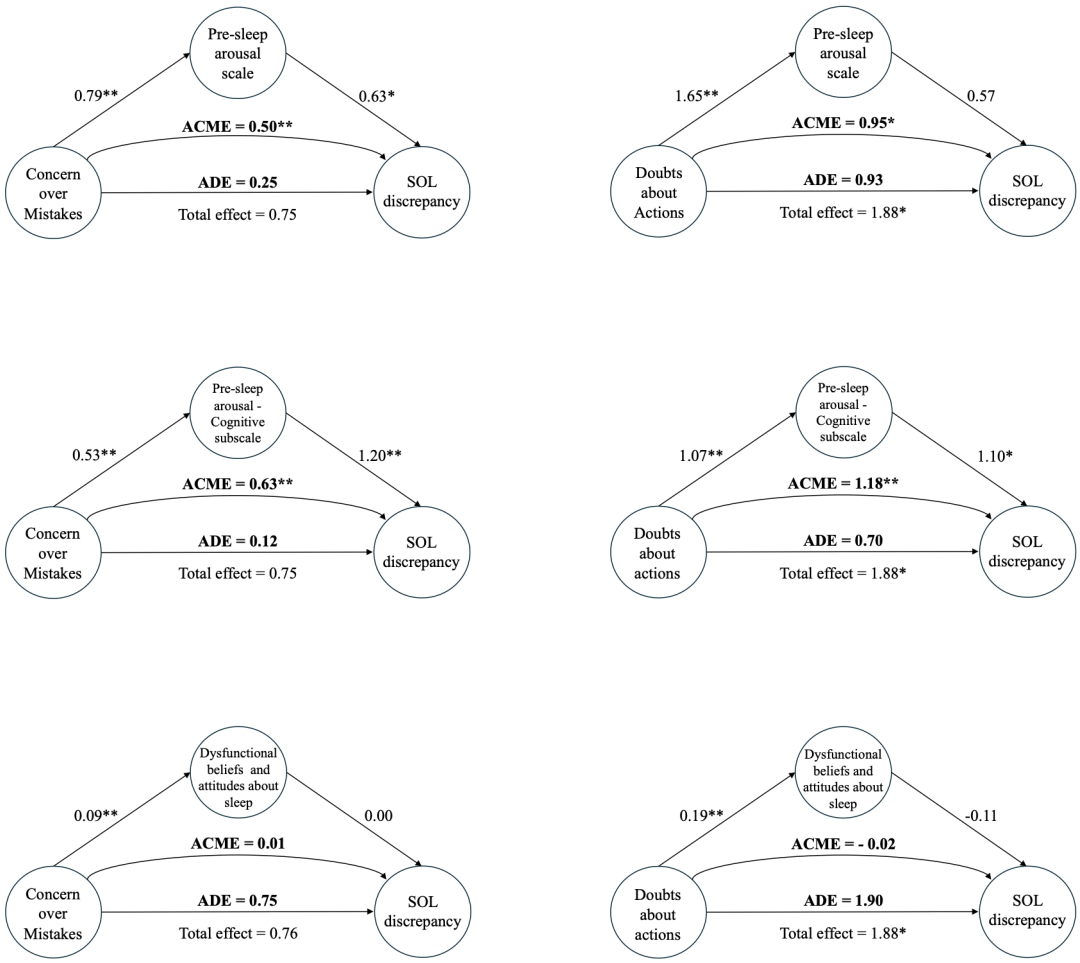
Results in Tables 6.3 and 6.4 show significant positive correlations were found between SOL_D (discrepancy in sleep onset latency) and Concern over Mistakes ($r = 0.26$, $p = .041$) and Doubts about Actions ($r = 0.29$, $p = .023$), which were considered to have small-to-medium effects (Cohen, 1988). However, only Doubts about Action was associated with sleep onset discrepancy in regression analysis as no other perfectionism scale or subscales were significant predictors of the various sleep-wake state discrepancy measures.

6.4.3 Mediation Analyses Using DBAS and PSAS as Mediators in the Relationships between Sleep Discrepancy Measures and selected Measures of Perfectionism

Results from the mediation analyses largely mirrored the results from the regression analyses. None of the mediation analyses using DBAS, DBAS subscales or the PSAS somatic subscale as mediators were significant (see Tables B2-B7 in Appendix). Given results relating to SOL_D are in line with sleep-wake state discrepancy typically found in insomnia, results relating to SOL_D are presented here. All mediation analyses results relating to WASO_D and TST_D can be found in Tables B2-B7 in the Appendix. As shown in Figure 6.2, while the total effect of Concern over Mistakes on SOL_D was not significant, the mediation effect of PSAS and PSAS-Cognition on that relationship was significant. An increase in Concern over Mistakes is associated with a larger discrepancy in SOL (higher perceived SOL relative to objective SOL) via PSAS and PSAS-Cognition as mediators. Similarly, the relationship between Doubts about Action and SOL_D was mediated by PSAS and PSAS-Cognition. Included in Figure 6.2 for comparison, the mediation analyses using DBAS as a mediator in the relationships between Concern over Mistakes and Doubts about Action with SOL_D were not significant. Considering the number of analyses conducted in the current study, which could increase the risk of Type 1 error, results should be interpreted with caution.

Figure 6.2

Results from mediation analyses using PSAS, PSAS subscale Cognition and DBAS as a mediator in the relationship between sleep onset latency discrepancy and Concern over Mistakes and Doubts about Actions subscales of perfectionism (n = 60, simulations = 10,000)



Notes. ACME = average causal mediation effects; ADE = average direct effects; CM = Concerns over Mistakes; DA = Doubts about Actions; PSAS = Pre-Sleep Arousal Scale; PSAS-C = Pre-Sleep Arousal Scale Cognitive arousal subscale; DBAS = Dysfunctional Beliefs and Attitudes about Sleep Scale; SOL_D = discrepancy in sleep onset latency. *p < .05, **p < .01.

6.5 Discussion

This study explored the relationships between dimensions of perfectionism and sleep-wake state discrepancy, as measured by self-reported and actigraphy-derived objective sleep measures. It was explored whether these relationships were mediated by dysfunctional sleep beliefs and attitudes and pre-sleep arousal. Results showed individuals who reported higher levels of perfectionism also demonstrated higher levels of sleep-wake state discrepancy. Specifically, those who reported higher levels of Concern over Mistakes and Doubts about Actions also reported higher discrepancy in sleep onset latency. Furthermore, Doubts about Actions was a significant predictor of sleep onset latency discrepancy, and that relationship was mediated by pre-sleep arousal and cognitive pre-sleep arousal. Pre-sleep arousal and cognitive pre-sleep arousal also mediated the relationship between Concern over Mistakes and sleep onset latency discrepancy. Overall, these results suggest certain aspects of perfectionism (i.e., Concern over Mistakes and Doubts about Actions) relate to a poorer perception of sleep relative to objective sleep measures. Exploratory analyses suggest that cognitive pre-sleep arousal may mediate this relationship and is associated with sleep-wake state discrepancy during sleep onset.

Compared to actigraphy, poor sleepers in the current study perceived their sleep to be worse than good sleepers despite having similar or better objective sleep measures. This is consistent with results of previous studies examining the sleep-wake state discrepancy in insomnia patients and healthy controls using actigraphy (Biddle et al., 2015; Buysse et al., 2010; Kudo et al., 2024; Maltezos et al., 2024). The current findings suggest sleep-wake state discrepancy may play a role in the relationship between perfectionism and poor sleep. The correlations between perfectionism dimensions of Concern over Mistakes and Doubts about Actions with discrepancy in sleep onset latency as well as the significant association between Doubts about Actions and sleep onset latency discrepancy are consistent with past research

findings that identified these facets of perfectionism to be associated with markers of poor sleep and insomnia (Akram et al., 2015; Akram et al., 2017; Akram et al., 2020; Andersson et al., 2005; Brand et al., 2015; Jansson-Frojmark & Linton, 2007; Lombardo et al., 2013; Lundh et al., 1994; Oh et al., 2026; Oh et al., 2024; Schmidt et al., 2018; Trudel-Fitzgerald et al., 2017; Vincent & Walker, 2000). It also suggests sleep-wake state discrepancy may account for the stronger relationship that perfectionism has with self-reported compared to objective markers of poor sleep, as found in our previous study (Oh et al., 2024). Given that sleep-wake state discrepancy is commonly experienced by people with insomnia, this provides a new line of preliminary evidence to support the theory that perfectionism may serve as a predisposing and potential perpetuating factor for insomnia (Castelnovo et al., 2019; Lundh et al., 1994; van de Laar et al., 2010).

We observed self-reported overestimation of sleep onset latency and total sleep time, and underestimation of wake after sleep onset relative to actigraphy measures. This is consistent with findings from a large community sample of women in the United States by Lehrer et al.(2022). These findings may appear to contradict past research indicating that patients with insomnia tend to underestimate total sleep time relative to objective measures of sleep using actigraphy (Harvey & Tang, 2012; Tang & Harvey, 2004, 2006). However, the difference may be accounted for by our current predominant community-based sample compared to clinical samples used in previous studies. This finding is also consistent with past demographic studies showing that sleep tends to be overestimated in the general population (Cho et al., 2022; Fernandez-Mendoza et al., 2011; Park et al., 2020; Van Den Berg et al., 2008). Furthermore, some studies have also reported the underestimation of self-reported WASO relative to objective WASO using actigraphy and polysomnography (Bianchi et al., 2013; Buysse et al., 2010; Kudo et al., 2024). Given that actigraphy proxies sleep via a lack of body movement, the detection of minor body movement during sleep as

wake could have also contributed to the overestimation of WASO relative to self-report (Lockley et al., 1999; Sadeh, 2011; van Hees et al., 2015).

Although both good and poor sleepers in our sample underestimated wake after sleep onset, the difference between self-reported and actigraphy-derived wake after sleep onset was not significant in poor sleepers, but it was significant in good sleepers. This is consistent with the finding that people with insomnia perceive their wake after sleep onset to be consistent with actigraphy-derived wake after sleep onset (Maltezos et al., 2024). It also aligns with the recommendation that unlike actigraphy measures of sleep onset latency and total sleep time, actigraphy wake after sleep onset is considered imprecise compared to polysomnography in assessing and treating adult insomnia (M. M. Smith et al., 2018). Given the above and that self-reported total sleep time was derived using wake after sleep onset, we focused our attention on sleep onset latency discrepancy.

Pre-sleep arousal, specifically cognitive pre-sleep arousal, mediated the relationship between sleep onset latency discrepancy and Doubts about Actions, as well as Concern over Mistakes. This current finding parallels past research that identified arousability and counterfactual processing as mediators in the relationship between perfectionism and poor sleep (Brand et al., 2015; Schmidt et al., 2018; Trudel-Fitzgerald et al., 2017). It is also consistent with recent research supporting the role of hyperarousal and pre-sleep arousal in insomnia. Zhao et al. (2024) identified hyperarousal as the link between insomnia and the perfectionism dimensions of Concern over Mistakes and Doubts about Actions. Similarly, Kuskens et al. (2023) found that those with higher Concern over Mistakes and Doubts about Actions experienced worse sleep on days of higher pre-sleep arousal than on days of lower pre-sleep arousal. This study takes the literature further by potentially identifying sleep-wake state discrepancy as a plausible symptom of poor sleep experienced by those who have high levels of perfectionism and experience hyperarousal in the pre-sleep period.

Individuals who are highly perfectionistic are thought to experience higher arousal in the period before sleep, which may contribute to a delay in sleep onset (Lundh et al., 1994; Vincent & Walker, 2000). One plausible explanation for the current findings may be that on nights when individuals are aroused due to being excessively concerned about mistakes or doubting their own actions that might have occurred during the day or in the past, sleep onset can become delayed due to rumination or worry. As such, the automaticity of sleep normalcy becomes disrupted, which would be consistent with the attention-intention-effort pathway model of insomnia (Espie et al., 2006). Given that self-reported sleep is assessed the next morning in studies of sleep-wake discrepancy, those who excessively doubt their own actions may subsequently doubt their ability to initiate sleep, leading them to question how long it took for them to fall asleep and/or even question their time asleep and mistaking it as wake, leading to an overestimation of sleep onset latency. This is consistent with time overestimation and perceiving sleep as wake in explaining sleep-wake state discrepancy when experiencing higher cognitive arousal, which were suggested to be related to worry, selective attention and monitoring (Harvey & Tang, 2012; Mercer et al., 2002; Tang & Harvey, 2005). Furthermore, this ties in with past research that found worry, anxiety and rumination to be significantly associated with Concern over Mistakes and Doubts about Actions (Flett et al., 2011; Handley et al., 2014; Xie et al., 2019) The current findings, therefore, add exploratory evidence to suggest pre-sleep arousal as an indirect effect through which perfectionism may influence the cognitive and emotional interpretations of sleep experiences associated with sleep-wake state discrepancy, which can lead to perception of poor sleep.

Notably, the current study did not find evidence to support the mediating role of dysfunctional sleep cognitions in the relationship between perfectionism and sleep-wake state discrepancy. This is inconsistent with a previous finding of the mediating role of

dysfunctional sleep cognitions between insomnia symptoms and Doubts about Actions using a similar but much larger general population sample by Akram et al. (2020). It is plausible that the current sample size was too small to detect the effects or that sleep-wake state discrepancy is not a symptom of insomnia that is affected by these dysfunctional sleep cognitions. However, our current study is consistent with the network analysis findings in a recent study of young adults by Zhao et al. (2024). The authors found only hyperarousal, but not dysfunctional sleep cognitions, to be a key node linking insomnia and perfectionism despite finding direct associations between insomnia severity, dysfunctional beliefs and attitudes about sleep and hyperarousal. The role, if any, that dysfunctional sleep cognitions play in the relationships between perfectionism and sleep-wake state discrepancy and insomnia remains unclear.

6.5.1 Theoretical and Clinical Implications

Results from the current study provide new exploratory evidence supporting prior theoretical conceptualisations and empirical literature suggesting that perfectionism is a contributing factor in poor sleep and insomnia. Specifically, pre-sleep arousal was identified as an indirect effect in which perfectionism may lead to sleep-wake state discrepancy. It is not uncommon for people with insomnia to report their sleep to be worse than objective sleep measures obtained simultaneously (Castelnovo et al., 2019). This study has identified sleep-wake state discrepancy to be associated with perfectionism via the mediating effect of pre-sleep arousal. Together, these provide insight into the theoretical conceptualisation of how perfectionism may serve as a plausible predisposing and perhaps perpetuating risk factor for poor sleep in line with cognitive models of insomnia (Castelnovo et al., 2019; Lundh et al., 1994; van de Laar et al., 2010; Vincent & Walker, 2000).

Although this study was conducted primarily on a community-based sample, it may provide some important clinical insights for insomnia management. It is possible that the

current findings could have stronger effects in a clinical sample. Nevertheless, the following discussion on clinical insights are speculative given the exploratory nature of the current study. It may be important for clinicians to consider possible traits of perfectionism, particularly Concern over Mistakes and Doubts about Actions, in addition to initial diagnostic indications of prolonged self-reported sleep onset latency when assessing the nature of their patients' sleep perceptions. The specific subscales of the FMPS can be easily incorporated into clinical practice to screen for such traits of perfectionism. Furthermore, clinicians should exercise caution in relying on self-reported sleep measures and consider supplementing with objective measures in the assessment and monitoring of sleep in this population group, particularly where sleep-wake state discrepancy may be contributing to the complaints of poor sleep. As suggested by Fernandez-Mendoza et al. (2011), different sleep phenotypes may respond better to different treatment approaches. The current results, if confirmed with a clinical sample in the future, suggest that in individuals who present with significant sleep-wake state discrepancy and high levels of perfectionism, it may be more appropriate to implement Cognitive Behavioural Therapy for Insomnia and Acceptance and Commitment Therapy for Insomnia than relying on sleep medication to reduce physiological hyperarousal and/or increase sleep duration. For example, providing psychoeducation to normalise sleep-wake state discrepancy, incorporating behavioural strategies, such as, avoiding clock checking; and introducing acceptance, mindfulness practice and relaxation training to reduce hyperarousal. Such strategies may also be more relevant than addressing dysfunctional beliefs and attitudes about sleep in the treatment of sleep-wake state discrepancy for this population group if the current findings hold true with a clinical sample. Lastly, treating perfectionistic concerns of making mistakes and doubts about actions, particularly if they relate to sleep may also be helpful in therapy. Such modifications to current standard treatment therapy will need to be tested in future research.

6.5.2 Strengths, Limitations and Future Directions

To our best knowledge, this is the first study to explore relationships between perfectionism and sleep-wake state discrepancy relating to poor sleep. Although actigraphy provided good ecological sleep data for this study, it lacks the capacity to capture other physiological and neurobiological markers of sleep, such as electrical brain activity, increased heart rate variability, muscle responses and cortical arousals, which have been suggested to contribute to sleep-wake state discrepancy (Harvey & Tang, 2012). Actigraphy may have contributed to a key limitation in the current study as self-reported lights-out time was used to partially derive objective sleep onset latency, which may be partly attributable to assessment artefact to reduce the accuracy of the actual incongruence between self-reported and objective discrepancy (Walton et al., 2024). While GeneActiv actigraphy is capable of estimating lights-out time based on the lack of movement and light, its accuracy is variable when relied on actigraphy alone, e.g., reading in bed under dim light while wearing long sleeve top, can be detected as sleep (Stone et al., 2020). Although the processing of GeneActiv actigraphy was found to be comparable with and without a sleep diary, a sleep diary is generally recommended when using actigraphy (Ancoli-Israel et al., 2015; Sansom et al., 2023). Consequently, the current study adopted the use of sleep diary to identify lights-out in an attempt to improve the accuracy of deriving objective sleep onset latency. Therefore, replicating this study using EEG-derived sleep estimates is needed to confirm the effects found here.

In a recent scoping review, Walton et al. (2024) identified alternate ways of computing sleep discrepancy measures other than arithmetic differences, which was used in the current study. For example, the Sleep Perception Index as demonstrated by Lecci et al. (2020) and Cini et al. (2025) allows for comparisons between sleep metrics and identification of patterns in discrepancy across sleep metrics. While no comparison between sleep metrics was made in

the current study and arithmetic differences are a commonly used method of calculating discrepancy measures (Walton et al., 2024) (e.g., Bensen-Boakes et al. (2023); D. B. Bensen-Boakes, Osman, et al. (2022); Moulder et al. (2024); Naito et al. (2026); Spina et al. (2023)), the Sleep Perception Index may be considered in future research. Until a consensus on sleep discrepancy measures and derivation is reached in the field, future studies should consider utilising other methods of sleep monitoring, such as, PSG, and different ways of deriving sleep discrepancy measures to explore if these factors play a role in the relationships between perfectionism and insomnia.

While the nature of this study was exploratory, the relatively small sample size with numerous analyses may increase risk of type 1 error and thus the results should be interpreted with caution. This will need further investigation in larger studies with prior hypotheses. Another limitation of this study is that resulting generalisations are based on a sample that consists of a small clinical subsample and predominantly female. While gender was included as a covariate in the analysis and insomnia is more prevalent in females, cautious generalisation of findings is warranted (Benjafield et al., 2025). The current findings were considered to have small effects, and were found using a general population sample that included both good and poor sleepers, whichcould have contributed to the conservative findings. Thereforeit is possible that stronger effects may be found using clinical samples. Although initial descriptive data analysis suggests differences exist between good and poor sleepers, between-group analysis was not conducted due to a lack of power. It will be ideal to recruit a larger sample, include both clinical and control samples and conduct between group analysis in future studies. The cross-sectional data also does not allow for causality to be determined, so future longitudinal studies are recommended. Another limitation of the current study relates to the averaging of multiple nights data, which assumes consistency across nights in patterns of sleep over/underestimation (Walton et al., 2024). Therefore, future

studies can focus on intraindividual differences across nights in these relationships to test whether daily fluctuations in levels of perfectionism impact on sleep and/or sleep-wake state discrepancy; and whether and how pre-sleep arousal plays a part in those relationships if they exist.

6.6 Conclusions

This is the first study to explore perfectionism as a possible factor in sleep-wake discrepancy in relation to markers of poor sleep. The current study found that perfectionism facets of high levels of Concern about Mistakes and Doubts about Actions may increase one's vulnerability to experiencing sleep-wake state discrepancy, and that relationship may be facilitated by heightened levels of pre-sleep arousal. These findings suggest perfectionism may be an important consideration in the assessment and treatment of poor sleep.

6.7 References

Akram, U., Ellis, J. G., & Barclay, N. L. (2015). Anxiety mediates the relationship between perfectionism and insomnia symptoms: A longitudinal study. *PLoS One, 10*(10), e0138865. https://doi.org/10.1371/journal.pone.0138865

Akram, U., Ellis, J. G., Myachykov, A., Chapman, A. J., & Barclay, N. L. (2017). Anxiety mediates the relationship between multidimensional perfectionism and insomnia disorder. *Personality and Individual Differences, 104*, 82-86. https://doi.org/10.1016/j.paid.2016.07.042

Akram, U., Gardani, M., Riemann, D., Akram, A., Allen, S. F., Lazuras, L., & Johann, A. F. (2020). Dysfunctional sleep-related cognition and anxiety mediate the relationship between multidimensional perfectionism and insomnia symptoms. *Cognitive Processing, 21*(1), 141-148. https://doi.org/10.1007/s10339-019-00937-8

Akram, U., Stevenson, J. C., Gardani, M., Allen, S., & Johann, A. F. (2023). Personality and insomnia: A systematic review and narrative synthesis. *Journal of Sleep Research*, e14031. https://doi.org/10.1111/jsr.14031

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders* (5th, text rev. ed.). American Psychiatric Association. https://doi.org/10.1176/appi.books.9780890425787

Ancoli-Israel, S., Martin, J. L., Blackwell, T., Buenaver, L., Liu, L., Meltzer, L. J., Sadeh, A., Spira, A. P., & Tyalor, D. J. (2015). The SBSM guide to actigraphy monioring: Clinical and research applications. *Behavioral Sleep Medicine, 13*, S4-S38. https://doi.org/10.1080/15402002.2015.1046356

Andersson, G., Airikka, M. L., Buhrman, M., & Kaldo, V. (2005). Dimensions of perfectionism and tinnitus distress. *Psychology, Health & Medicine, 10*(1), 78-87. https://doi.org/10.1080/13548500512331315389

Appleton, S. L., Reynolds, A. C., Gill, T. K., Melaku, Y. A., & Adams, R. J. (2022). Insomnia prevalence varies with symptom criteria used with implications for epidemiological studies: Role of anthropometrics, sleep habit, and comorbidities. *Nature and Science of Sleep, 14*, 775-790. https://doi.org/10.2147/NSS.S359437

Azevedo, M. H., Bos, S. C., Soares, M. J., Marques, M., Pereira, A. T., Maia, B., Gomes, A. A., & Macedo, A. (2010). Longitudinal study on perfectionism and sleep disturbance. *World Journal of Biological Psychiatry, 11*(2 Pt 2), 476-485. https://doi.org/10.3109/15622970903304467

Azevedo, M. H., Soares, M. J., Bos, S. C., Gomes, A. A., Maia, B., Marques, M., Pereira, A. T., & Macedo, A. (2009). Perfectionism and sleep disturbance. *World Journal of Biological Psychiatry, 10*(3), 225-233. https://doi.org/10.1080/15622970701367930

Bastien, C. H., Vallieres, A., & Morin, C. M. (2001). Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Medicine, 2*(4), 297-307. https://doi.org/10.1016/s1389-9457(00)00065-4

Benjafield, A. V., Sert Kuniyoshi, F. H., Malhotra, A., Martin, J. L., Morin, C. M., Maurer, L. F., Cistulli, P. A., Pepin, J. L., Wickwire, E. M., & medXcloud, g. (2025). Estimation of the global prevalence and burden of insomnia: a systematic literature review-based analysis. *Sleep Medicine Reviews, 82*, 102121. https://doi.org/10.1016/jsmrv.2025.102121

Bensen-Boakes, D. B., Loffler, K., Lack, L., Paterson, J., Scott, H., & Lovato, N. (2023). Measuring sleep-wake state disrepancy in the home across multiple nights. *Sleep Advances, 4*, A12-13. https://doi.org/10.1093/sleepadvances/zpad035.036

Bensen-Boakes, D. B., Lovato, N., Meaklim, H., Bei, B., & Scott, H. (2022). "Sleep-wake state discrepancy": Toward a common understanding and standardized nomenclature. *Sleep, 45*(10). https://doi.org/10.1093/sleep/zsac187

Bensen-Boakes, D. B., Osman, A., Lack, L., Catcheside, P., Antic, N., Smith, S. S., Chai-Coetzer, C. L., O'Grady, A., Dunn, N., Robinson, J., McEvoy, D., & Sweetman, A. (2022). The effect of Cognitive Behavioural Therapy for Insomnia (CBT-I) on subjective-objective sleep discrepancy in individuals with co-morbid insomnia and sleep apnoea: A randomised controlled trial. *Applied Sciences, 12*(4), 1787. https://doi.org/10.3390/app12041787

Besser, A., Flett, G. L., Hewitt, P. L., & Guez, J. (2008). Perfectionism, and cognitions, affect, self-esteem, and physiological reactions in a performance situation. *Journal of Rational-Emotive & Cognitive-Behavior Therapy, 26*(3), 206-228. https://doi.org/10.1007/s10942-007-0067-0

Bianchi, M. T., Williams, K. L., McKinney, S., & Ellenbogen, J. M. (2013). The subjective-objective mismatch in sleep perception among those with insomnia and sleep apnea. *Journal of Sleep Research, 22*, 557-568. https://doi.org/10.1111/jsr.12046

Biddle, D. J., Robillard, R., Hermens, D. F., Hickie, I. B., & Glozier, N. (2015). Accuracy of self-reported sleep parameters compared with actigraphy in young people with mental ill-health. *Sleep Health, 1*(3), 214-220. https://doi.org/10.1016/j.sleh.2015.07.006

Bin, Y. S., Marshall, N. S., & Glozier, N. (2012). The burden of insomnia on individual function and healthcare consumption in Australia. *Australian and New Zealand*

Journal of Public Health, 36(5), 462-468. https://doi.org/10.1111/j.1753-6405.2012.00845.x

Blanken, T. F., Benjamins, J. S., Borsboom, D., Vermunt, J. K., Paquola, C., Ramautar, J., Dekker, K., Stoffers, D., Wassing, R., Wei, Y., & Van Someren, E. J. W. (2019). Insomnia disorder subtypes derived from life history and traits of affect and personality. *Lancet Psychiatry, 6*(2), 151-163. https://doi.org/10.1016/S2215-0366(18)30464-4

Brand, S., Kirov, R., Kalak, N., Gerber, M., Puhse, U., Lemola, S., Correll, C. U., Cortese, S., Meyer, T., & Holsboer-Trachsler, E. (2015). Perfectionism related to self-reported insomnia severity, but not when controlled for stress and emotion regulation. *Neuropsychiatric Disease and Treatment, 11*, 263-271. https://doi.org/10.2147/NDT.S74905

Buysse, D. J., Cheng, Y., Germain, A., Moul, D. E., Franzen, P. L., Fletcher, M., & Monk, T. H. (2010). Night-to-night sleep variability in older adults with and without chronic insomnia. *Sleep Medicine, 11*(1), 56-64. https://doi.org/10.1016/j.sleep.2009.02.010

Buysse, D. J., Germain, A., Hall, M., Monk, T. H., & Nofzinger, E. A. (2011). A neurobiological model of insomnia. *Drug Discovery Today: Disease Models, 8*(4), 129-137. https://doi.org/10.1016/j.ddmod.2011.07.002

Carskadon, M. A., Dement, W. C., Mtler, M. M., Guilleminault, C., Zarcone, V. P., & Spiegel, R. (1976). Self-reports versus sleep laboratory findings in 122 drug-free subjects with complaints of chronic insomnia. *American Journal of Psychiatry, 133*(12), 1382-1388. https://doi.org/10.1176/ajp.133.12.1382

Castelnovo, A., Ferri, R., Punjabi, N. M., Castronovo, V., Garbazza, C., Zucconi, M., Ferini-Strambi, L., & Manconi, M. (2019). The paradox of paradoxical insomnia: A

theoretical review towards a unifying evidence-based definition. *Sleep Medicine Reviews, 44*, 70-82. https://doi.org/10.1016/j.smrv.2018.12.007

Cho, S. E., Kang, J. M., Ko, K. P., Lim, W. J., Redline, S., Winkleman, J. W., & Kang, S. G. (2022). Association between subjective-objective discrepancy of sleeping time and health-related quality of life: A community-based polysomnographic study. *Psychosomatic Medicine, 84*(4), 505-512. https://doi.org/10.1097/PSY.0000000000001070

Choi, S. J., Suh, S., Ong, J., & Joo, E. Y. (2016). Sleep Misperception in chronic insomnia patients with obstructive sleep apnea syndrome: Implications for clinical assessment. *Journal of Clinical Sleep Medicine, 12*(11), 1517-1525. https://doi.org/10.5664/jcsm.6280

Cini, E., Bolengo, F., Fasiello, E., Berra, F., Gorgoni, M., Sforza, M., Casoni, F., Proserpio, P., Castronovo, V., De Gennaro, L., Ferini-Strambi, L., & Galbiati, A. (2025). Sleep State Misperception in Insomnia: The Role of Sleep Instability and Emotional Dysregulation. *Brain Sci, 15*(10). https://doi.org/10.3390/brainsci15101078

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd ed.). Routledge Academic.

Edinger, J. D., Bonnet, M. H., Bootzin, R. R., Doghramji, K., Dorsey, C. M., Espie, C. A., Jamieson, A. O., McCall, W. V., Morin, C. M., & Stepanski, E. J. (2004). Derivation of research diagnostic criteria for insomnia: Report of an American Academy of Sleep Medicine Work Group. *Sleep, 27*(8), 1567-1596. https://doi.org/10.1093/sleep/27.8.1567

Edinger, J. D., & Krystal, A. D. (2003). Subtyping primary insomnia: Is sleep state misperception a distinct clinical entity? *Sleep Medicine Reviews, 7*(3), 203-214. https://doi.org/10.1053/smrv.2002.0253

Espie, C. A., Broomfield, N. M., MacMahon, K. M., Macphee, L. M., & Taylor, L. M. (2006). The attention-intention-effort pathway in the development of psychophysiologic insomnia: A theoretical review. *Sleep Medicine Reviews, 10*(4), 215-245. https://doi.org/10.1016/j.smrv.2006.03.002

Fernandez-Mendoza, J., Calhoun, S. L., Bixler, E. O., Karataraki, M., Liao, D., Vela-Bueno, A., Jose Ramos-Platon, M., Sauder, K. A., Basta, M., & Vgontzas, A. N. (2011). Sleep misperception and chronic insomnia in the general population: Role of objective sleep duration and psychological profiles. *Psychosomatic Medicine, 73*(1), 88-97. https://doi.org/10.1097/PSY.0b013e3181fe365a

Flett, G. L., Coulter, L. M., Hewitt, P. L., & Nepon, T. (2011). Perfectionism, rumination, worry, and depressive symptoms in early adolescents. *Canadian Journal of School Psychology, 26*(3), 159-176. https://doi.org/10.1177/0829573511422039

Frost, R. O., Marten, P., Lahart, C., & Rosenblate, R. (1990). The dimensions of perfectionism. *Cognitive Therapy and Research, 14*(5), 449-468. https://doi.org/10.1007/BF01172967

Handley, A. K., Egan, S. J., Kane, R. T., & Rees, C. S. (2014). The relationships between perfectionism, pathological worry and generalised anxiety disorder. *BMC Psychiatry, 14*(98), 1-8. https://doi.org/10.1186/1471-244X-14-98

Harvey, A. G. (2002). A cognitive model of insomnia. *Behaviour Research and Therapy, 40*(8), 869-893. https://doi.org/10.1016/S0005-7967(01)00061-4

Harvey, A. G., & Tang, N. K. (2012). (Mis)perception of sleep in insomnia: a puzzle and a resolution. *Psychol Bull, 138*(1), 77-101. https://doi.org/10.1037/a0025730

Hermans, L. W. A., Nano, M. M., Leufkens, T. R., van Gilst, M. M., & Overeem, S. (2020). Sleep onset (mis)perception in relation to sleep fragmentation, time estimation and pre-sleep arousal. *Sleep Medicine, X 2*, 1-6. https://doi.org/10.1016/j.sleepx.2020.100014

Hewitt, P. L., & Flett, G. L. (1991). Perfectionism in the self and social contexts: Conceptualisation, assessment, and association with psychopathology. *Journal of Personality and Social Psychology, 60*(3), 456-470. https://doi.org/10.1037/0022-3514.60.3.456

Jansson-Frojmark, M., & Linton, S. J. (2007). Is perfectionism related to pre-existing and future insomnia? A prospective study. *British Journal of Clinical Psychology, 46*(1), 119-124. https://doi.org/10.1348/014466506x158824

Johann, A. F., Feige, B., Hertenstein, E., Nissen, C., Benz, F., Steinmetz, L., Baglioni, C., Riemann, D., Spiegelhalder, K., & Akram, U. (2023). The effects of cognitive behavioral therapy for insomnia on multidimensional perfectionism. *Behaviour Therapy, 54*(2), 386-399. https://doi.org/10.1016/j.beth.2022.10.001

Johann, A. F., Hertenstein, E., Kyle, S. D., Baglioni, C., Feige, B., Nissen, C., Riemann, D., & Spiegelhalder, K. (2017). Perfectionism and polysomnography-determined markers of poor sleep. *Journal of Clinical Sleep Medicine, 13*(11), 1319-1326. https://doi.org/10.5664/jcsm.6806

Kales, A., Caldwell, A. B., Preston, T. A., Healey, S., & Kales, J. D. (1976). Personality patterns in insomnia. Theoretical implications. *Archives of General Psychiatry, 33*, 1128-1134. https://doi.org/10.1001/archpsyc.1976.01770090118013

Koval, P., Hinton, J., Dozo, N., Gellson, J., Alvarez, M., Harrison, A., Vu, D., Susanto, R., Jayaputera, G., & Sinnott, R. (2019). *SEMA3: Smartphone Ecological Momentary Assessment, version 3.* In http://www.sema3.com

Kudo, M., Ayabe, N., Takeshima, M., Ogasawara, M., Itoh, Y., Yoshizawa, K., Kitamura, S., & Mishima, K. (2024). Association between sleep state misperception and bedtime behavior in patients with chronic insomnia. *Scientific Reports, 14*(1), 13991. https://doi.org/10.1038/s41598-024-64355-3

Kuskens, A., Stricker, J., Hertrampf, L. S., Peitrowsky, R., & Gieselmann, A. (2023). Perfectionism, perceived stress, and pre-sleep arousal in insomnia: Effects on sleep quality in a daily life study. *Journal of Clinical Sleep Medicine, 20*(3), 433-443. https://doi.org/10.5664/jcsm.10910.

Lecci, S., Cataldi, J., Betta, M., Bernardi, G., Heinzer, R., & Siclari, F. (2020). Electroencephalographic changes associated with subjective under- and overestimation of sleep duration. *Sleep, 43*(11). https://doi.org/10.1093/sleep/zsaa094

Lehrer, H. M., Yao, Z., Krafty, R. T., Evans, M. A., Buysse, D. J., Kravitz, H. M., Matthews, K. A., Gold, E. B., Harlow, S. D., Samuelsson, L. B., & Hall, M. H. (2022). Comparing polysomnography, actigraphy, and sleep diary in the home environment: The Study of Women's Health Across the Nation (SWAN) Sleep Study. *Sleep Advances, 3*(1), zpac001. https://doi.org/10.1093/sleepadvances/zpac001

Liao, J., Zhu, S., & Li, X. (2018). Anxiety and depression in paradoxical insomnia: A case-control study. *Neuropsychiatric Disease and Treatment, 14*, 231-238. https://doi.org/10.2147/NDT.S156058

Lockley, S. W., Skene, D. J., & Arendt, J. (1999). Comparison between subjective and actigraphic measurement of sleep and sleep rhythms. *Journal of Sleep Research, 8*(3), 175-183. https://doi.org/10.1046/j.1365-2869.1999.00155.x

Lombardo, C., Mallia, L., Battagliese, G., Grano, C., & Violani, C. (2013). Perfectionism mediates the relationship between insomnia and depressive symptoms. *Sleep and Biological Rhythms, 11*(2), 90-98. https://doi.org/10.1111/sbr.12009

Lundh, L. G., & Broman, J. E. (2000). Insomnia as an interaction between sleep-interfering and sleep-interpreting. *Journal of Psychomatic Research, 49*, 299-310. https://doi.org/10.1016/S0022-3999(00)00150-1

Lundh, L. G., Broman, J. E., Hetta, J., & Saboonchi, F. (1994). Perfectionism and insomnia. *Scandinavian Journal of Behaviour Therapy, 23*(1), 3-18. https://doi.org/10.1080/16506079409455949

Lundh, L. G., Lundqvist, K., Broman, J. E., & Hetta, J. (1991). Vicious cycles of sleeplessness, sleep phobia, and sleep-incompatible behaviours in patients with persistent insomnia. *Scandinavian Journal of Behaviour Therapy, 20*(3-4), 101-114. https://doi.org/10.1080/16506079109456289

Maia, B. R., Soares, M. J., Pereira, A. T., Marques, M., Bos, S. C., Gomes, A., Valente, J., Azevedo, M. H., & Macedo, A. (2011). Affective state dependence and trait stability of perfectionism in sleep disturbances. *Revista Brasileira de Psiquiatria, 33*(3), 252-260. https://doi.org/10.1590/s1516-44462011005000014

Maltezos, A., Perrault, A. A., Walsh, N. A., Phillips, E. M., Gong, K., Tarelli, L., Smith, D., Cross, N. E., Pomares, F. B., Gouin, J. P., & Dang-Vu, T. T. (2024). Methodological approach to sleep state misperception in insomnia disorder: Comparison between

multiple nights of actigraphy recordings and a single night of polysomnography recording. *Sleep Medicine, 115*, 21-29. https://doi.org/10.1016/j.sleep.2024.01.027

Manconi, M., Ferri, R., Sagrada, C., Punjabi, N. M., Tettamanzi, E., Zucconi, M., Oldani, A., Castronovo, V., & Ferini-Strambi, L. (2010). Measuring the error in sleep estimation in normal subjects and in patients with insomnia. *Journal of Sleep Research, 19*(3), 478-486. https://doi.org/10.1111/j.1365-2869.2009.00801.x

Martin, J. L., & Hakim, A. D. (2011). Wrist actigraphy. *Chest, 139*(6), 1514-1527. https://doi.org/10.1378/chest.10-1872

Means, M. K., Edinger, J. D., Glenn, D. M., & Fins, A. I. (2003). Accuracy of sleep perceptions among insomnia sufferers and normal sleepers. *Sleep Medicine, 4*(4), 285-296. https://doi.org/10.1016/s1389-9457(03)00057-1

Mercer, J. D., Bootzin, R. R., & Lack, L. C. (2002). Insomniacs' perception of wake instead of sleep. *Sleep, 25*(5), 564-571. https://doi.org/ 10.1093/sleep/25.5.559

Molnar, D. S., Thai, S., Blackburn, M., Zinga, D., Flett, G. L., & Hewitt, P. L. (2023). Dynamic changes in perfectionism dimensions and psychological distress among adolescents assessed before and during the COVID-19 pandemic. *Child Development, 94*(1), 254-271. https://doi.org/10.1111/cdev.13855

Monk, T. H., Reynolds III, C. F., Kupfer, D. J., Buysse, D. J., Coble, P. A., Hayes, A. J., Machen, M. A., Petrie, S. R., & Ritenour, A. M. (1994). The Pittsburgh Sleep Diary. *Journal of Sleep Research, 3*(2), 111-120. https://doi.org/10.1111/j.1365-2869.1994.tb00114.x

Morin, C. M. (1993). *Insomnia: Psychological assessment and management*. Guilford Press.

Morin, C. M., Belleville, G., Belanger, L., & Ivers, H. (2011). The Insomnia Severity Index: Psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep, 34*(5), 601-608. https://doi.org/10.1093/sleep/34.5.601

Morin, C. M., Vallieres, A., & Iver, H. (2007). Dysfunctional Beliefs and Attitudes about Sleep (DBAS): Validation of a brief version (DBAS-16). *Sleep, 30*(11), 1547-1554. https://doi.org/10.1093/sleep/30.11.1547

Moulder, Z., Sweetman, A., Lovato, N., Micic, G., Lack, L., & Scott, H. (2024). Sleep-wake state discrepancy does not impair the efficacy of cognitive behavioural therapy for insomnia: Findings from a large clinic sample. *Journal of Sleep Research, 33*(5), e14142. https://doi.org/10.1111/jsr.14142

Naito, K., Iwamoto, K., Miyata, S., Okada, I., Kawai, K., Fujimoto, A., Kogo, Y., Mori, D., Matsuyama, N., Ando, M., Ozaki, N., & Ikeda, M. (2026). Effect of lemborexant on sleep-wake state discrepancy in participants with insomnia disorder. *Psychopharmacology (Berl), 243*(1), 133-143. https://doi.org/10.1007/s00213-025-06845-4

Nicassio, P. M., Mendlowitz, D. R., Fussell, J. J., & Petras, L. (1985). The phenomenology of the pre-sleep state: The development of the pre-sleep arousal scale. *Behavior Research and Therapy, 23*(3), 263-271. https://doi.org/10.1016/0005-7967(85)90004-X

O'Rourke, H. P., & MacKinnon, D. P. (2018). Reasons for testing mediation in the absence of an intervention effect: A research imperative in prevention and intervention research. *Journal of Studies on Alcoholism and Drugs, 79*(2), 171-181. https://doi.org/10.15288/jsad.2018.79.171

Oh, S. Y., Meaklim, H., Nicholas, C. L., Cunnington, D., Patrick, C. J., Schenker, M., & Phillips, L. J. (2026). Bidirectional associations between daily symptoms of perfectionism and poor sleep: The mediating role of stress. *Behavioural Sleep Medicine*, 1-14. https://doi.org/10.1080/15402002.2026.2657920

Oh, S. Y., Meaklim, H., Nicholas, C. L., Cunnington, D., Schenker, M., Patrick, C. J., Windred, D., & Phillips, L. J. (2024). Perfect enough to sleep? Perfectionism and actigraphy-determined markers of insomnia. *Behavioral Sleep Medicine*, 1-16. https://doi.org/10.1080/15402002.2024.2355476

Ong, J. C., Ulmer, C. S., & Manber, R. (2012). Improving sleep with mindfulness and acceptance: A metacognitive model of insomnia. *Behaviour Research and Therapy, 50*(11), 651-660. https://doi.org/10.1016/j.brat.2012.08.001

Palagini, L., Mauri, M., Dell'Osso, L., Riemann, D., & Drake, C. L. (2016). Trait- and pre-sleep-state-dependent arousal in insomnia disorders: What role may sleep reactivity and sleep-related metacognitions play? A pilot study. *Sleep Medicine, 25*, 42-48. https://doi.org/10.1016/j.sleep.2016.07.020

Park, S., Park, K., Shim, J. S., Youm, Y., Kim, J., Lee, E., & Kim, H. C. (2020). Psychosocial factors affecting sleep misperception in middle-aged community-dwelling adults. *PLoS One, 15*(10), e0241237. https://doi.org/10.1371/journal.pone.0241237

Perlis, M. L., Giles, D. E., Mendelson, W. B., Bootzin, R. R., & Wyatt, J. K. (1997). Psychophysiological insomnia: The behavioural model and a neurocognitive perspective. *Journal of Sleep Research, 6*(3), 179-188. https://doi.org/10.1046/j.1365-2869.1997.00045.x

Rezaie, L., Vakili-Amini, Y., Paschall, E., & Khazaie, H. (2020). Personality profiles in paradoxical insomnia: A case-control study. *Sleep Science, 13*(4), 242-248. https://doi.org/10.5935/1984-0063.20190148

Richardson, C., & Gradisar, M. (2020). Perfectionism and insomnia in adolescents: The role of vulnerability to stress and gender. *Journal of Adolescence, 85*, 70-79. https://doi.org/10.1016/j.adolescence.2020.10.003

Riemann, D., Spiegelhalder, K., Feige, B., Voderholzer, U., Berger, M., Perlis, M., & Nissen, C. (2010). The hyperarousal model of insomnia: A review of the concept and its evidence. *Sleep Medicine Reviews, 14*(1), 19-31. https://doi.org/10.1016/j.smrv.2009.04.002

Sadeh, A. (2011). The role and validity of actigraphy in sleep medicine: An update. *Sleep Medicine Reviews, 15*(4), 259-267. https://doi.org/10.1016/j.smrv.2010.10.001

Sansom, K., Reynolds, A., McVeigh, J., Mazzotti, D. R., Dhaliwal, S. S., Maddison, K., Walsh, J., Singh, B., Eastwood, P., & McArdle, N. (2023). Estimating sleep duration: performance of open-source processing of actigraphy compared to in-laboratory polysomnography in the community. *Sleep Adv, 4*(1), zpad028. https://doi.org/10.1093/sleepadvances/zpad028

Schmidt, R. E., Courvoisier, D. S., Cullati, S., Kraehenmann, R., & der Linden, M. V. (2018). Too imperfect to fall asleep: Perfectionism, pre-sleep counterfactual processing, and insomnia. *Frontiers in Psychology, 9*, 1288. https://doi.org/10.3389/fpsyg.2018.01288

Smith, M. M., Sherry, S. B., Chen, S., Saklofske, D. H., Mushquash, C., Flett, G. L., & Hewitt, P. L. (2018). The perniciousness of perfectionism: A meta-analytic review of the perfectionism-suicide relationship. *Journal of Personality, 86*(3), 522-542. https://doi.org/10.1111/jopy.12333

Spina, M. A., Andrillon, T., Quin, N., Wiley, J. F., Rajaratnam, S. M. W., & Bei, B. (2023). Does providing feedback and guidance on sleep perceptions using sleep wearables improve insomnia? Findings from "Novel Insomnia Treatment Experiment": a randomized controlled trial. *Sleep, 46*(9). https://doi.org/10.1093/sleep/zsad167

Stone, J. E., McGlashan, E. M., Facer-Childs, E. R., Cain, S. W., & Phillips, A. J. K. (2020). Accuracy of the GENEActiv Device for Measuring Light Exposure in Sleep and Circadian Research. *Clocks Sleep, 2*(2), 143-152. https://doi.org/10.3390/clockssleep2020012

Streatfeild, J., Smith, J., Mansfield, D., Pezzullo, L., & Hillman, D. (2021). The social and economic cost of sleep disorders. *Sleep, 44*(11). https://doi.org/10.1093/sleep/zsab132

Tang, N. K., & Harvey, A. G. (2004). Correcting distorted perception of sleep in insomnia: A novel behavioural experiment? *Behaviour Research and Therapy, 42*(1), 27-39. https://doi.org/10.1016/s0005-7967(03)00068-8

Tang, N. K., & Harvey, A. G. (2005). Time estimation ability and distorted perception of sleep in insomnia. *Behavioral Sleep Medicine, 3*(3), 134-150. https://doi.org/10.1207/s15402010bsm0303_2

Tang, N. K., & Harvey, A. G. (2006). Altering misperception of sleep in insomnia: Behavioral experiment versus verbal feedback. *Journal of Consulting and Clinical Psychology, 74*(4), 767-776. https://doi.org/10.1037/0022-006X.74.4.767

Trudel-Fitzgerald, C., Savard, J., Slim, L. M., Roy, R. C., Flett, G. L., Hewitt, P. L., & Ivers, H. (2017). The relationship of perfectionism with psychological symptoms in cancer patients and the contributing role of hyperarousability and coping. *Psychology & Health, 32*(4), 381-401. https://doi.org/10.1080/08870446.2016.1273354

van de Laar, M., Verbeek, I., Peveragie, D., Aldenkamp, A., & Overeem, S. (2010). The role of personality traits in insomnia. *Sleep Medicine Reviews, 14*, 61-68. https://doi.org/10.1016/j.smrv.20

Van Den Berg, J. F., Van Rooij, F. J., Vos, H., Tulen, J. H., Hofman, A., Miedema, H. M., Neven, A. K., & Tiemeier, H. (2008). Disagreement between subjective and actigraphic measures of sleep duration in a population-based study of elderly persons. *Journal of Sleep Research, 17*(3), 295-302. https://doi.org/10.1111/j.1365-2869.2008.00638.x

van Hees, V. T., Sabia, S., Anderson, K. N., Denton, S. J., Oliver, J., Catt, M., Abell, J. G., Kivimaki, M., Trenell, M. I., & Singh-Manoux, A. (2015). A novel, open access method to assess sleep duration using a wrist-worn accelerometer. *PLoS One, 10*(11), e0142533. https://doi.org/10.1371/journal.pone.0142533

Vincent, N. K., & Walker, J. R. (2000). Perfectionism and chronic insomnia. *Journal of Psychosomatic Research, 49*, 349-354. https://doi.org/10.1016/s0022-3999(00)00175-6

Walton, T. F., Ree, M. J., Fueggle, S. N., & Bucks, R. S. (2024). A scoping review of sleep discrepancy methodology: What are we measuring and what does it mean? *Sleep Medicine, 126*, 32-66. https://doi.org/10.1016/j.sleep.2024.11.016

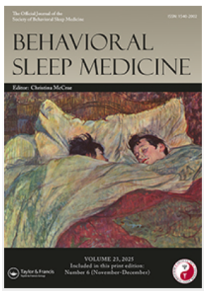
Xie, Y., Kong, Y., Yang, J., & Chen, F. (2019). Perfectionism, worry, rumination, and distress: A meta-analysis of the evidence for the perfectionism cognition theory. *Personality and Individual Differences, 139*, 301-312. https://doi.org/10.1016/j.paid.2018.11.028

Zhao, W., Van Someren, E. J. W., Xu, Z., Ren, Z., Tang, L., Li, C., & Lei, X. (2024). Identifying the insomnia-related psychological issues associated with hyperarousal: A

network perspective. *International Journal of Psychophysiology, 195*, 112276. https://doi.org/10.1016/j.ijpsycho.2023.112276

Chapter 7

Study 3 - Bidirectional Associations between Daily Symptoms of Perfectionism and Poor Sleep: The Mediating Role of Stress



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Bidirectional Associations between Daily Symptoms of Perfectionism and Poor Sleep: The Mediating Role of Stress

Susie Y. Oh[a,b], Hailey Meaklim[a,c], Christian L. Nicholas[a], David Cunnington[d], Cameron J. Patrick[e], Maya Schenker[a], and Lisa J. Phillips[a]

This chapter contains an original research article which was accepted for publication in *Behavioral Sleep Medicine* on 16 April 2026 and has been formatted to conform with the format of this thesis. The references cited in this manuscript can be found at the end of this chapter. Abbreviations used in this chapter are introduced again in line with the published manuscript. Supplementary tables, figures and material are included in appendix C.

7.1 Abstract

Objectives: Perfectionism is a risk factor for poor sleep. Past studies have examined the relationship between perfectionism and sleep using summary statistics that do not account for intraindividual day-to-day variability. Using ecological momentary assessment, this study investigated the bidirectional and temporal relationships between perfectionism and sleep, and the mediating effects of stress. **Methods:** Sixty-three adults (85.7% females, mean age 30.13 ± 10.96 years) were sampled from the Australian general population. Measures collected over 14 days included the Pittsburgh Sleep Diary, Daily Perfectionism Measures, Daily Stress Inventory, the Concerns over Mistakes and Doubts about Actions subscales from the Frost Multidimensional Perfectionism Scale, and Socially Prescribed Perfectionism subscale from the Hewitt-Flett Multidimensional Perfectionism Scale. **Results:** Perfectionism levels were positively associated with sleep onset variability (*p's ≤.04*). The relationship between perfectionism and poor sleep was significant at the between-person level in both directions *(p's ≤.041)*, with stress mediating the relationship of sleep predicting next-day perfectionism *(p's ≤.042).* At the within-person level, stress mediated the relationship with higher perfectionism leading to higher stress, which then related to lower sleep quality *(p's ≤ .009)*. Poorer sleep did not predict next-day perfectionism and was not mediated by stress. **Conclusions:** Perfectionism and sleep appear bidirectionally linked. Individuals with higher perfectionism scores were more likely to experience disrupted sleep and vice versa. Changes in perfectionism did not directly impact same night sleep, but this relationship was mediated by stress. Therefore, consider the role of perfectionism and stress management when assessing and treating poor sleep.

Keywords: perfectionism, sleep disturbance, stress, sleep health

7.2 Introduction

Perfectionism is recognised as a transdiagnostic process contributing to psychopathology (Egan et al., 2011; Limburg et al., 2017). Perfectionism is generally defined as having excessively high standards and being overly critical of oneself; and conceptualised as a multidimensional construct with two higher-order dimensions: perfectionistic concerns and perfectionistic strivings (Frost et al., 1990; Hewitt et al., 1991; Stoeber & Otto, 2006). Perfectionistic concerns involve dimensions of having concerns about making mistakes, doubting one's actions and being fearful of not meeting others' expectations or high standards for oneself; and are associated with psychological difficulties such as anxiety, depression and stress. Perfectionistic strivings, which involve dimensions of having high personal standards and being organised and structured, are associated with psychological wellbeing (Stoeber & Otto, 2006). Therefore, as a multidimensional construct, perfectionism can be both adaptive and maladaptive.

Perfectionism has traditionally been conceptualised as a stable trait or personality disposition with enduring and substantial between-person differences. However, perfectionism has also been conceived as a cognitive-affective construct that can be changed or shaped by dynamic contextual influences, situational cues and interpersonal experiences, e.g., intrusive and high parental pressures (Boone & Soenens, 2015; Flett & Hewitt, 2002a; Rice & Aldea, 2006; Ståhlberg et al., 2020; Vecchione & Marsicano, 2023). This conceptualisation is supported by evidence that perfectionism can be reduced through engagement in therapy for clinical perfectionism and induced in adults without psychopathology in a day (Boone & Soenens, 2015; Boone, Soenens, Mouratidis, et al., 2012; Galloway et al., 2022; Ip, 2025; Suh et al., 2019; Wegerer, 2024). Short-term longitudinal research ranging from 7 to 21 days has also found components of perfectionism such as perfectionistic cognitions, perfectionistic self-presentation, perfectionistic concerns

and strivings can fluctuate day-to-day and week to week (Boone, Soenens, Mouratidis, et al., 2012; Mackinnon et al., 2014; Mackinnon et al., 2017; Mackinnon et al., 2019). Furthermore, such state-like dynamic variations in perfectionism predict psychopathology, including social anxiety, psychological distress, perceived stress, subjective well-being, alcohol-related problems, binge eating behaviours and eating disorder symptoms (Boone & Soenens, 2015; Boone, Soenens, Mouratidis, et al., 2012; Mackinnon et al., 2014; Mackinnon et al., 2017; Mackinnon et al., 2019; Merwin et al., 2022; Molnar et al., 2023). These findings indicate dynamic state-like variations can occur in perfectionism in addition to its trait-like stability.

7.2.1 Perfectionism as a predisposing factor of poor sleep

Perfectionism is postulated as a risk factor for poor sleep and insomnia (Espie et al., 2006; Lundh et al., 1994; Riemann et al., 2010). Poor sleep refers to experiencing insomnia symptoms, such as prolonged sleep onset latency, prolonged awakenings after sleep onset, poor sleep quality and/or waking too early in the morning. In the model of insomnia by Lundh and Broman (2000), perfectionism was theorised to be a vulnerability factor for insomnia via dysfunctional sleep-interpreting processes. They proposed that when facing temporary sleep problems, perfectionistic individuals worry about sleeplessness leading to pre-sleep arousal and rumination that further interferes with sleep. Perfectionistic interpretations of how bad their sleep was may further contribute to the vicious cycle that causes sleep to vary beyond the typically stable sleep-wake patterns driven by biological homeostatic sleep drive and the circadian clock (Lundh & Broman, 2000). Therefore, studying whether and how perfectionism may exacerbate poor sleep may be helpful in the understanding and management of poor sleep.

Past research has found evidence of associations between perfectionism and poor sleep (e.g., Akram et al., 2023; Stuck et al., 2021). In a meta-analysis, Stricker et al. (2023) identified perfectionistic concerns, predominantly Concerns over Mistakes (adverse over-

reaction to mistakes as failures), Doubts about Actions (doubting one's own actions and behaviours) and Socially Prescribed Perfectionism (having expectations that others expect one to have high standards), to be associated positively with insomnia. Since then, studies have added further evidence to support the associations between Concern over Mistakes and Doubts about Action; and self-reported sleep duration, sleep efficiency, sleep onset latency and sleep quality (Akram et al., 2023; Elbadawi et al., 2025; Johann et al., 2023; Oh et al., 2024; Zhao et al., 2024). Together, past research has consistently identified relationships between perfectionism dimensions of Concerns over Mistakes, Doubts about Actions and Socially Prescribed Perfectionism and markers of poor sleep.

The experience of heightened stress has been identified as an indirect pathway that may explain how and why perfectionism contributes to poor sleep. According to the mediating hypothesis, the constant striving for unrealistic high standards and critical self-evaluation increase one's stress level and stress reactivity, which can adversely affect well-being, including sleep (Dunkley, 2017; Flett & Hewitt, 2002b; Lundh et al., 1994). Flett and Hewitt (2002b) theorised that perfectionism contributes to unhealthy outcomes via stress in various ways. These included stress generation from having unrealistic goals, stress anticipation by being preoccupied with possible stressors, stress perpetuation via maladaptive tendencies, such as, rumination in maintaining and prolonging stressful periods; and stress enhancement where unhelpful cognitive appraisal or reactivity magnifies stress. Support for a mediating role of stress in the relationship between perfectionism and sleep has been found in several studies (Brand et al., 2015; Molnar et al., 2020; Oh et al., 2024; Richardson & Gradisar, 2020). However, a recent study found daily stress did not mediate the link between perfectionism and sleep, so the role that stress plays in that relationship remains unclear (Kuskens et al., 2023).

7.2.2 Intraindividual variability in sleep

In examining the relationship between sleep and perfectionism, intraindividual variability (IIV) in sleep should be a consideration. This is because people with poor sleep often describe feeling their sleep is out of control due to inconsistency or night-to-night fluctuations in their sleep difficulties (Morin & Espie, 2007). However, sleep and insomnia research has typically relied on mean levels when quantifying sleep parameters from data collected over time. This leads to potentially missing out on more clinically nuanced insights and patterns to understanding sleep problems that could be derived by analysing those fluctuations in daily sleep (Bei et al., 2016; Bredeli et al., 2022). Intraindividual sleep variability quantifies the extent to which an individual's sleep parameter differs from its average over time. It further captures the dynamic process of how sleep is influenced day-to-day by other factors, such as stress, mood, cognitions, biological rhythms, and social interactions (Bei et al., 2016).

In a foundational systematic review, Bei et al. (2016) identified that compared to normal sleepers, individuals with insomnia consistently demonstrated more IIV in sleep onset latency, wake after sleep onset, sleep efficiency and sleep quality. Furthermore, poorer physical and mental health have been associated with higher sleep variability (Messman et al., 2024). Higher IIV in sleep were also associated with higher insomnia severity, more dysfunctional beliefs and attitudes about sleep and higher fatigue level, which often exacerbated and perpetuated sleep problems (Bredeli et al., 2022). These findings suggest studying sleep variability provides critical clinical insights to poor sleep. To date, no study has examined whether daily fluctuations in perfectionism are associated with and/or contribute to day-to-day sleep variability and how daily stress might affect those relationships.

7.2.3 Potential bidirectional relationship between perfectionism and poor sleep

While previous research has investigated the relationship from perfectionism to poor sleep, it is possible that poor sleep may also influence the levels of perfectionism, forming a vicious cycle to maintain and worsen one another over time. In a longitudinal study, Akram et al. (2015) found baseline insomnia symptoms to be associated with future Doubts about Actions, and the relationship was partially mediated by anxiety symptoms. The authors postulated that poor sleep amplifies preoccupation with daytime functioning and performance, which contributes to self-evaluation and criticism, leading to an increase in perfectionistic tendencies. In contrast, a longitudinal study of adolescents by Richardson and Gradisar (2020) found insomnia did not predict total perfectionism, however, Socially Prescribed Perfectionism predicted insomnia symptoms over time. There is little research that examined the relationship from sleep to perfectionism, so it remains unclear if poor sleep plays a part in increasing perfectionism. The possibility of daily fluctuations in sleep being associated with and/or contributing to daily levels of perfectionism and whether daily stress plays a mediating role in these reversing relationships are yet to be explored.

7.2.4 The Current Study

The current study aimed to examine the bidirectional and temporal associations between perfectionism and sleep, and the mediating effects of stress in those relationships. It utilised a short-term longitudinal design with repeated ecological momentary assessments (EMA) across 14 days to capture daily variations in self-reported sleep, stress and perfectionism in individuals with normal sleep and varying sleep difficulties. Specific hypotheses were: (1) higher levels of perfectionism measures of Concerns over Mistakes, Doubts about Actions and Socially Prescribed Perfectionism would be associated with higher sleep variability, as measured by the variance in sleep across the 14 days; (2A) between participants, those with higher perfectionism levels (i.e., higher levels of Concerns over

Mistakes and Doubts about Actions) compared to the sample would experience worse sleep (i.e, longer sleep onset latency and lower sleep quality) and vice versa; and (2B) these relationships would be mediated by stress. Given the limited research and the exploratory nature of the current study, no a priori hypotheses were formulated on the day-to-day relationships between sleep and perfectionism, as well as how stress mediates these effects daily.

7.3 Materials and Method

7.3.1 Participants

Recruitment of adult participants, aged 18 years and above, occurred via the University of Melbourne Research Experience Program (REP), social media, word-of-mouth or referrals by sleep physicians at the Melbourne Sleep Disorder Centre. Participants from the REP were undergraduate psychology students, who responded to an online advertisement at the University of Melbourne, Australia, to participate in exchange for course credit. An online eligibility screening survey, including demographic information, via Qualtrics (https://www.qualtrics.com) was completed by all potential participants and to exclude those with the following considerations: (a) current diagnosis of mental illness excluding insomnia disorder; (b) central nervous disorder (c) prior head injury; (d) shift work, defined as paid work with rotating shifts, outside of 7:00AM to 6:00PM or starting before 7:00AM or after 2:00PM; and (e) symptoms indicative of sleep disorders other than insomnia (e.g., obstructive sleep apnoea, restless leg syndrome). Participants were screened using a sleep algorithm to exclude sleep disorders other than insomnia as presented in Wilson et al. (2010). Participants with and without insomnia disorder (no clinical insomnia diagnosis was required for participation) were included to capture a broad range of sleep quality and variability. Participants self-reported insomnia symptomology via the Insomnia Severity Index (ISI, see below, Bastien et al., 2001).

Out of the 1132 screening responses obtained, 243 were deemed eligible after removing duplicate and incomplete responses. The final sample consisted of 63 participants, who agreed to participate in and completed the 2-week sleep study. Each participant provided informed written consent online and was given an online gift voucher of $25 upon study completion. The University of Melbourne's Human Research Ethics Committee granted approval for this research study (HREC 1955374). Self-reported sleep data in summary statistics from this current sample were previously analysed and published in a study by Oh et al. (2024).

7.3.2 Study Protocol

All individuals who met eligibility criteria received information about the study protocol via an in-person or online (via Zoom [https://zom.us]) meeting with the first author (S.O). Participants who agreed to participate in the two-week sleep and EMA study then completed additional surveys (see below). During the two-week study period, participants responded to daily surveys using the Smartphone Ecological Momentary Assessment app (Koval et al., 2019), with reminders scheduled once in the morning (sleep-related measures) and once at night (daytime perfectionism measures). At the end of the 14-day sleep study period, participants attended a debriefing session when they completed the post-study survey (see below) and received remuneration.

7.3.3 Sleep Measures

7.3.3.1 Pittsburgh Sleep Diary (PSD). The Pittsburgh Sleep Diary records bedtime, lights out time, minutes to sleep, total number of times awake, total number of minutes awake during the night, wake time, and sleep quality (Monk et al., 1994). Questions include "went to bed last night at", "lights out at", "minutes until fell asleep", "finally woke at", etc. These data were used to derive total time in bed (time between bedtime and wake up time), sleep onset latency, wake after sleep onset, total sleep time (time between sleep time, which is

derived as lights out time plus sleep onset latency, and wake time minus wake after sleep onset), number of awakenings and sleep efficiency (calculated as total sleep time / total time in bed * 100%). The PSD captures sleep quality using a Likert scale ranging from 0 for "very bad" to 10 for "very good". To measure IIV of these measures across the 14-day study period, the square root of each variable's variance was used as per previous research (Bei et al., 2016; Bredeli et al., 2022).

7.3.3.2 Insomnia Severity Index (ISI). At the end of the14-day sleep study period, participants completed the Insomnia Severity Index (Bastien et al., 2001). The 7-item self-report ISI measures the nature, severity and impact of insomnia rated on a 5-point Likert scale. over the past 14 days. These items assess difficulties falling and staying asleep, problems with early morning awakenings, sleep satisfaction, distress by sleep problem, difficulties with daytime functioning and how noticeable impairment from sleep problems were to others. Answers range from 0 (no problem) to 4 (very severe problem) and are summed to yield a total score ranging from 0 to 28. A cut-off score of 10 was used to detect insomnia in community sample with 86.1% sensitivity and 87.7% specificity (Morin et al., 2011).

7.3.4 Perfectionism & Stress Measures

7.3.4.1 Perfectionism Scales. Three subscales were used to assess perfectionism dimensions of trait perfectionism at baseline. They are Concern over Mistakes and Doubts about Actions from the Frost Multidimensional Perfectionism Scale (FMPS; Frost et al., 1990); and the Socially Prescribed Perfectionism from the Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS; Hewitt & Flett, 1991). The FMPS subscales are made up of items rated on a Likert scale from 1 (disagree strongly) to 5 (agree strongly). The Concern over Mistakes subscale consists of 9 items while the Doubts about Actions subscale consists of 4 items, giving a maximum score of 45 and 20 respectively (Frost et al., 1990). The

Socially Prescribed Perfectionism subscale consists of 15 items, which are rated on a 7-point Likert scale from 1 (disagree) to 7 (agree) for a total score range from 15 to 105 (Hewitt et al., 1991). Higher scores in each subscale indicated higher levels of trait perfectionism.

7.3.4.2 Daily Perfectionism Measures (DPM). Currently, there is no validated instrument available to measure state perfectionism. Therefore, three broad questions were created for this study, "I was concerned about mistake(s) I made today", "I had doubts about how well I did things today" and "Others had high expectations of me today". They were administered to participants at the end of each day via the SEMA3 app to capture daily fluctuations in Concerns over Mistakes, Doubts about Actions and Socially Prescribed Perfectionism respectively. Responses were rated from 1 (never) to 5 (always). We refer to this as the Daily Perfectionism Measures (DPM). Higher DPM scores indicated higher levels of state perfectionism.

7.3.4.3 Daily Stress Inventory (DSI). To assess participants' daily stress level, the Daily Stress Inventory was administered at the end of each day via the SEMA3 app (Brantley et al., 1987). It consists of 58 relatively minor stressful events or stressors, e.g., "Performed poorly at task", "Was embarrassed", "Argued with another person", etc. Participants indicated if they experienced those stressors in the past 24 hours, and where applicable, they rated the impact on their stress level using a 7-point Likert scale ranging from 1 (not stressful) to 7 (caused panic). Three scores are then obtained: 1) a frequency score (FREQ) consisting of the total number of events endorsed for the day; 2) an impact score (SUM) which is the sum of all impact ratings for the day; and 3) an average impact rating of the stressful events for the day (SUM/FREQ). Higher scores indicated higher levels of stress experienced for the day and AIR was used in mediating analyses.

7.3.5 Statistical Analysis

All analyses were conducted using the statistical software package R (version 4.4.2; http://www.R-project.org/). The sample was analysed as a whole and no between group analysis was conducted. To assess hypothesis that higher levels of perfectionism will be associated with higher sleep variability, the associations between measures of perfectionism (Concern over Mistakes, Doubts about Actions and Socially Prescribed Perfectionism) and IIV sleep measures (sleep onset latency, total sleep time, wake after sleep onset, sleep efficiency, number of awakenings and sleep quality) were analysed using Pearson correlations. Correlations of .10, .30 and .50 are considered small, medium and large effects respectively (Cohen, 1988).

Before linear mixed-effects modelling (LMM) was used to test the between and within-subject hypotheses, sample size and data missingness was assessed. The study sample size was well above recommended minimums (Maas & Hox, 2005). On average, missing data at 17.31% was within expected missingness range of 18 to 23% for research using EMA (Ottenstein & Werner, 2022; Williams et al., 2021). Multilevel logistic regression models were conducted to predict missingness of each variable from observed same-day and lagged predictors. This is consistent with recommendations in EMA research and LMM as an evaluation of the plausibility of the missing at random assumption by testing whether missingness depends on observed data, including prior measurements (Enders, 2022; West et al., 2014). Results indicate missingness was independent of observed variables, which is consistent with plausible missing at random assumption. The only exception was missingness in sleep quality, which was modestly predicted by prior day Concerns over Mistakes. Overall, these results broadly support plausible missing at random assumption and thus, the use of maximum likelihood estimates in LMM for subsequent analyses. However, results should be interpreted with caution since missing at random assumption cannot be definitely tested.

Following Barr et al. (2013), models were initially fitted with the maximal random effect structure, including random slopes using restricted maximum likelihood estimation. However, the random slope models failed to converge, so all multilevel models were estimated with random intercepts and fixed slopes. For each combination of EMA sleep and perfectionism variable, a separate multilevel model was run accounting for within-person variability (mean-centred) and between-person variability (grand mean-centred) in line with Brown (2021). Age and gender were included as covariates using bootstrapping with 10,000 simulations in sensitivity analyses. Results remained unchanged, therefore models without covariates are presented here.

Next, multilevel mediation analyses were performed for each model by incorporating average impact rating of stressful events for the day as a mediator. Age and gender were also included as covariates in sensitivity analyses. All multilevel analysis was conducted using R package lavaan (Rosseel, 2012). As lavaan is unable to provide bootstrapping for clustered data, R package brms was used to rerun each model using Bayesian multilevel mediation with 4000 simulations to confirm lavaan results (Bürkner, 2017). As per O'Rourke and MacKinnon (2018), mediation analyses were conducted despite non-significant total effect. Sleep onset latency was the only outcome variable that was skewed and therefore, log transformed. Model assumptions and effects were visually inspected and met. Alpha level was set at $p < .05$ for two-tailed analyses.

7.4 Results

7.4.1 Descriptive Data

A total of 63 participants, aged 18-66 years ($M = 30.13$, $SD = 10.96$) and of whom 85.7% identified as female, were included in the final sample. Participants reported ISI scores that ranged from 0 to 25 ($M = 7.63$, $SD = 5.92$). Using an ISI score exceeding 9, 39.7% of the sample were classified as 'poor sleepers' (Morin et al., 2011). Mean and standard deviations

of sleep measures are presented in Table 7.1. Mean and standard deviations of perfectionism measures collected once at baseline (FMPS and HFMPS subscales), and daily perfectionism EMA measures are presented in Table 7.2. Intraclass correlations greater than .05 in daily perfectionism indicated substantial day-to-day state-like variation and thus suitable for multilevel analysis (Preacher et al., 2010).

Table 7.1.

Mean scores and standard deviations of sleep measures

			Range	
	M	SD	Minimum	Maximum
Sleep onset latency (minutes)	21.80	28.71	0	270
Wake after sleep onset (minutes)	19.06	33.47	0	270
Total sleep time (hours)	7.30	1.49	1.33	12.50
Number of awakenings	1.46	1.52	0	9
Sleep efficiency (%)	91.65	9.63	34	100
Sleep quality [rate 0 (very bad) to 10 (very good)]	6.49	2.18	0	10

Notes. SOL, sleep onset latency; WASO, wake after sleep onset; TST, total sleep time; NOA, number of awakenings; SE, sleep efficiency; SQ, sleep quality.

Table 7.2

Mean scores and standard deviations of perfectionism measures, and intraclass correlations of daily perfectionism and stress measures

	M	SD	Sample Range	Intraclass
Subscales from FMPS and HFMPS				
FMPS: Concern over Mistakes	26.70	8.16	11-45 (9-45)	
FMPS: Doubts about Actions	11.84	3.80	5-20 (4-20)	
HFMPS: Socially Prescribed Perfectionism	52.10	13.01	28-105 (15-105)	
Daily Perfectionism Measures				
Daily Concern over Mistakes	2.01	1.13	1-5 (1-5)	.52
Daily Doubts about Actions	2.23	1.22	1-5 (1-5)	.54
Daily Socially Prescribed Perfectionism	1.87	1.11	1-5 (1-5)	.48
Daily Stress Inventory	2.27	1.24	0-6 (N.A.)	.63

Notes. FMPS, Frost Multidimensional Perfectionism Scale; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; AIR, average impact rating of stressful events for the day**.**

7.4.2 Correlation Analyses between Sleep Variability and Perfectionism Measures

Table 7.3 shows the number and strength of correlations between sleep IIV and perfectionism dimensions. Specifically, IIV in sleep onset latency correlated significantly with Concern over Mistakes (p = .04) and Doubts about Actions (p = .01). These correlations were considered to have small to medium effects (Cohen, 1988).

Table 7.3

Correlations between sleep variability and perfectionism measures

n = 63	1	2	3	4	5	6	7	8	9	10
1. CM										
2. DA	.61**									
3. SPP	.65**	.51**								
4. SOL variability	.26*	.32*	.10							
5. WASO variability	-.06	.01	.07	.06						
6. TST variability	.11	.19	.08	.07	.15					
7. NOA variability	-.02	-.04	-.06	-.17	.01	.09				
8. SE variability	.02	.14	.04	.48**	.82**	.26*	-.11			
9. SQ variability	-.04	.09	-.01	.07	.31*	.19	.05	.35		
10. DSI variability	.11	.05	.30*	.22	.24	.14	.01	.10	.09	
11. ISI	.42**	.43**	.50**	.24*	.40**	.10	.04	.44**	.26*	.18

Notes. CM, Concern over Mistakes; DA, Doubts about Actions; SPP, Socially Prescribed Perfectionism; variability is calculated as standard deviation of sleep and stress measures: SOL, sleep onset latency; WASO, wake after sleep onset; TST, total sleep time; NOA, number of awakenings; SE, sleep efficiency; SQ, sleep quality, DSI, Daily Stress Inventory; ISI, Insomnia Severity Index. *$p < .05$, **$p < .01$.

7.4.3 Perfectionism Predicting Sleep with Mediating Effects of Stress

LMM summaries of between- and within-person changes in daily perfectionism predicting sleep during the same night with daily stress as a mediator are presented in Table 7.4. Model summaries of multilevel analysis before mediation are presented in Appendix C Table C1. Results were consistent across analyses. Between-person effects showed that individuals with higher Concern over Mistakes had longer sleep onset latency and lower

sleep quality. Furthermore, those with higher levels of Doubts about Action had lower sleep quality. Stress did not mediate any relationships from perfectionism to sleep. No within-person effects were found for changes in perfectionism to predict sleep during the same night. However, daily stress mediated the relationships from Concerns over Mistakes and Doubts about Actions to sleep quality. See Figures 7.1 and 7.2. Sensitivity analyses including covariates and Bayesian models are presented in Appendix C Tables C3 and C5 respectively.

7.4.4 Sleep Predicting Next-day Perfectionism with Mediating Effects of Stress

LMM summaries of daily sleep predicting daily perfectionism with daily stress as a mediator are presented in Table 7.5, showing between-person and within-person effects. Initial analysis before mediation is presented in Appendix C Table C2. Between-person effects showed that individuals with longer sleep onset latency and lower sleep quality reported higher levels of Concerns over Mistakes and Daily Doubts about Actions, and those relationships were mediated by stress. No within-person effect was found for sleep onset latency and sleep quality in predicting next-day Concerns over Mistakes and Doubts about Actions. Stress did not affect these relationships. Sensitivity analyses including covariates and Bayesian models are presented in Appendix C Tables C4 and C6 respectively.

Table 7.4

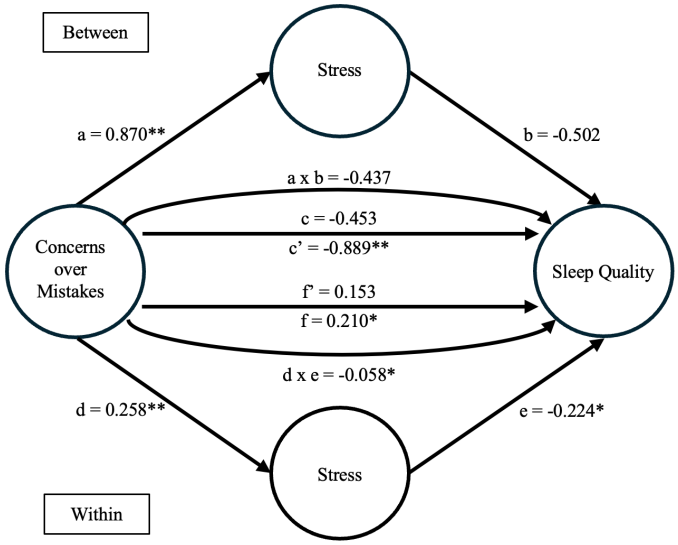
Multilevel analysis of daily perfectionism predicting daily sleep using daily stress as a mediator (n = 63)

	Sleep Onset Latency		Sleep Quality	
	Direct Pathway	Mediated Pathway	Direct Pathway	Mediated Pathway
Daily Concerns over Mistake				
Within	-0.061 [-0.093 - 0.061]	0.0138 [-0.004 - 0.03]	0.153 [-0.035 - 0.340]	**-0.058* [**-0.096 - -0.020] *p* = .003
Between	**0.298*** [0.012 - 0.584] *p* = .041	-0.061 [-0.359 - 0.236]	**-0.889**** [-1.329 - -0.449] *p* < .001	-0.437 [-0.957 - 0.084]
Daily Doubts about Actions				
Within	0.001 [-0.066 - 0.068]	0.011 [-0.006 - 0.027]	0.075 [-0.089 - 0.240]	**-0.050*** [-0.088 - -0.013] *p* = .009
Between	0.217 [0.055 - 0.489]	0.006 [-0.301 - 0.313]	**-0.813**** [-1.263 - 0.364] *p < .001*	-0.347 [-0.892 - 0.199]

Notes. Results are unstandardised regression coefficients [95% confidence interval]. **p* < .05, ***p* < .001.

Figure 7.1

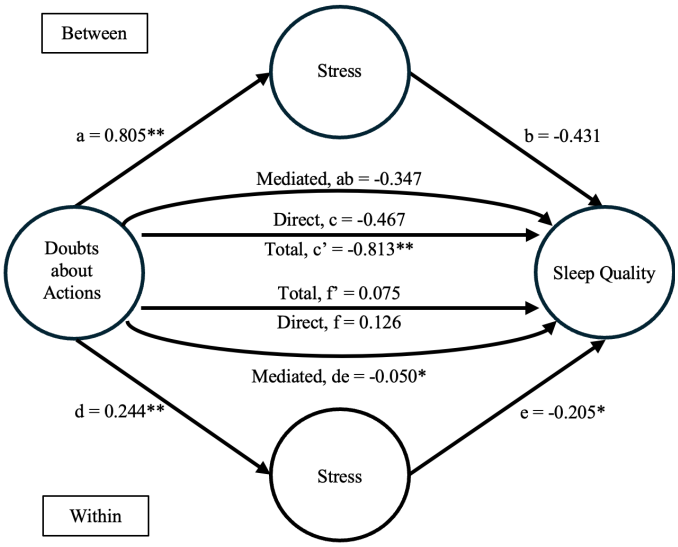
Multilevel path analysis of daily Concerns over Mistakes predicting sleep quality using daily stress as a mediator



Notes. a x b and d x e, indirect mediated pathway, c and f, total effect without mediator, c' and f', direct effect controlling for mediator, results presented are unstandardised regression coefficients. *$p < .05$, **$p < .001$.

Figure 7.2

Multilevel path analysis of daily Doubts about Action predicting sleep quality using daily stress as a mediator



Notes. a x b and d x e, indirect mediated pathway, c and f, total effect without mediator, c' and f', direct effect controlling for mediator, results presented are unstandardised regression coefficients. *$p < .05$, **$p < .001$.

Table 7.5

Multilevel analysis of daily sleep predicting daily perfectionism using daily stress as a mediator (n = 63)

	Daily Concerns over Mistakes		Daily Doubts about Actions	
	Direct Pathway	Mediated Pathway	Direct Pathway	Mediated Pathway
Sleep onset latency				
Within	0.002 [-0.002 - 0.005]	0.001 [-0.000 - 0.005]	0.002 [-0.001 - 0.005]	0.001 [-0.000 - 0.002]
Between	**0.017*** [0.007 - 0.028] p =.001	**0.008*** [0.000 -0.016] p = .042	**0.017*** [0.006 - 0.028] p = .003	**0.010*** [0.001 - 0.019] p = .029
Sleep quality				
Within	-0.002 [-0.053 - 0.048]	-0.008 [-0.021 - 0.006]	-0.034 [-0.092 - 0.023]	-0.008 [-0.022 - 0.006]
Between	**-0.266**** [-0.409 - -0.122] p < .001	**-0.164*** *[-0.270 - -0.058] p = .002*	**-0.301**** [-0.434 - -0.168] p < .001	**-0.196**** [-0.304 - - 0.088] p < .001

Notes. Results are unstandardised regression coefficients [95% confidence interval]. *p < .05, **p < .001.

7.5 Discussion

The current study is the first to examine the relationship between perfectionism and sleep variability. It investigated the direct temporal effects of changes in perfectionism and sleep and vice versa on a day-to-day basis, with daily stress as a mediator across a 14-day longitudinal design with repeated EMA. Correlations showed that higher levels of perfectionism were associated with higher variability in sleep onset latency. Multilevel analysis results suggest that at the between person level, a relationship between perfectionism and poor sleep exists and is bidirectional. Individuals with higher perfectionistic tendencies were more likely to experience disrupted sleep (i.e., prolonged sleep onset latency and poorer sleep quality), and conversely, those with more disrupted sleep also reported elevated perfectionism. However, changes in daily perfectionism did not directly influence sleep or vice versa. Nonetheless, stress provided an indirect pathway from daytime perfectionism to the same night of sleep, showing that stress mediated that relationship, but only in this direction. Compared to one's own average level of perfectionism, greater perfectionism tendencies during the day led to higher stress, which in turn predicted lower sleep quality that night. Stress did not mediate the effect of sleep on next-day perfectionism. These results highlight the role stress plays in the relationships between sleep and perfectionism.

Overall, results suggest higher perfectionism is associated with poorer sleep. Specifically, all between-person results were significant in both directions of the relationships between perfectionism and sleep, except for Doubts about Actions not predicting sleep onset latency. These results provide support for the bidirectionality in those relationships, suggesting that those with higher levels of perfectionism tend to report worse sleep, and those with worse sleep also tend to report higher levels of perfectionistic concerns. The finding is consistent with previous research indicating that perfectionism is associated positively with sleep onset latency and negatively with sleep quality and that insomnia symptoms are

associated with and predict future perfectionism levels (e.g.,Akram et al., 2015; Akram et al., 2023; Elbadawi et al., 2025; Oh et al., 2024; Richardson & Gradisar, 2020).

The lack of within-person effects in both directions of the relationship between perfectionism and sleep suggests that day-to-day fluctuations in perfectionism do not affect day-to-day fluctuations in sleep and vice versa. This implies that there are trait-like fluctuations in perfectionism, which are not linked to, and fluctuate independently from, sleep. However, it is important to consider that instrument insensitivity might explain the lack of intraindividual relationships. As there was no existing validated measure of daily perfectionism, the items that formed the DPM were adapted from FMPS and HFMPS. The restricted response options on the 5-point Likert scale may have not been sufficiently nuanced to capture changes over time, thereby reducing its sensitivity. Furthermore, reliance on a single item derived from an instrument established at the between-person level may not have reflected the full dimensionality of the daily construct and should be reconsidered in future research (Brose et al., 2020). Nonetheless, the intraclass correlations, which measure the proportion of between person variation to total variation, were acceptable for multilevel analysis (Preacher et al., 2010).

Another consideration relates to sample characteristics, which might have also contributed to the lack of within-person effects. Participants in this study were drawn from the general population and included individuals who report a range of normal sleep and insomnia symptoms, which may have reduced the likelihood of finding within-person effects compared to a clinical sample. It is also possible that the current study did not have enough power to detect any within-person effects given the short study duration of 14-days, particularly if those effects were small.

This study found the experience of heightened stress as an indirect pathway in the effect of daytime perfectionism on sleep quality at the within person level and in the

relationship between sleep and perfectionism at the between person level. At the within person level, when a person reported higher than their average daily perfectionism level, they also reported higher levels of stress for that day, which led to worse sleep quality that night. This suggests that individuals who experience higher than their average levels of state-like perfectionism are at greater risk of experiencing stress, which then adversely affects sleep. This contrasts with the finding by Kuskens et al. (2023) that stress was not a pathway in the link between perfectionism and sleep. The difference in outcomes is likely due to differences in methodology. Kuskens et al. (2023) studied how trait perfectionism at baseline related to daily sleep and stress measures, whereas here, daily fluctuations in perfectionism, stress and sleep were studied. The current finding is, however, consistent with previous research findings that trait perfectionism was associated with poor sleep via stress and provides further evidence to support the mediating hypothesis of stress in the relationship between perfectionism and sleep (Brand et al., 2015; Lundh et al., 1994; Molnar et al., 2020). Furthermore, the mediating effects found at the between-person level in this study offers initial evidence that individuals who experience poorer sleep tend to report higher levels of stress which increase their level of perfectionism.

7.5.1 Clinical Implications

Overall, the current study indicates that perfectionism is a risk factor for poor sleep and that stress plays an indirect role in the bidirectional relationships between sleep and perfectionism. When assessing and delivering treatment for poor sleep, it may be helpful for clinicians to consider whether perfectionism is playing a role in the patient's poor sleep and treatment response. More importantly, stress management may be an important consideration when delivering therapy for sleep difficulties to people who also report high levels of perfectionism. Specifically, when sleep difficulties are experienced, stress management may be a viable initial target for intervention for people with high perfectionism. Stress

management strategies, such as, progressive muscle relaxation, deep breathing and guided imagery, which can be delivered face-to-face or easily accessed via recorded audio are effective in promoting states of relaxation and reducing symptoms of anxiety and distress (Hamdani et al., 2022; Toussaint et al., 2021). Such interventions may be helpful in preventing the worsening of sleep difficulties, particularly while waiting for access to limited behavioural sleep medicine providers and specialist sleep therapy resources, such as, Cognitive Behavioural Therapy for Insomnia (Koffel et al., 2018).

7.5.2 Strengths, Limitations and Future Directions

The current study extended the perfectionism-sleep literature beyond cross-sectional evidence. To our knowledge, this is the first study to examine the relationship between perfectionism and sleep at an intraindividual level and provided new evidence that poor sleep predicted perfectionistic thinking, as opposed to the reverse of perfectionism predicting sleep, which is well supported by previous research (e.g., Azevedo et al., 2009; Molnar et al., 2020; Oh et al., 2024; Vincent & Walker, 2000). As already noted, due to the lack of a validated measure of daily perfectionism, key dimensions from the FMPS and HFPMS were used in a novel approach. We therefore developed the Daily Perfectionism Measures. However, it is possible that the Daily Perfectionism Measures were not sensitive enough to capture the nuanced day-to-day fluctuations in these perfectionism dimensions. This highlights the need for future research to develop a validated measure for capturing daily fluctuations in levels of perfectionism to facilitate further intraindividual variability studies in the future. The current study has limited the analysis of relationships between daily perfectionism and markers of poor sleep using only dimensions of Concerns over Mistakes and Doubts about Actions. It is possible that day-to-day fluctuations in other perfectionism subscales may be related to poor sleep and therefore, should be explored in future research. Finally, this study may have

lacked sufficient power to detect potential effects. Future work should increase sample size, extend study duration, and include clinical samples.

7.6 Conclusions

This is the first study to explore the bidirectional relationships between perfectionism and sleep using ecological momentary assessment data and found that perfectionism and poor sleep influence each other bidirectionally at the between-person level. Individuals who reported higher levels of perfectionism tend to report longer sleep onset latency and lower sleep quality, and those who report longer sleep onset latency and lower sleep quality also tended to report higher levels of perfectionism. Furthermore, stress appears to be an indirect pathway linking sleep and perfectionism. The only within-person effect found indicates that when individuals experience higher than their average level of perfectionism, they are also more likely to experience stress which leads to lower sleep quality. These findings suggest when assessing and treating sleep problems, perfectionism may be an important factor to consider. Additionally, when individuals with poor sleep report high levels of perfectionism, stress management may be an important therapy target.

7.7 References

Akram, U., Ellis, J. G., & Barclay, N. L. (2015). Anxiety mediates the relationship between perfectionism and insomnia symptoms: A longitudinal study. *PLoS One*, 10(10), e0138865. https://doi.org/10.1371/journal.pone.0138865

Akram, U., Stevenson, J. C., Gardani, M., Allen, S., & Johann, A. F. (2023). Personality and insomnia: A systematic review and narrative synthesis. *Journal of Sleep Research*, e14031. https://doi.org/10.1111/jsr.14031

Azevedo, M. H., Soares, M. J., Bos, S. C., Gomes, A. A., Maia, B., Marques, M., Pereira, A. T., & Macedo, A. (2009). Perfectionism and sleep disturbance. *World Journal of Biological Psychiatry*, 10(3), 225-233. https://doi.org/10.1080/15622970701367930

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, 68(3). https://doi.org/10.1016/j.jml.2012.11.001

Bastien, C. H., Vallieres, A., & Morin, C. M. (2001). Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Medicine*, 2(4), 297-307. https://doi.org/https://doi.org/10.1016/s1389-9457(00)00065-4

Bei, B., Wiley, J. F., Trinder, J., & Manber, R. (2016). Beyond the mean: A systematic review on the correlates of daily intraindividual variability of sleep/wake patterns. *Sleep Medicine Review*, 28, 108-124. https://doi.org/10.1016/j.smrv.2015.06.003

Boone, L., & Soenens, B. (2015). In double trouble for eating pathology? An experimental study on the combined role of perfectionism and body dissatisfaction. *Journal of Behavior Therapy and Experimental Psychiatry*, 47, 77-83. https://doi.org/10.1016/j.jbtep.2014.11.005

Boone, L., Soenens, B., Mouratidis, A., Vansteenkiste, M., Verstuyf, J., & Braet, C. (2012). Daily fluctuations in perfectionism dimensions and their relation to eating disorder symptoms. *Journal of Research in Personality*, 46(6), 678-687. https://doi.org/10.1016/j.jrp.2012.08.001

Brand, S., Kirov, R., Kalak, N., Gerber, M., Puhse, U., Lemola, S., Correll, C. U., Cortese, S., Meyer, T., & Holsboer-Trachsler, E. (2015). Perfectionism related to self-reported insomnia severity, but not when controlled for stress and emotion regulation. *Neuropsychiatric Disease and Treatment*, 11, 263-271. https://doi.org/10.2147/NDT.S74905

Brantley, P. J., Waggoner, C. D., Jones, G. N., & Rappaport, N. B. (1987). A Daily Stress Inventory: Development, reliability, and validity. *Journal of Behavioral Medicine*, 10(1), 61-74. https://doi.org/https://doi.org/10.1007/bf00845128

Bredeli, E., Vestergaard, C. L., Sivertsen, B., Kallestad, H., Overland, S., Ritterband, L. M., Glozier, N., Pallesen, S., Scott, J., Langsrud, K., & Vedaa, O. (2022). Intraindividual variability in sleep among people with insomnia and its relationship with sleep, health and lifestyle factors: An exploratory study. *Sleep Medicine*, 89, 132-140. https://doi.org/10.1016/j.sleep.2021.12.006

Brose, A., Schmiedek, F., Gerstorf, D., & Voelkle, M. C. (2020). The measurement of within-person affect variation. *Emotion*, 20(4), 677-699. https://doi.org/10.1037/emo0000583

Brown, V. A. (2021). An introduction to Linear Mixed-Effects Modeling in R. *Advances in Methods and Practices in Psychological Science*, 4(1). https://doi.org/10.1177/2515245920960351

Bürkner, P. (2017). brms: An R package for Bayesian Multilevel Models using Stan. *Journal of Statistical Software*, 80(1), 1-28. https://doi.org/doi:10.18637/jss.v080.i01

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Routledge Academic.

Dunkley, D. M. (2017). Perfectionism and daily stress, coping, and affect. Advancing multilevel explanatory conceptualisations. In J. Stoeber (Ed.), *The psychology of perfectionism: Theory, research, applications* (pp. 222–242). Routledge/Taylor & Francis Group. https://doi.org/https://doi.org/10.1037/a0034673

Egan, S. J., Wade, T. D., & Shafran, R. (2011). Perfectionism as a transdiagnostic process: A clinical review. *Clinical Psychology Review*, 31(2), 203-212. https://doi.org/10.1016/j.cpr.2010.04.009

Elbadawi, M. H., Mubasher, A. A., Abdulgalil, A. A., Alsaid, A., Elameen, N., Magdi, R., Mohamed, W. A., & Fadul, M. H. (2025). The relationship between perfectionism and quality of sleep: A cross-sectional study among Sudanese medical students. *Health Science Reports*, 8(7), e71075. https://doi.org/10.1002/hsr2.71075

Enders, C. K. (2022). *Applied missing data analysis* (2nd ed.). The Guildord Press.

Espie, C. A., Broomfield, N. M., MacMahon, K. M., Macphee, L. M., & Taylor, L. M. (2006). The attention-intention-effort pathway in the development of psychophysiologic insomnia: A theoretical review. *Sleep Medicine Review*, 10(4), 215-245. https://doi.org/10.1016/j.smrv.2006.03.002

Flett, G. L., & Hewitt, P. L. (2002). *Perfectionism: Theory, research, and treatment*. (G. L. Flett & P. L. Hewitt, Eds.). American Psychological Association. https://doi.org/https://doi.org/10.1037/10458-000

Frost, R. O., Marten, P., Lahart, C., & Rosenblate, R. (1990). The dimensions of perfectionism. *Cognitive Therapy and Research*, 14(5), 449-468. https://doi.org/https://doi.org/10.1007/BF01172967

Galloway, R., Watson, H., Greene, D., Shafran, R., & Egan, S. J. (2022). The efficacy of randomised controlled trials of cognitive behaviour therapy for perfectionism: A systematic review and meta-analysis. *Cognitive Behavior Therapy*, 51(2). https://doi.org/10.1080/16506073.2021.1952302

Hamdani, S. U., Zill, E. H., Zafar, S. W., Suleman, N., Um Ul, B., Waqas, A., & Rahman, A. (2022). Effectiveness of relaxation techniques 'as an active ingredient of psychological interventions' to reduce distress, anxiety and depression in adolescents: A systematic review and meta-analysis. *International Journal of Mental Health Systems*, 16(1), 31. https://doi.org/10.1186/s13033-022-00541-y

Hewitt, P. L., & Flett, G. L. (1991). Perfectionism in the self and social contexts: Conceptualisation, assessment, and association with psychopathology. *Journal of Personality and Social Psychology*, 60(3), 456-470. https://doi.org/https://doi.org/10.1037/0022-3514.60.3.456

Hewitt, P. L., Flett, G. L., Turnbull-Donovan, W., & Mikail, S. F. (1991). The Multidimensional Perfectionism Scale: Reliability, validity, and psychometric properties in psychiatric samples. *Psychological Assessment: A Journal of Consulting Clinical Psychology*, 3(3), 464-468. https://doi.org/https://doi.org/10.1037/1040-3590.3.3.464

Ip, V. (2025). Cognitive behavioural therapy outcomes for clinical perfectionism: A scoping review. *Technology in Medicine*, 102(1), 7-17. https://doi.org/https://doi.org/10.33137/utmj.v102i1.42426

Johann, A. F., Feige, B., Hertenstein, E., Nissen, C., Benz, F., Steinmetz, L., Baglioni, C., Riemann, D., Spiegelhalder, K., & Akram, U. (2023). The effects of Cognitive Behavioral Therapy for insomnia on multidimensional perfectionism. *Behavior Therapy*, 54(2), 386-399. https://doi.org/10.1016/j.beth.2022.10.001

Koffel, E., Bramoweth, A. D., & Ulmer, C. S. (2018). Increasing access to and utilization of cognitive behavioral therapy for insomnia (CBT-I): A narrative review. *Journal of General Internal Medicine*, 33(6), 955-962. https://doi.org/10.1007/s11606-018-4390-1

Koval, P., Hinton, J., Dozo, N., Gellson, J., Alvarez, M., Harrison, A., Vu, D., Susanto, R., Jayaputera, G., & Sinnott, R. (2019). *SEMA3: Smartphone Ecological Momentary Assessment*, version 3. In http://www.sema3.com

Kuskens, A., Stricker, J., Hertrampf, L. S., Peitrowsky, R., & Gieselmann, A. (2023). Perfectionism, perceived stress, and pre-sleep arousal in insomnia: Effects on sleep quality in a daily life study. *Journal of Clinical Sleep Medicine*, 20(3), 433-443. https://doi.org/10.5664/jcsm.10910.

Limburg, K., Watson, H. J., Hagger, M. S., & Egan, S. J. (2017). The relationship between perfectionism and psychopathology: A meta-analysis. *Journal of Clinical Psychology*, 73(10), 1301-1326. https://doi.org/10.1002/jclp.22435

Lundh, L.G., Broman, J. E., Hetta, J., & Saboonchi, F. (1994). Perfectionism and insomnia. *Scandinavian Journal of Behaviour Therapy*, 23(1), 3-18. https://doi.org/10.1080/16506079409455949

Lundh, L. G., & Broman, J. E. (2000). Insomnia as an interaction between sleep interfering and sleep-interpreting processes. *Journal of Psychosomatic Research*, 49, 299-310. https://doi.org/https://doi.org/10.1016/S0022-3999(00)00150-1

Maas, C. J. M., & Hox, J. J. (2005). Sufficient sample sizes for multilevel modeling. *Methodology*, 1(3), 86-92. https://doi.org/10.1027/1614-2241.1.3.86

Mackinnon, S. P., Battista, S. R., Sherry, S. B., & Stewart, S. H. (2014). Perfectionistic self-presentation predicts social anxiety using daily diary methods. *Personality and Individual Differences*, 56, 143-148. https://doi.org/10.1016/j.paid.2013.08.038

Mackinnon, S. P., Kehayes, I. L., Leonard, K. E., Fraser, R., & Stewart, S. H. (2017). Perfectionistic concerns, social negativity, and subjective well-being: A test of the Social Disconnection Model. *Journal of Personality*, 85(3), 326-340. https://doi.org/10.1111/jopy.12243

Mackinnon, S. P., Ray, C. M., Firth, S. M., & O'Connor, R. M. (2019). Perfectionism, negative motives for drinking, and alcohol-related problems: A 21-day diary study. *Journal of Research in Personality*, 78, 177-188. https://doi.org/10.1016/j.jrp.2018.12.003

Merwin, K. E., Mackinnon, S. P., O'Connor, R. M., & Flett, G. L. (2022). Socially prescribed perfectionism predicts next-day binge eating behaviors over 20-days. *Journal of Counseling Psychology*, 69(4), 554-564. https://doi.org/10.1037/cou0000600

Messman, B. A., Wiley, J. F., Feldman, E., Dietch, J. R., Taylor, D. J., & Slavish, D. C. (2024). Irregular sleep is linked to poorer mental health: A pooled analysis of eight studies. *Sleep Health*, 10(4), 493-499. https://doi.org/10.1016/j.sleh.2024.03.004

Molnar, D. S., Janssen, W. F., & Sirois, F. M. (2020). Sleeping perfectly? Trait perfectionism, perceived stress, and sleep quality. *Personality and Individual Differences*, 167, 110244. https://doi.org/10.1016/j.paid.2020.110244

Molnar, D. S., Thai, S., Blackburn, M., Zinga, D., Flett, G. L., & Hewitt, P. L. (2023). Dynamic changes in perfectionism dimensions and psychological distress among adolescents assessed before and during the COVID-19 pandemic. *Child Development*, 94(1), 254-271. https://doi.org/10.1111/cdev.13855

Monk, T. H., Reynolds III, C. F., Kupfer, D. J., Buysse, D. J., Coble, P. A., Hayes, A. J., Machen, M. A., Petrie, S. R., & Ritenour, A. M. (1994). The Pittsburgh Sleep Diary. *Journal of Sleep Research*, 3(2), 111-120. https://doi.org/https://doi.org/10.1111/j.1365-2869.1994.tb00114.x

Morin, C. M., Belleville, G., Belanger, L., & Ivers, H. (2011). The Insomnia Severity Index: Psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep*, 34(5), 601-608. https://doi.org/https://doi.org/10.1093/sleep/34.5.601

Morin, C. M., & Espie, C. A. (2007). *Insomnia: A clinical guide to assessment and treatment.* Springer Science & Business Media.

O'Rourke, H. P., & MacKinnon, D. P. (2018). Reasons for testing mediation in the absence of an intervention effect: A research imperative in prevention and intervention research. *Journal of Studies on Alcohol and Drugs*, 79(2), 171-181. https://doi.org/10.15288/jsad.2018.79.171

Oh, S. Y., Meaklim, H., Nicholas, C. L., Cunnington, D., Schenker, M., Patrick, C. J., Windred, D., & Phillips, L. J. (2024). Perfect enough to sleep? Perfectionism and actigraphy-determined markers of insomnia. *Behavioral Sleep Medicine*, 1-16. https://doi.org/10.1080/15402002.2024.2355476

Ottenstein, C., & Werner, L. (2022). Compliance in ambulatory assessment studies: Investigating study and sample characteristics as predictors. *Assessment*, 29(8), 1765-1776. https://doi.org/10.1177/10731911211032718

Preacher, K. J., Zyphur, M. J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods*, 15(3), 209-233. https://doi.org/10.1037/a0020141

Rice, K. G., & Aldea, M. A. (2006). State dependence and trait stability of perfectionism: A short-term longitudinal study. *Journal of Counseling Psychology*, 53(2), 205-213. https://doi.org/10.1037/0022-0167.53.2.205

Richardson, C., & Gradisar, M. (2020). Perfectionism and insomnia in adolescents: The role of vulnerability to stress and gender. *Journal of Adolescence*, 85, 70-79. https://doi.org/10.1016/j.adolescence.2020.10.003

Riemann, D., Spiegelhalder, K., Feige, B., Voderholzer, U., Berger, M., Perlis, M., & Nissen, C. (2010). The hyperarousal model of insomnia: A review of the concept and its evidence. *Sleep Medicine Review*, 14(1), 19-31. https://doi.org/10.1016/j.smrv.2009.04.002

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software*, 48(2), 1-36. https://doi.org/doi:10.18637/jss.v048.i02.

Ståhlberg, J., Tuominen, H., Pulkka, A. T., & Niemivirta, M. (2020). Students' perfectionistic profiles: Stability, change, and associations with achievement goal orientations. *Psychology in the Schools*, 58(1), 162-184. https://doi.org/10.1002/pits.22444

Stoeber, J., & Otto, K. (2006). Positive conceptions of perfectionism: Approaches, evidence, challenges. *Personality and Social Psychology Reivew*, 10(4), 295-319. https://doi.org/10.1207/s15327957pspr1004_2

Stricker, J., Kroger, L., Johann, A. F., Kuskens, A., Gieselmann, A., & Pietrowsky, R. (2023). Multidimensional perfectionism and poor sleep: A meta-analysis of bivariate associations. *Sleep Health*, 9(2), 228-235. https://doi.org/10.1016/j.sleh.2022.09.015

Stuck, B. A., Maurer, J. T., Schlarb, A. A., Schredl, M., & WeeB, H.G. (2021). *Practice of sleep medicine: Sleep disorders in children and adults*. Springer.

Suh, H., Sohn, H., Kim, T., & Lee, D. G. (2019). A review and meta-analysis of perfectionism interventions: Comparing face-to-face with online modalities. *Journal of Counseling Psychology*, 66(4), 473-486. https://doi.org/10.1037/cou0000355

Toussaint, L., Nguyen, Q. A., Roettger, C., Dixon, K., Offenbacher, M., Kohls, N., Hirsch, J., & Sirois, F. (2021). Effectiveness of progressive muscle relaxation, deep breathing, and guided imagery in promoting psychological and physiological states of relaxation. *Evidence-Based Complementary and Alternative Medicine*, 2021, 5924040. https://doi.org/10.1155/2021/5924040

Vecchione, M., & Marsicano, G. (2023). Mean-level change of perfectionism in late childhood: A 2-year longitudinal investigation. *Current Psychology*, 43(14), 12321-12334. https://doi.org/10.1007/s12144-023-05317-2

Vincent, N. K., & Walker, J. R. (2000). Perfectionism and chronic insomnia. Journal of *Psychosomatic Research*, 49, 349-354. https://doi.org/https://doi.org/10.1016/s0022-3999(00)00175-6

Wegerer, M. (2024). Cognitive-behavioral treatment of perfectionism: An overview of the state of research and practical therapeutical procedures. *Verhaltenstherapie*, 34(1), 1-10. https://doi.org/10.1159/000532044

West, B. T., Welch, K. B., & Galecki, A. T. (2014). *Linear mixed models: A practical guide to using statistical software* (2nd ed.). CRC Press. https://ebookcentral.proquest.com/lib/unimelb/detail.action?docID=1640582

Williams, M. T., Lewthwaite, H., Fraysse, F., Gajewska, A., Ignatavicius, J., & Ferrar, K. (2021). Compliance with mobile Ecological Momentary Assessment of self-reported health-related behaviors and psychological constructs in adults: Systematic review and meta-analysis. *Journal of Medical Internet Research*, 23(3), e17023. https://doi.org/10.2196/17023

Wilson, S. J., Nutt, D. J., Alford, C., Argyropoulos, S. V., Baldwin, D. S., Bateson, A. N., Britton, T. C., Crowe, C., Dijk, D. J., Espie, C. A., Gringras, P., Hajak, G., Idzikowski, C., Krystal, A. D., Nash, J. R., Selsick, H., Sharpley, A. L., & Wade, A. G. (2010). British Association for Psychopharmacology consensus statement on evidence-based treatment of insomnia, parasomnias and circadian rhythm disorders. *Journal of Psychopharmacology*, 24(11), 1577-1601. https://doi.org/10.1177/0269881110379307

Zhao, W., Van Someren, E. J. W., Xu, Z., Ren, Z., Tang, L., Li, C., & Lei, X. (2024). Identifying the insomnia-related psychological issues associated with hyperarousal: A network perspective. *International Journal of Psychophysiology*, 195, 112276. https://doi.org/10.1016/j.ijpsycho.2023.112276

PART III

Chapter 8

General Discussion

"Have the courage to be imperfect."

-Alfred Adler-

8.1 Overview of Rationale and Primary Aims

This thesis aimed to explore relationships between sleep and perfectionism by using both the FMPS and HFMPS to explore how different facets of perfectionism might relate to objective and subjective markers of poor sleep. In study 1, the relationship between sleep and perfectionism was explored using measures of sleep obtained via actigraphy and sleep diary. It addressed the lack of prior research exploring the relationship between perfectionism and objectively measured sleep and allowed for a comparison of those relationships based on sleep that is measured subjectively and objectively. In study 2, the role of perfectionism in poor sleep was investigated by focusing on SWSD – the discrepancy between subjective and objective measures of sleep, a commonly reported symptom of insomnia (Castelnovo et al., 2019). Finally, in study 3, the relationship between perfectionism and sleep was explored further by taking an intraindividual approach using daily measures, which allowed for investigation of potential bidirectional effects between sleep and perfectionism. Therefore, this thesis presents novel explorations of the relationship between perfectionism and sleep.

8.2 Summary of Findings

Study 1 found that high levels of perfectionism were associated with poor sleep measured objectively using actigraphy and subjectively using sleep diaries. The associations between perfectionism and subjective sleep measures were stronger than those with objective sleep measures and differed. Subjective SOL and SE correlated with Concern over Mistakes,

Doubts about Actions, Personal Standards and Self-oriented Perfectionism. In comparison, Socially Prescribed Perfectionism and Parental Expectations were associated with objective SOL and SE. Stress was identified as a mediator in the relationships between objective SE and Concern over Mistakes and Doubts about Actions, indicating that stress might be a mechanism through which perfectionism affect sleep.

The main finding from Study 2 was a positive indirect effect of perfectionism on SWSD through pre-sleep arousal. Specifically, Concern over Mistakes and Doubts about Actions correlated with discrepancy in SOL, and Doubts about Action also predicted the discrepancy in SOL. Furthermore, those relationships are mediated by cognitive pre-sleep arousal, which refers to worries or racing mind that occur before sleep or during wake and is disruptive to sleep (Nicassio et al., 1985). These findings suggest that SWSD increases if one's level of perfectionism is higher and those relationships operate indirectly through an increase in pre-sleep arousal. Given that SWSD is a symptom of insomnia, these findings provide new evidence that one's vulnerability to poor sleep increases with increasing levels of perfectionism (Castelnovo et al., 2019).

In study 3, interindividual, intraindividual and bidirectional relationships between perfectionism and subjective sleep were found. The primary finding was a positive association between perfectionism and variability in SOL. At the interindividual level, there were significant bidirectional relationships between perfectionism and poor sleep. Specifically, individuals who reported higher Concern over Mistakes also reported longer SOL and lower sleep quality on average and vice versa. Similarly, those who reported higher Doubts about Actions also reported lower sleep quality, and those who reported longer SOL and lower sleep quality reported higher levels of Doubts about Actions the next day. Furthermore, stress mediated the relationships of sleep and next day perfectionism levels. At the intraindividual level, there were no direct associations between daytime perfectionism on

nighttime sleep or vice versa. However, stress mediated the relationships of increasing Concern over Mistakes and Doubts about Action predicting lower sleep quality during the night. Poor sleep did not predict changes in next day perfectionism and there were no mediation effect by stress. These findings suggest bidirectional relationships exist between perfectionism and sleep, but only at the interindividual level and provide novel evidence that perfectionism is a risk factor for poor sleep via the mechanism of stress, but not vice versa.

8.3 Synthesis and Implications of Findings

8.3.1 Perfectionism as a Risk Factor for Poor Sleep

The findings from this thesis provide further evidence to support the theory that perfectionism is a risk factor for poor sleep. Firstly, existing evidence of the relationships between subjective markers of poor sleep and perfectionism was replicated in an Australian general population sample in Study 1 (Akram et al., 2015; Akram et al., 2017; Akram et al., 2020; Andersson et al., 2005; Brand et al., 2015; Jansson-Frojmark & Linton, 2007; Lombardo et al., 2013; Lundh et al., 1994; Richardson & Gradisar, 2020; Trudel-Fitzgerald et al., 2017; Vincent & Walker, 2000). The associations between perfectionism and objective markers of poor sleep derived from actigraphy supported previous findings that perfectionism is associated with polysomnography-derived objective sleep disturbances (Johann et al., 2017). Study 2 demonstrated that having higher levels of perfectionism predisposes one to SWSD via higher levels of pre-sleep arousal. Study 3 revealed that bidirectional relationships exist between perfectionism and subjective sleep at the interindividual level. Lastly, stress appears to be a key mechanism through which perfectionism affects sleep. Stress mediated the relationship between objective sleep and perfectionism in Study 1 and the relationship between subjective sleep and perfectionism in Study 3. These findings are consistent with past findings of stress as a mediator in the relationship between sleep and perfectionism

(Akram et al., 2015; Akram et al., 2017; Akram et al., 2020; Brand et al., 2015; Jansson-Frojmark & Linton, 2007).

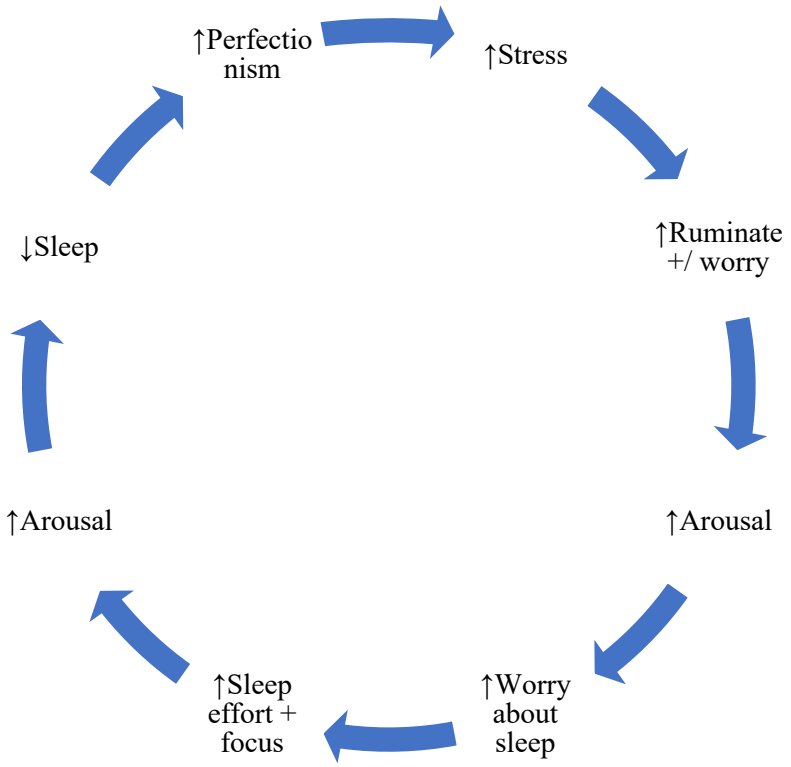
Based on the above findings, it is plausible that when experiencing life stressors, individuals who have higher levels of perfectionism may become overly concerned about potential mistakes they have made, doubting their own actions and/or evaluating their own performances based on their own perceived expectations from others. Consequently, they may stay awake ruminating about what had happened in the past and worrying about what will happen in the future, which may increase both cognitive and emotional arousal and ultimately lead to prolonged sleep onset latency and a reduction in sleep efficiency. Furthermore, as suggested by Lundh et al. (1991), worries about sleeplessness and the upcoming impact of insufficient sleep on future performance, i.e., making mistakes, not able to act appropriately or meeting their own or others' standards as perceived or expected, can also emerge with prolonged sleep onset latency to drive further arousal. These perfectionistic cognitive processes would meet the sleep interfering and sleep interpreting processes as put forth by Lundh and Broman (2000)'s integrative model of insomnia. See Figure 8.1 for illustration.

Additionally, individuals with high perfectionism levels are likely to aim to perform to high standards and become worried and concerned about their ability to function and perform if they are not sleeping well. In line with Espie et al. (2006)'s attention-intention-effort pathway (AIE) model of insomnia, these individuals are likely to engage in sleep effort, trying to "sleep perfectly", intending to sleep and paying attention to and/or becoming preoccupied with their sleep and sleeplessness in an effort to preserve their next-day performance, which adds further to their failure of de-arousal to disrupt the automaticity of the sleep process leading to psychophysiologic insomnia (Espie et al., 2006). Lundh et al. (1991) also suggested that such individuals tend to push themselves even when fatigued to

disrupt the rhythms of activity and rest. By the same reasoning, it would be expected that such individuals will engage in excessive sleep effort, which further disrupts the automatic sleep process.

Figure 8.1

Illustration of how perfectionism, stress and arousals can plausibly drive poor sleep in a vicious cycle



The bidirectionality of relationships between perfectionism and sleep found in Study 3 were interindividual effects. At the intraindividual level, those who reported higher than their average level of perfectionism tended to report higher stress and poorer sleep, but the reverse relationship was not found. While this suggests trait-like fluctuations in perfectionism may be independent of sleep, it is possible that this relationship was not detected due to a lack of power or instrument insensitivity in this thesis. It is theoretically plausible that individuals experiencing their higher-than-average levels of perfectionism after a stressful day may experience a poor night's sleep, which, in turn, increases their stress levels and activates their

concerns about their daytime performances. Therefore, a vicious cycle develops whereby perfectionistic concerns are triggered by stress leading to poor sleep, then the poor sleep leads to further stress and triggers next-day perfectionistic concerns to keep the poor sleep and perfectionistic concerns going and potentially leading to chronic insomnia. If so, perfectionism may also be a maintaining factor of poor sleep in addition to being a predisposing risk factor. For illustration, see Figure 8.1.

8.3.2 Facets of Perfectionism Affect Sleep Differently

The FMPS and HFMPS and their subscales provide different insights into the relationships between perfectionism and poor sleep. Results from Study 1 indicates that specific facets of perfectionism are drivers of poor sleep for individuals with high perfectionism levels. Perfectionistic concerns relating to self-evaluation, as measured by Concern over Mistakes, Doubts about Actions, Personal Standards and Self-oriented Perfectionism, correlated to subjective markers of poor sleep. On the other hand, perfectionistic concerns relating to others' evaluations of their performance, as measured by Socially Prescribed Perfectionism and Parental Expectations, correlated to and predicted objective markers of poor sleep. Although FMPS and HFMPS have been shown to overlap with each other, they appear to capture different facets of perfectionism that influence sleep differently (Frost et al., 1993). It appears that when perfectionistic concerns are self-driven or internalised standards, they negatively impact on the perception of sleep. In contrast, perfectionistic concerns that are perceived to be externally driven by others tend to impact on objective measures of sleep.

Furthermore, Study 1 revealed that the correlations between the perfectionism and objective markers of poor sleep were weaker than those between perfectionism and subjective markers of poor sleep. When comparing the two perfectionism scales, Frost et al. (1993) found significant and distinct variance of Socially Prescribed Perfectionism with

Concerns over Mistakes, Parental Expectations and Parental Criticism even when the other components were controlled for. Although each variable accounted for unique variance in Socially Prescribed Perfectionism, the persistence of independent associations suggests that no single construct fully explains variance in Socially Prescribed Perfectionism. It seems Socially Prescribed Perfectionism was able to capture the unique associations between perfectionism and objective sleep markers. It is possible that individual subscales in the FMPS, such as, Parental Expectations and Parental Criticism, are not sufficiently broad to affect objectively measured sleep. However, broader social pressures, as measured by the Socially Prescribed Perfectionism, a subscale of the HFMPS, can do so. Therefore, both FPMS and HFMPS and their subscales appear to identify different aspects of perfectionism that is relevant to sleep.

8.3.3 Perfectionism Contributes to SWSD via Pre-sleep Cognitive Arousal

The results from Study 2 showed how perfectionism contributes to SWSD through pre-sleep cognitive arousals. It is plausible that during stressful periods, individuals with high levels of perfectionism engage in rumination and worry before sleep leading to pre-sleep cognitive arousal, which leads to longer sleep onset latency and lower sleep efficiency. When they do eventually fall asleep, self-doubt may lead to them to question if they have slept well, sufficiently or adequately, leading them to experience and report worse sleep than objectively measured. Perlis et al. (1997) proposed that arousals during sleep onset and sleep-wake transitions may contribute to SWSD. Therefore, it is possible that individuals with high levels of self-doubt may question their ability to sleep, which may be reinforced by heighted arousal or agitation throughout the night, leading them to underestimate their sleep compared to objectively obtained sleep measures. Alternatively, their arousal through the night remains high as they continue to monitor whether they are sleeping, either consciously or subconsciously. Thus, it might feel like they are not sleeping even if they did fall asleep,

leading to SWSD. This idea aligns with theoretical models suggesting neurobiological mechanisms where SWSD is driven by central nervous system hyperarousal and with animal models showing stress, which may be further exacerbated by high perfectionism levels, can lead to REM instability and fragmentation and induce SWSD (Dressle & Riemann, 2023; McCullough et al., 2021; Perlis et al., 1997; Reid et al., 2022; Riemann et al., 2022). On the basis that perfectionism is associated with arousals and can exacerbate the vulnerability to stress, these findings contribute evidence to support the hyperarousal model of insomnia with perfectionism as a risk factor for SWSD, a symptom of insomnia (Besser et al., 2008; Riemann et al., 2010; van de Laar et al., 2010).

8.4 Theoretical, Research and Clinical Implications

8.4.1 Perfectionism Subscales are Relevant in Sleep Research and Clinical Practice

The results from this thesis support suggestions that perfectionism increases one's vulnerability to insomnia (Espie et al., 2006; Lundh et al., 1994; van de Laar et al., 2010). However, specific facets of perfectionism in the form of having excessive Concerns over Mistakes, Doubts about Actions and Socially Prescribed Perfectionism appear to be most relevant to sleep. This thesis has demonstrated how the different facets of perfectionism might be relevant to sleep research. It also highlights that the subscales of both the FMPS and HFMPS can potentially identify how perfectionism as a personality trait can contribute to poor sleep and may provide nuanced and relevant insights in clinical practice.

8.4.2 Consider Perfectionism in Case Conceptualisation

This thesis has highlighted the importance of keeping perfectionism in mind as a potential risk factor when assessing and treating clients for poor sleep. As suggested by Muench et al. (2022), a case conceptualisation approach can help isolate the most relevant factors to an individual's sleep problems, which will allow clinician to take a more nuanced approach to treatment to improve therapy efficacy. Taking a case conceptualisation approach

as proposed by Manber and Carney (2015), treatment is individualised to address significant underlying factors that perpetuate insomnia, e.g., sleep restriction therapy might work for significant sleep extension while stimulus control therapy might work better for hyperarousal and sleep effort. Where perfectionism and stress are identified as the potential underlying drivers of the poor sleep during case conceptualisation, addressing and managing the perfectionism and stress that is pertinent to the poor sleep appears important.

8.4.3 Potential Additions and/or Modifications to CBT-I

Traditionally, the components of CBT-I include psychoeducation, sleep restriction therapy, stimulus control therapy, sleep hygiene and cognitive therapy. These are delivered sequentially and may be supplemented by other adjunct interventions, such as, relaxation, deep breathing, progressive muscle relaxation, mindfulness meditation and grounding (Walker et al., 2022). However, Johann et al. (2023) noted clients with high perfectionism may have trouble with sleep restriction therapy as it can lead to excessive daytime sleepiness, fatigue and low mood, which can potentially lead to therapy dropout. Those authors also found that perfectionism and insomnia are positively associated with sleep effort and pre-sleep arousal, which can disrupt the automatic process of sleep, and perfectionism levels can rise upon completion of CBT-I. As such, including a brief assessment of perfectionism during initial assessment then bearing that assessment in mind during case formulation and treatment planning is important.

Clinicians may need to use clinical judgment when delivering CBT-I to potentially address the client's perfectionistic concerns relating to sleep and introduce relaxation and stress management strategies to manage pre-sleep arousals before implementing sleep restriction therapy. This is because when stressed, clients with high perfectionism may struggle with worries and rumination about their own performance, which may include their adherence to sleep restriction therapy and lead to therapy dropout (Johann et al., 2023).

Furthermore, perfectionistic cognitions pertinent to sleep should be addressed in the cognitive therapy component of CBT-I. The main goal is to reduce the risk of failing sleep restriction therapy and/or minimise therapy dropout in the therapy process and prevent an increase in perfectionism levels upon completion of therapy to reduce the risk of a relapse. As shown, perfectionism may exacerbate poor sleep on a day-to-day basis when experiencing stress. Both perfectionism and stress may interfere with the treatment process for poor sleep, thus, the identification and management of perfectionism and stress become more salient in CBT-I when working with clients from this population group. The management of perfectionism in the context of poor sleep should be a key clinical consideration, and modifications and additions to CBT-I to manage perfectionism and stress may be helpful to improve therapy outcomes.

8.4.4 Considerations when treating SWSD

The findings from this thesis relating to SWSD and perfectionism supports the proposal that actigraphy can be helpful in cases of SWSD by enhancing compliance and rapport as proposed by Muench et al. (2022). Muench et al. (2022) suggest that CBT-I compliance is improved by surveillance while rapport is enhanced via the halo effect because patient confidence increases with the integration of using a device and data collection while in treatment. The incorporation of actigraphy in therapy for this population group may be helpful in dispelling some of the self-doubts about whether they are sleeping through the night. Having a device that is monitoring their sleep may also improve hyperarousal by reducing conscious or subconscious vigilance, checking or monitoring of whether they are asleep throughout the night or during transitions between sleep and wake.

Given that actigraphy is recommended in clinical sleep medicine to diagnose and monitor insomnia and SWSD, the findings from this project offer some novel psychological insights into the potential presentation and management of SWSD for clients who also report

high levels of perfectionism (Liguori et al., 2023). Prior to introducing the concept of SWSD, it is important not to invalidate the client's subjective experience to prevent reinforcing their perfectionistic concerns about making mistakes or having doubts about their sleep. It is, therefore, important to discuss the various ways in which sleep is measured, how discrepancy between measures can occur, provide a strong psychoeducation around SWSD and explain how intrusive mental activity in the form of rumination and worry, pre-sleep emotional state and cognitive and psychological factors can lead to and influence SWSD experiences (Harvey, 2002; Perlis et al., 1997; Stephan & Siclari, 2023). The key is not to exacerbate perfectionistic cognitions further.

8.5 Strengths

There were four key strengths of this program of research. The first is the inclusion of both subjective and objective sleep measures. This thesis is the first to utilise actigraphy to study sleep objectively in relation to perfectionism. This allowed for the collection of sleep data in participants' natural sleep environment with data collected ecologically across a period of 14 days to capture daily and state-like symptoms across time. As such, subjective and objective sleep measures could be compared within the same individual, which allowed for a complete exploration of the potential relationships between sleep and perfectionism. This led to the novel finding of the relationship between SWSD and perfectionism and the identification of its mechanism via pre-sleep cognitive arousal.

Another key strength was the inclusion of both the FMPS and HFPMS, which facilitated a comprehensive investigation of how the different facets of perfectionism relate to markers of poor sleep. This allowed for a comprehensive exploration of how different facets of perfectionism are associated with sleep - only a limited number of previous studies had included both perfectionism scales (e.g., Akram et al., 2015; Akram et al., 2017; Vincent & Walker, 2000). This led to the insight that internally driven perfectionistic concerns (e.g.,

Concerns over Mistakes, Doubts about Actions) affect subjective sleep measures while externally driven perfectionistic concerns (e.g., Socially Prescribed Perfectionism, Parental Expectations) affect objective sleep measures. It also led to the identification of the role perfectionism may play in SWSD.

This was the first study to explore the bidirectional and temporal relationships between sleep and perfectionism at both interindividual and intraindividual levels with subjective sleep data collected over a two-week period. Daily self-reported perfectionism and mood measures were also collected over the study period, enabling the exploration of the effects of daily stress as a mechanism in those relationships. These explorations were made possible by adapting key dimensions from the FMPS and HFPMS as the Daily Perfectionism Measures in this project. Consequently, this thesis was able to explore the bidirectional relationships between perfectionism and poor sleep, and the mediating role of stress in those relationships. These findings showed that not only does perfectionism play a role in poor sleep, but poor sleep may also play a role in perfectionism, which was previously unidentified.

Lastly, this thesis also provided a comprehensive investigation with an Australian adult population, which had not been previously done and augmented previous findings of the relationships between perfectionism and poor sleep and adding evidence to support theories of insomnia implicating perfectionism as a risk factor and stress as an underlying mechanism (e.g., Azevedo et al., 2010; Lundh et al., 1994; Maia et al., 2011; Richardson & Gradisar, 2020; van de Laar et al., 2010).

8.6 Limitations and Future Directions

8.6.1. Limitations Pertaining to Sample

A key weakness lies with the use of general population sample instead of a clinical sample (e.g., people diagnosed with insomnia). The initial plan to recruit a larger and more balanced sample of clinical and general population sample was not possible due to the

COVID-19 pandemic and a pivot was made to include a sample with no sleep problems to a range of insomnia symptom severities. Therefore, the findings relating to poor sleep may be conservative and should be further investigated with a clinical sample in future research. Secondly, 85% of participants were female. While the prevalence of insomnia is significantly higher in females than males with an odd ratio of 1.58 (Zeng et al., 2020), the sex ratio of the sample is not representative of the balanced male to female ratio of the general population in Australia (Australian Bureau of Statistics, 2025). Therefore, the current findings have limited generalisability to males. Future investigations should include a sample that is more representative of the sex ratio in the general population, including participants who identify as neither male nor female. Lastly, the sample was recruited with a potential self-selection bias. Invitation to participation explicitly included both good and poor sleepers and mentioned that the project was studying perfectionism, well-being and sleep. Those who tend to perceive their sleep to be poor or their perfectionism to be high might have been more likely to accept the invitation due to their personal interest in the topics. Consequently, it might have led to an overestimation of perfectionism levels and/or subjective sleep disturbances.

8.6.2. Methodological Limitations

The research project recruited a total of 65 participants who completed a sleep study over a two-week period. The sample size was considered small for some analyses, particularly for those based on average values, which might have contributed to an increase in type two error and non-significant findings (Columb & Atkinson, 2016). Future investigations should include a larger sample to improve power of analysis. In this research project, actigraphy was used to derive objective sleep measure based on the lack of movement as a proxy for sleep and was, therefore, incapable of capturing sleep architecture or other physiological sleep data. With new wearable devices capable of capturing objective

physiological sleep measures and sleep architecture becoming available (see Chapter 2.2.1.3 for brief discussion), future research should explore how these other objective sleep measures and those derived from polysomnography might relate to perfectionism. Such objective sleep measures will allow for the exploration of and identification of how perfectionism may influence sleep in other objective measures, e.g., impact on sleep stages, arousal index, etc.

Quantification of objective sleep measures and the subsequent derivation of sleep discrepancy measures are limited by our chosen methods. In this thesis, actigraphy setting was optimised for sleep detection. Future research should consider optimising settings for detecting wake. Furthermore, the derivation of sleep discrepancy measures was based on arithmetic differences in this study. A recent review identified alternative methods of computing sleep discrepancy measures (Walton et al., 2024). Another recent study showed that the environment and method of data collection (e.g., in-laboratory and at-home) as well as differences between samples can impact how SWSD is assessed because good sleepers and sleepers with insomnia disorder demonstrate opposite patterns and severity of SWSD (Maltezos et al., 2024). These recent methodological findings should be considered in future research.

Studies 1 and 2 were based on cross-sectional data, so causality could not be determined. To establish causality, future studies should take a longitudinal exploration of the relationships between sleep and perfectionism. Finally, the adaptation of selected subscales from the FMPS and HFPMS into the Daily Perfectionism Measures have not yet been validated. It is a possibility that these measures were not sensitive enough to capture the daily effects of perfectionism on sleep, which might have contributed to non-significant findings. Currently, there is no daily measures of perfectionism available, a gap that should be addressed in future research to facilitate more intraindividual studies in this area.

8.6.3. Other Limitations

Finally, the aim of this research project was to explore the relationships between perfectionism and sleep. Sleep improvement interventions through CBT-I with considerations of perfectionism were beyond the scope of this research project. Further research is required to investigate the efficacy of interventions to improve sleep and perfectionism and to determine the optimal sequencing of specific interventions for sleep and perfectionism

8.7 Conclusions

Perfectionism was first theorised to be a risk factor for the development of poor sleep and insomnia by Lundh et al. (1994). Despite the passage of more than 30 years, there has been limited research into the relationships between perfectionism and sleep. This thesis aimed to fill that research gap by undertaking a comprehensive study of how multidimensional perfectionism and markers of poor sleep relate to each other. This project included both the FMPS and HFMPS and was the first to utilise actigraphy to collect objective sleep measures in participants' natural sleep environment while collecting corresponding subjective sleep measures using a sleep diary and EMA over the two-week study period. Consequently, the project contributed some novel findings to the field.

Overall, subjective poor sleep related stronger to perfectionism than objective poor sleep. Individual subscales from the FMPS and HFMPS (reflecting different facets of perfectionism) appear to relate to poor sleep differently, but stress plays a mediating role in those relationships. A novel finding is the discrepancy between objective and subjective sleep, which was found to be indirectly related to perfectionism through pre-sleep cognitive arousal, indicating perfectionism increases one's susceptibility to poor sleep through an increase in pre-sleep arousal. Lastly, bidirectional effects between perfectionism and poor sleep were also identified as a first in this area of research and identified stress as a

mechanism in those relationships. These findings support theories suggesting perfectionism as a risk factor for poor sleep and insomnia.

When assessing and treating poor sleep, perfectionism as a risk factor should be considered. The FMPS and HFMPS, along with stress and pre-sleep arousal assessment, might be useful in identifying some underlying drivers of poor sleep. Furthermore, the clinical use of actigraphy might help detect SWSD in this population group. Interventions to identify and improve perfectionism that is impacting on sleep would likely be valuable adjuncts to sleep interventions. Cognitive restructuring to target perfectionistic cognitions and improve sleep perception as well as relaxation strategies to target stress and arousals might be particularly beneficial in this population group.

Chapter 9

References

Ackermann, S., & Rasch, B. (2014). Differential effects of non-REM and REM sleep on memory consolidation? *Current Neurology & Neuroscience Report, 14*(2), 430. https://doi.org/10.1007/s11910-013-0430-8

Adams, R., Appleton, S., Taylor, A., McEvoy, D., & Antic, N. (2016). *Report to the Sleep Health Foundation 2016 sleep health survey of Australian adults*. https://www.sleephealthfoundation.org.au/pdfs/surveys/SleepHealthFoundation-Survey.pdf

Adams, R. J., Appleton, S. L., Taylor, A. W., Gill, T. K., Lang, C., McEvoy, R. D., & Antic, N. A. (2017). Sleep health of Australian adults in 2016: Results of the 2016 Sleep Health Foundation national survey. *Sleep Health, 3*(1), 35-42. https://doi.org/10.1016/j.sleh.2016.11.005

Agnew, H. W., Jr., Webb, W. B., & Williams, R. L. (1966). The first night effect: An EEG study of sleep. *Psychophysiology, 2*(3), 263-266. https://doi.org/10.1111/j.1469-8986.1966.tb02650.x

Akram, U. (2018). Objective sleep and personality. *Journal of Clinical Sleep Medicine, 14*(3), 485-486. https://doi.org/10.5664/jcsm.7010

Akram, U., Ellis, J. G., & Barclay, N. L. (2015). Anxiety mediates the relationship between perfectionism and insomnia symptoms: A longitudinal study. *PLoS One, 10*(10), e0138865. https://doi.org/10.1371/journal.pone.0138865

Akram, U., Ellis, J. G., Myachykov, A., Chapman, A. J., & Barclay, N. L. (2017). Anxiety mediates the relationship between multidimensional perfectionism and insomnia

disorder. *Personality and Individual Differences, 104*, 82-86. https://doi.org/10.1016/j.paid.2016.07.042

Akram, U., Gardani, M., Riemann, D., Akram, A., Allen, S. F., Lazuras, L., & Johann, A. F. (2020). Dysfunctional sleep-related cognition and anxiety mediate the relationship between multidimensional perfectionism and insomnia symptoms. *Cognitive Processing, 21*(1), 141-148. https://doi.org/10.1007/s10339-019-00937-8

Akram, U., Stevenson, J. C., Gardani, M., Allen, S., & Johann, A. F. (2023). Personality and insomnia: A systematic review and narrative synthesis. *Journal of Sleep Research*, e14031. https://doi.org/10.1111/jsr.14031

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders* (5th, text rev. ed.). American Psychiatric Association. https://doi.org/10.1176/appi.books.9780890425787

Ancoli-Israel, S., Martin, J. L., Blackwell, T., Buenaver, L., Liu, L., Meltzer, L. J., Sadeh, A., Spira, A. P., & Tyalor, D. J. (2015). The SBSM guide to actigraphy monioring: Clinical and research applications. *Behavioral Sleep Medicine, 13*, S4-S38. https://doi.org/10.1080/15402002.2015.1046356

Andersson, G., Airikka, M. L., Buhrman, M., & Kaldo, V. (2005). Dimensions of perfectionism and tinnitus distress. *Psychology, Health & Medicine, 10*(1), 78-87. https://doi.org/10.1080/13548500512331315389

Angarita, G. A., Emadi, N., Hodges, S., & Morgan, P. T. (2016). Sleep abnormalities associated with alcohol, cannabis, cocaine, and opiate use: A comprehensive review. *Addiction Science and Clinical Practice, 11*(1), 9. https://doi.org/10.1186/s13722-016-0056-7

Antza, C., Kostopoulos, G., Mostafa, S., Nirantharakumar, K., & Tahrani, A. (2021). The links between sleep duration, obesity and type 2 diabetes mellitus. *Journal of Endocrinology, 252*(2), 125-141. https://doi.org/10.1530/JOE-21-0155

Appleton, S. L., Reynolds, A. C., Gill, T. K., Melaku, Y. A., & Adams, R. J. (2022). Insomnia prevalence varies with symptom criteria used with implications for epidemiological studies: Role of anthropometrics, sleep habit, and comorbidities. *Nature and Science of Sleep, 14*, 775-790. https://doi.org/10.2147/NSS.S359437

Arnardottir, E. S., Islind, A. S., & Oskarsdottir, M. (2021). The future of sleep measurements: A review and perspective. *Sleep Medicine Clinics, 16*(3), 447-464. https://doi.org/10.1016/j.jsmc.2021.05.004

Aserinksy, E., & Kleitman, N. (1953). Regularly occurring periods of eye motility, and concomitant phenomena, during sleep. *Science, 118*(3062), 273-274. https://doi.org/10.1126/science.118.3062.273

Attard, K. P., Adams, R. J. T., Vakulin, A., & Reynolds, A. C. (2019). Sleep and help seeking behaviours in Australia: A narrative review. *OBM Neurobiology, 3*(2), 1-1. https://doi.org/10.21926/obm.neurobiol.1902029

Australian Bureau of Statistics. (2025). *Regional population by age and sex*. https://www.abs.gov.au/statistics/people/population/regional-population-age-and-sex/2024#key-statistics

Australian Government. (2023). *Australian Government response to the House of Representatives Standing Committee on health, aged care and sport report: Bedtime reading - Inquiry into sleep health awareness in Australia*. https://www.health.gov.au/resources/publications/bedtime-reading-inquiry-into-sleep-health-awareness-in-australia?language=en

Azevedo, M. H., Bos, S. C., Soares, M. J., Marques, M., Pereira, A. T., Maia, B., Gomes, A. A., & Macedo, A. (2010). Longitudinal study on perfectionism and sleep disturbance. *World Journal of Biological Psychiatry, 11*(2 Pt 2), 476-485. https://doi.org/10.3109/15622970903304467

Azevedo, M. H., Soares, M. J., Bos, S. C., Gomes, A. A., Maia, B., Marques, M., Pereira, A. T., & Macedo, A. (2009). Perfectionism and sleep disturbance. *World Journal of Biological Psychiatry, 10*(3), 225-233. https://doi.org/10.1080/15622970701367930

Banfi, T., Valigi, N., di Galante, M., d'Ascanio, P., Ciuti, G., & Faraguna, U. (2021). Efficient embedded sleep wake classification for open-source actigraphy. *Scientific Reports, 11*(1), 345. https://doi.org/10.1038/s41598-020-79294-y

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language, 68*(3). https://doi.org/10.1016/j.jml.2012.11.001

Bastien, C. H., Vallieres, A., & Morin, C. M. (2001). Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Medicine, 2*(4), 297-307. https://doi.org/10.1016/s1389-9457(00)00065-4

Baumeister, R. F. (1990). Suicide as an escape from self. *Psychological Review, 97*, 90-113. https://doi.org/10.1037/0033-295X.97.1.90

Beersma, D. G. M. (1998). Models of human sleep regulation. *Sleep Medicine Reviews, 2*(1), 31-43. https://doi.org/10.1016/S1087-0792(98)90052-1

Bei, B., Seeman, T. E., Carroll, J. E., & Wiley, J. F. (2017). Sleep and physiological dysregulation: A closer look at sleep intraindividual variability. *Sleep, 40*(9). https://doi.org/10.1093/sleep/zsx109

Bei, B., Wiley, J. F., Trinder, J., & Manber, R. (2016). Beyond the mean: A systematic review on the correlates of daily intraindividual variability of sleep/wake patterns. *Sleep Medicine Reviews, 28*, 108-124. https://doi.org/10.1016/j.smrv.2015.06.003

Benjafield, A. V., Sert Kuniyoshi, F. H., Malhotra, A., Martin, J. L., Morin, C. M., Maurer, L. F., Cistulli, P. A., Pepin, J. L., Wickwire, E. M., & medXcloud, g. (2025). Estimation of the global prevalence and burden of insomnia: a systematic literature review-based analysis. *Sleep Medicine Reviews, 82*, 102121. https://doi.org/10.106/jsmrv.2025.102121

Bensen-Boakes, D. B., Loffler, K., Lack, L., Paterson, J., Scott, H., & Lovato, N. (2023). Measuring sleep-wake state disrepancy in the home across multiple nights. *Sleep Advances, 4*, A12-13. https://doi.org/10.1093/sleepadvances/zpad035.036

Bensen-Boakes, D. B., Lovato, N., Meaklim, H., Bei, B., & Scott, H. (2022). "Sleep-wake state discrepancy": Toward a common understanding and standardized nomenclature. *Sleep, 45*(10). https://doi.org/10.1093/sleep/zsac187

Bensen-Boakes, D. B., Osman, A., Lack, L., Catcheside, P., Antic, N., Smith, S. S., Chai-Coetzer, C. L., O'Grady, A., Dunn, N., Robinson, J., McEvoy, D., & Sweetman, A. (2022). The effect of Cognitive Behavioural Therapy for Insomnia (CBT-I) on subjective-objective sleep discrepancy in individuals with co-morbid insomnia and sleep apnoea: A randomised controlled trial. *Applied Sciences, 12*(4), 1787. https://doi.org/10.3390/app12041787

Besser, A., Flett, G. L., Hewitt, P. L., & Guez, J. (2008). Perfectionism, and cognitions, affect, self-esteem, and physiological reactions in a performance situation. *Journal of Rational-Emotive & Cognitive-Behavior Therapy, 26*(3), 206-228. https://doi.org/10.1007/s10942-007-0067-0

Bianchi, M. T., Williams, K. L., McKinney, S., & Ellenbogen, J. M. (2013). The subjective-objective mismatch in sleep perception among those with insomnia and sleep apnea. *Journal of Sleep Research, 22*, 557-568. https://doi.org/10.1111/jsr.12046

Biddle, D. J., Robillard, R., Hermens, D. F., Hickie, I. B., & Glozier, N. (2015). Accuracy of self-reported sleep parameters compared with actigraphy in young people with mental ill-health. *Sleep Health, 1*(3), 214-220. https://doi.org/10.1016/j.sleh.2015.07.006

Bin, Y. S., Marshall, N. S., & Glozier, N. (2012). The burden of insomnia on individual function and healthcare consumption in Australia. *Australian and New Zealand Journal of Public Health, 36*(5), 462-468. https://doi.org/10.1111/j.1753-6405.2012.00845.x

Blanken, T. F., Benjamins, J. S., Borsboom, D., Vermunt, J. K., Paquola, C., Ramautar, J., Dekker, K., Stoffers, D., Wassing, R., Wei, Y., & Van Someren, E. J. W. (2019). Insomnia disorder subtypes derived from life history and traits of affect and personality. *Lancet Psychiatry, 6*(2), 151-163. https://doi.org/10.1016/S2215-0366(18)30464-4

Boone, L., & Soenens, B. (2015). In double trouble for eating pathology? An experimental study on the combined role of perfectionism and body dissatisfaction. *Journal of Behavior Therapy and Experimental Psychiatry, 47*, 77-83. https://doi.org/10.1016/j.jbtep.2014.11.005

Boone, L., Soenens, B., Mouratidis, A., Vansteenkiste, M., Verstuyf, J., & Braet, C. (2012). Daily fluctuations in perfectionism dimensions and their relation to eating disorder symptoms. *Journal of Research in Personality, 46*(6), 678-687. https://doi.org/10.1016/j.jrp.2012.08.001

Boone, L., Soenens, B., Vansteenkiste, M., & Braet, C. (2012). Is there a perfectionist in each of us? An experimental study on perfectionism and eating disorder symptoms. *Appetite, 59*(2), 531-540. https://doi.org/10.1016/j.appet.2012.06.015

Borbély, A. A. (1982). A two process model of sleep regulation. *Human Neuuobiologq, 1*(3), 195-204.

Borbély, A. A., Daan, S., Wirz-Justice, A., & Deboer, T. (2016). The two-process model of sleep regulation: A reappraisal. *Journal of Sleep Research, 25*(2), 131-143. https://doi.org/10.1111/jsr.12371

Brand, S., Kirov, R., Kalak, N., Gerber, M., Puhse, U., Lemola, S., Correll, C. U., Cortese, S., Meyer, T., & Holsboer-Trachsler, E. (2015). Perfectionism related to self-reported insomnia severity, but not when controlled for stress and emotion regulation. *Neuropsychiatric Disease and Treatment, 11*, 263-271. https://doi.org/10.2147/NDT.S74905

Brantley, P. J., Waggoner, C. D., Jones, G. N., & Rappaport, N. B. (1987). A Daily Stress Inventory: Development, reliability, and validity. *Journal of Behavioral Medicine, 10*(1), 61-74. https://doi.org/10.1007/bf00845128

Bredeli, E., Vestergaard, C. L., Sivertsen, B., Kallestad, H., Overland, S., Ritterband, L. M., Glozier, N., Pallesen, S., Scott, J., Langsrud, K., & Vedaa, O. (2022). Intraindividual variability in sleep among people with insomnia and its relationship with sleep, health and lifestyle factors: An exploratory study. *Sleep Medicine, 89*, 132-140. https://doi.org/10.1016/j.sleep.2021.12.006

Breheny, M., Ross, I., Ladyman, C., Signal, L., Dew, K., & Gibson, R. (2023). "It's Just [Complicated] Sleep": Discourses of Sleep and Ageing in the Media. *Gerontologist*. https://doi.org/10.1093/geront/gnad058

Brinkman, J. E., Reddy, V., & Sharma, S. (2023). *Physiology of sleep*. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK482512/

Brose, A., Schmiedek, F., Gerstorf, D., & Voelkle, M. C. (2020). The measurement of within-person affect variation. *Emotion, 20*(4), 677-699. https://doi.org/10.1037/emo0000583

Brown, V. A. (2021). An introduction to linear mixed-effects modeling in R. *Advances in Methods and Practices in Psychological Science, 4*(1). https://doi.org/10.1177/2515245920960351

Bürkner, P. (2017). brms: An R package for Bayesian Multilevel Models using Stan. *Journal of Statistical Software, 80*(1), 1-28. https://doi.org/10.18637/jss.v080.i01

Buysse, D. J., Ancoli-Israel, S., Edinger, J. D., Lichstein, K. L., & Morin, C. M. (2006). Recommendations for a standard research assessment of insomnia. *Sleep, 29*(9), 1155-1173. https://doi.org/10.1093/sleep/29.11.1380

Buysse, D. J., Cheng, Y., Germain, A., Moul, D. E., Franzen, P. L., Fletcher, M., & Monk, T. H. (2010). Night-to-night sleep variability in older adults with and without chronic insomnia. *Sleep Medicine, 11*(1), 56-64. https://doi.org/10.1016/j.sleep.2009.02.010

Buysse, D. J., Germain, A., Hall, M., Monk, T. H., & Nofzinger, E. A. (2011). A neurobiological model of insomnia. *Drug Discovery Today: Disease Models, 8*(4), 129-137. https://doi.org/10.1016/j.ddmod.2011.07.002

Buysse, D. J., Reynolds III, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1988). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research, 28*(2), 192-213. https://doi.org/10.1016/0165-1781(89)90047-4

Callaghan, T., Greene, D., Shafran, R., Lunn, J., & Egan, S. J. (2024). The relationships between perfectionism and symptoms of depression, anxiety and obsessive-

compulsive disorder in adults: A systematic review and meta-analysis. *Cognitive Behaviour Therapy, 53*(2), 121-132. https://doi.org/10.1080/16506073.2023.2277121

Carskadon, M. A., & Dement, W. C. (2017). Normal human sleep. In *Principles and Practice of Sleep Medicine* (pp. 15-24.e13). https://doi.org/10.1016/b978-0-323-24288-2.00002-7

Carskadon, M. A., Dement, W. C., Mtler, M. M., Guilleminault, C., Zarcone, V. P., & Spiegel, R. (1976). Self-reports versus sleep laboratory findings in 122 drug-free subjects with complaints of chronic insomnia. *American Journal of Psychiatry, 133*(12), 1382-1388. https://doi.org/10.1176/ajp.133.12.1382

Castelnovo, A., Ferri, R., Galbiati, A., Rossi, A., Zucconi, M., Castronovo, V., Strambi, L. F., & Manconi, M. (2021). Extreme sleep state misperception: From psychopathology to objective-subjective sleep measures. *International Journal of Psychophysiology, 167*, 77-85. https://doi.org/10.1016/j.ijpsycho.2021.06.011

Castelnovo, A., Ferri, R., Punjabi, N. M., Castronovo, V., Garbazza, C., Zucconi, M., Ferini-Strambi, L., & Manconi, M. (2019). The paradox of paradoxical insomnia: A theoretical review towards a unifying evidence-based definition. *Sleep Medicine Reviews, 44*, 70-82. https://doi.org/10.1016/j.smrv.2018.12.007

Cattell, R. B., & Kline, P. (1977). *The scientific analysis of personality and motivaiton.* Academic Press.

Cerolini, S. (2023). Linking sleep deprivation and binge eating: Empirical evidence and underlying mechanisms. In V. B. Patel & V. R. Preedy (Eds.), *Eating Disorders* (pp. 1103-1119). Springer, Cham. https://doi.org/10.1007/978-3-031-16691-4_64

Chan, J. K., & Nicholas, C. L. (2018). EEG changes between sleeping and wakefulness: Characteristics and neural generation. In P. N. Murphy (Ed.), *The Routledge International Handbook of Psychobiology* (pp. 461-478). Routledge.

Chang, J. R., Fu, S. N., Li, X., Li, S. X., Wang, X., Zhou, Z., Pinto, S. M., Samartzis, D., Karppinen, J., & Wong, A. Y. (2022). The differential effects of sleep deprivation on pain perception in individuals with or without chronic pain: A systematic review and meta-analysis. *Sleep Medicine Reviews, 66*, 101695. https://doi.org/10.1016/j.smrv.2022.101695

Chaput, J. P., Dutil, C., Featherstone, R., Ross, R., Giangregorio, L., Saunders, T. J., Janssen, I., Poitras, V. J., Kho, M. E., Ross-White, A., Zankar, S., & Carrier, J. (2020). Sleep timing, sleep consistency, and health in adults: A systematic review. *Applied Physiology, Nutrition and Metabolism, 45*(10 (Suppl. 2)), S232-S247. https://doi.org/10.1139/apnm-2020-0032

Chen, S., Saklofske, D. H., Flett, G. L., & Hewitt, P. L. (2024). Assessing and evaluating the perfectionism social disconnection model: Social support, loneliness, and distress among undergraduate, law, and medical students. *Journal of Psychoeducational Assessment, 42*(6), 743-767. https://doi.org/10.1177/07342829241244951

Cho, S. E., Kang, J. M., Ko, K. P., Lim, W. J., Redline, S., Winkleman, J. W., & Kang, S. G. (2022). Association between subjective-objective discrepancy of sleeping time and health-related quality of life: A community-based polysomnographic study. *Psychosomatic Medicine, 84*(4), 505-512. https://doi.org/10.1097/PSY.0000000000001070

Choi, S. J., Suh, S., Ong, J., & Joo, E. Y. (2016). Sleep Misperception in chronic insomnia patients with obstructive sleep apnea syndrome: Implications for clinical assessment. *Journal of Clinical Sleep Medicine, 12*(11), 1517-1525. https://doi.org/10.5664/jcsm.6280

Choong, S. Y., Byrne, J. E. M., Drummond, S. P. A., Rispoli-Yovanovic, M., Jones, A., Lum, J. A. G., & Staiger, P. K. (2025). A meta-analytic investigation of the effect of sleep

deprivation on inhibitory control. *Sleep Medicine Reviews, 80*, 102042. https://doi.org/10.1016/j.smrv.2024.102042

Chung, F., Yegneswaran, B., Liao, P., Chung, S. A., Vairavanathan, S., Islam, S., Khajehdehi, A., & Shapiro, C. M. (2008). STOP questionnaire. A tool to screen patients for obstructive sleep apnea. *Anesthesiology, 108*(6), 812-821. https://doi.org/10.1097/ALN.0b013e31816d83e4

Cini, E., Bolengo, F., Fasiello, E., Berra, F., Gorgoni, M., Sforza, M., Casoni, F., Proserpio, P., Castronovo, V., De Gennaro, L., Ferini-Strambi, L., & Galbiati, A. (2025). Sleep State Misperception in Insomnia: The Role of Sleep Instability and Emotional Dysregulation. *Brain Sci, 15*(10). https://doi.org/10.3390/brainsci15101078

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd ed.). Routledge Academic.

Columb, M. O., & Atkinson, M. S. (2016). Statistical analysis: Sample size and power estimations. *BJA Education, 16*(5), 159-161. https://doi.org/10.1093/bjaed/mkv034

Corr, P. J., Stoeber, J., & Saklofske, D. (2017). Perfectionism and personality. In J. Stoeber (Ed.), *The psychology of perfectionism* (pp. 68-88). Routledge.

Correia, M., Rosado, A., & Serpa, S. (2017). Psychometric properties of the Portuguese version of the Frost Multidimensional Perfectionism Scale. *International Journal of Psychological Research, 10*(1), 8-17. https://doi.org/10.21500/20112084.2109

Cox, B. J., & Enns, M. W. (2003). Relative stability of dimensions of perfectionism in depression. *Canadian Journal of Behavioural Science, 35*,124-132. https://doi.org/10.1037/h0087194

Cox, R., Ruber, T., Staresina, B. P., & Fell, J. (2020). Phase-based coordination of hippocampal and neocortical oscillations during human sleep. *Communications Biology, 3*(1), 176. https://doi.org/10.1038/s42003-020-0913-5

Cudney, L. E., Frey, B. N., McCabe, R. E., & Green, S. M. (2022). Investigating the relationship between objective measures of sleep and self-report sleep quality in healthy adults: A review. *Journal of Clinical Sleep Medicine, 18*(3), 927-936. https://doi.org/10.5664/jcsm.9708

Cunnington, D., Junge, M. F., & Fernando, A. T. (2013). Insomnia: Prevalence, consequences and effective treatment. *The Medical Journal of Australia, 199*(8), S36-40. https://doi.org/10.5694/mja13.10718

Curran, T., & Hill, A. P. (2019). Perfectionism is increasing over time: A meta-analysis of birth cohort differences from 1989 to 2016. *Psychology Bulletin, 145*(4), 410-429. https://doi.org/10.1037/bul0000138

De Cuyper, K., Claes, L., Hermans, D., Pieters, G., & Smits, D. (2015). Psychometric properties of the Multidimensional Perfectionism Scale of Hewitt in a Dutch-speaking sample: Associations with the big five personality traits *Journal of Personality Assessment, 97*(2), 182-190. https://doi.org/10.1080/00223891.2014.963591

de Zambotti, M., Goldstein, C., Cook, J., Menghini, L., Altini, M., Cheng, P., & Robillard, R. (2024). State of the science and recommendations for using wearable technology in sleep and circadian research. *Sleep, 47*(4). https://doi.org/10.1093/sleep/zsad325

Deatherage, J. R., Roden, R. D., & Zouhary, K. (2009). Normal sleep architecture. *Seminars in Orthodontics, 15*(2), 86-87. https://doi.org/10.1053/j.sodo.2009.01.002

Del Brutto, O. H., Mera, R. M., Rumbea, D. A., Sedler, M. J., & Castillo, P. R. (2024). Poor sleep quality increases mortality risk: A population-based longitudinal prospective study in community-dwelling middle-aged and older adults. *Sleep Health, 10*(1), 144-148. https://doi.org/10.1016/j.sleh.2023.10.009

Deloitte Access Economics. (2017). *Asleep on the job - Costs of inadequate sleep in Australia*. S. H. Foundation. https://www.sleephealthfoundation.org.au/special-sleep-reports/asleep-on-the-job-costs-of-inadequate-sleep-in-australia

Demichelis, O. P., Grainger, S. A., McKay, K. T., Bourdaniotis, X. E., Churchill, E. G., & Henry, J. D. (2022). Sleep, stress and aggression: Meta-analyses investigating associations and causality. *Neuroscience & Biobehavioral Reviews, 139*, 104732. https://doi.org/10.1016/j.neubiorev.2022.104732

Diekelmann, S., & Born, J. (2010). The memory function of sleep. *Nature Reviews Neuroscience, 11*(2), 114-126. https://doi.org/10.1038/nrn2762

Dolsen, E. A., Asarnow, L. D., & Harvey, A. G. (2014). Insomnia as a transdiagnostic process in psychiatric disorders. *Current Psychiatry Reports, 16*(9), 471. https://doi.org/10.1007/s11920-014-0471-y

Dressle, R. J., & Riemann, D. (2023). Hyperarousal in insomnia disorder: Current evidence and potential mechanisms. *Journal of Sleep Research, 32*(6), e13928. https://doi.org/10.1111/jsr.13928

Dunkley, D. M. (2017). Perfectionism and daily stress, coping, and affect. Advancing multilevel explanatory conceptualisations. In J. Stoeber (Ed.), *The psychology of perfectionism: Theory, research, applications* (pp. 222–242). Routledge/Taylor & Francis Group. https://doi.org/10.1037/a0034673

Dunkley, D. M., Blankstein, K. R., Masheb, R. M., & Grilo, C. M. (2006). Personal standards and evaluative concerns dimensions of‘clinical’ perfectionism: A reply to Shafran et al. (2002, 2003) and Hewitt et al. (2003). *Behaviour Research and Therapy, 44*, 63−84. https://doi.org/10.1016/j.brat.2004.12.004

Edinger, J. D., Bonnet, M. H., Bootzin, R. R., Doghramji, K., Dorsey, C. M., Espie, C. A., Jamieson, A. O., McCall, W. V., Morin, C. M., & Stepanski, E. J. (2004). Derivation

of research diagnostic criteria for insomnia: Report of an American Academy of Sleep Medicine Work Group. *Sleep, 27*(8), 1567-1596. https://doi.org/10.1093/sleep/27.8.1567

Edinger, J. D., & Krystal, A. D. (2003). Subtyping primary insomnia: Is sleep state misperception a distinct clinical entity? *Sleep Medicine Reviews, 7*(3), 203-214. https://doi.org/10.1053/smrv.2002.0253

Egan, S. J., Wade, T. D., & Shafran, R. (2011). Perfectionism as a transdiagnostic process: A clinical review. *Clinical Psychology Review, 31*(2), 203-212. https://doi.org/10.1016/j.cpr.2010.04.009

Egan, S. J., Wade, T. D., Shafran, R., & Antony, M. M. (2014). *Cognitive behavioral treatment of perfectionism*. Guilford Publications.

Ekirch, A. R. (2015). The modernization of western sleep: Or, does insomnia have a history? *Past & Present, 226*(1), 149-192. https://doi.org/10.1093/pastj/gtu040

Elbadawi, M. H., Mubasher, A. A., Abdulgalil, A. A., Alsaid, A., Elameen, N., Magdi, R., Mohamed, W. A., & Fadul, M. H. (2025). The relationship between perfectionism and quality of sleep: A cross-sectional study among Sudanese medical students. *Health Science Reports, 8*(7), e71075. https://doi.org/10.1002/hsr2.71075

Enders, C. K. (2022). *Applied missing data analysis* (2nd ed.). The Guildord Press.

Espie, C. A., Broomfield, N. M., MacMahon, K. M., Macphee, L. M., & Taylor, L. M. (2006). The attention-intention-effort pathway in the development of psychophysiologic insomnia: A theoretical review. *Sleep Medicine Reviews, 10*(4), 215-245. https://doi.org/10.1016/j.smrv.2006.03.002

European Medicines Agency. (2011). *Guideline on medicinal products for the treatment of insomnia*

Fernandez-Mendoza, J., Calhoun, S. L., Bixler, E. O., Karataraki, M., Liao, D., Vela-Bueno, A., Jose Ramos-Platon, M., Sauder, K. A., Basta, M., & Vgontzas, A. N. (2011). Sleep misperception and chronic insomnia in the general population: Role of objective sleep duration and psychological profiles. *Psychosomatic Medicine, 73*(1), 88-97. https://doi.org/10.1097/PSY.0b013e3181fe365a

Feuth, T. (2024). Interactions between sleep, inflammation, immunity and infections: A narrative review. *Immunity Inflammation and Disease, 12*(10), e70046. https://doi.org/10.1002/iid3.70046

Fischer, J., Dogas, Z., Bassetti, C. L., Berg, S., Grote, L., Jennum, P., Levy, P., Mihaicuta, S., Nobili, L., Riemann, D., Puertas Cuesta, F. J., Raschke, F., Skene, D. J., Stanley, N., Pevernagie, D., Executive Committee of the Assembly of the National Sleep, S., & Board of the European Sleep Research Society, R. G. (2012). Standard procedures for adults in accredited sleep medicine centres in Europe. *Journal of Sleep Research, 21*(4), 357-368. https://doi.org/10.1111/j.1365-2869.2011.00987.x

Flett, G. L., Coulter, L. M., Hewitt, P. L., & Nepon, T. (2011). Perfectionism, rumination, worry, and depressive symptoms in early adolescents. *Canadian Journal of School Psychology, 26*(3), 159-176. https://doi.org/10.1177/0829573511422039

Flett, G. L., & Heald, J. L. (2024). The need to focus on perfectionism in suicide assessment, treatment and prevention. *World Psychiatry, 23*(1), 152-154. https://doi.org/ 10.1002/wps.21157

Flett, G. L., & Hewitt, P. L. (2002a). Perfectionism and maladjustment: An overview of theoretical, definitional, and treatment issues. In *Perfectionism: Theory, research, and treatment.* (pp. 5-31). American Psychological Association. https://doi.org/10.1037/10458-001

Flett, G. L., & Hewitt, P. L. (2002b). *Perfectionism: Theory, research, and treatment.* (G. L. Flett & P. L. Hewitt, Eds.). American Psychological Association. https://doi.org/10.1037/10458-000

Flett, G. L., & Hewitt, P. L. (2019). Reflections on three decades of research on multidimensional perfectionism: An introduction to the special issue on further advances in the assessment of perfectionism. *Journal of Psychoeducational Assessment, 38*(1), 3-14. https://doi.org/10.1177/0734282919881928

Flett, G. L., Hewitt, P. L., Nepon, T., Sherry, S. B., & Smith, M. (2022a). The destructiveness and public health significance of socially prescribed perfectionism: A review, analysis, and conceptual extension. *Clin Psychol Rev, 93*, 102130. https://doi.org/10.1016/j.cpr.2022.102130

Flett, G. L., Hewitt, P. L., Nepon, T., Sherry, S. B., & Smith, M. (2022b). The destructiveness and public health significance of socially prescribed perfectionism: A review, analysis, and conceptual extension. *Clinical Psychology Review, 93*, 102130. https://doi.org/10.1016/j.cpr.2022.102130

Food and Drug Administration. (1997). Guidance for industry: Guidelines for the clinical evaluation of hypnotic drugs.

Frost, R. O., Heimberg, R. G., Holt, C. S., Mattia, J. I., & Neubauer, A. L. (1993). A comparison of two measures of perfectionism. *Personality and Individual Differences, 14*(1), 119-126. https://doi.org/10.1016/0191-8869(93)90181-2

Frost, R. O., Marten, P., Lahart, C., & Rosenblate, R. (1990). The dimensions of perfectionism. *Cognitive Therapy and Research, 14*(5), 449-468. https://doi.org/10.1007/BF01172967

Galloway, R., Watson, H., Greene, D., Shafran, R., & Egan, S. J. (2022). The efficacy of randomised controlled trials of cognitive behaviour therapy for perfectionism: A

systematic review and meta-analysis. *Cognitive Behaviour Therapy, 51*(2), 170-184. https://doi.org/10.1080/16506073.2021.1952302

Garbarino, S., Lanteri, P., Bragazzi, N. L., Magnavita, N., & Scoditti, E. (2021). Role of sleep deprivation in immune-related disease risk and outcomes. *Communications Biology, 4*(1), 1304. https://doi.org/10.1038/s42003-021-02825-4

Gaudrea, P., Schellenbert, B. J. I., Gareau, A., Kljajic, K.,& Manoni-Millar, S. (2022). Because excellencism is more than good enough: On the need to distinguish the pursuit of excellence from the pursuit of perfection. *Journal of Personality and Social Psychology: Personality Processes and Individual Differences, 122*(6), 1117-1145. https://doi.org/10.1037/pspp0000411

Gavino, A., Nogueira, R., L., P.-C., & Godoy, A. (2019). Psychometric properties of the Frost Multidimensional Perfetionism Scale in Spanish children and adolescents. *Assessment, 26*(3), 445-464. https://doi.org/10.1177/1073191117740204

Gelabert et al. (2011) - Gelabert, E., Garcia-Esteve, L., Martin-Santos, R., Gutierrez, F., Torres, A., & Subira, S. (2011). Psychometric properties of the Spanish version of the Frost Multidimensional Perfectionism Scale. *Psicothema, 23*, 133-139. https://openalex.org/W2155098364

Gibbings, A., Ray, L. B., Berberian, N., Nguyen, T., Shahidi Zandi, A., Owen, A. M., Comeau, F. J. E., & Fogel, S. M. (2021). EEG and behavioural correlates of mild sleep deprivation and vigilance. *Clinical Neurophysiology, 132*(1), 45-55. https://doi.org/10.1016/j.clinph.2020.10.010

Gillett, G., Watson, G., Saunders, K. E., & McGowan, N. M. (2021). Sleep and circadian rhythm actigraphy measures, mood instability and impulsivity: A systematic review. *Journal of Psychiatric Research, 144*, 66-79. https://doi.org/10.1016/j.jpsychires.2021.09.043

Goswami, A., & Baksi, R. (2025). Perfectionism as a catalyst to anxiety and burnout: A study among students. *International Journal of Psychology Sciences, 7*(1), 273-287. https://doi.org/10.33545/26648377.2025.v7.i1d.103

Grote, L., & Puertas, F. J. (2021). The clinical interview and clinical examination. In C. Bassetti, W. McNicholas, T. Paunio, & P. Peigneux (Eds.), *Sleep medicine textbook* (2nd ed.). European Sleep Research Society.

Gyori, D., & Balazs, J. (2021). Nonsuicidal self-injury and perfectionism: A systematic review. *Frontiers in Psychiatry, 12*, 691147. https://doi.org/10.3389/fpsyt.2021.691147

Hamdani, S. U., Zill, E. H., Zafar, S. W., Suleman, N., Um Ul, B., Waqas, A., & Rahman, A. (2022). Effectiveness of relaxation techniques 'as an active ingredient of psychological interventions' to reduce distress, anxiety and depression in adolescents: A systematic review and meta-analysis. *International Journal of Mental Health Systems, 16*(1), 31. https://doi.org/10.1186/s13033-022-00541-y

Handley, A. K., Egan, S. J., Kane, R. T., & Rees, C. S. (2014). The relationships between perfectionism, pathological worry and generalised anxiety disorder. *BMC Psychiatry, 14*(98), 1-8. https://doi.org/10.1186/1471-244X-14-98

Harvey, A., Watkins, E., Mansell, W., & Shafran, R. (2004). *Cognitive behavioural processes across psychological disorders: A transdiagnostic approach to research and treatment*. Oxford University Press. https://doi.org/10.1093/med:psych/9780198528883.002.0003

Harvey, A. G. (2002). A cognitive model of insomnia. *Behaviour Research and Therapy, 40*(8), 869-893. https://doi.org/10.1016/S0005-7967(01)00061-4

Harvey, A. G. (2008). Insomnia, psychiatric disorders, and the transdiagnostic perspective. *Current Directions in Psychological Science, 17*(5), 299-303. https://doi.org/10.1111/j.1467-8721.2008.00594.x

Harvey, A. G., Murray, G., Chandler, R. A., & Soehner, A. (2011). Sleep disturbance as transdiagnostic: Consideration of neurobiological mechanisms. *Clinical Psychology Review, 31*(2), 225-235. https://doi.org/10.1016/j.cpr.2010.04.003

Harvey, A. G., & Tang, N. K. (2012). (Mis)perception of sleep in insomnia: A puzzle and a resolution. *Psychology Bulletin, 138*(1), 77-101. https://doi.org/10.1037/a0025730

Harvey, C. J., Gehrman, P., & Espie, C. A. (2014). Who is predisposed to insomnia: A review of familial aggregation, stress-reactivity, personality and coping style. *Sleep Medicine Reviews, 18*(3), 237-247. https://doi.org/10.1016/j.smrv.2013.11.004

Hedstrom, A. K., Hossjer, O., Bellocco, R., Ye, W., Trolle, L. Y., & Akerstedt, T. (2021). Insomnia in the context of short sleep increases suicide risk. *Sleep, 44*(4). https://doi.org/10.1093/sleep/zsaa245

Henson, J., Covenant, A., Hall, A. P., Herring, L., Rowlands, A. V., Yates, T., & Davies, M. J. (2024). Waking up to the importance of sleep in type 2 diabetes management: A narrative review. *Diabetes Care, 47*(3), 331-343. https://doi.org/10.2337/dci23-0037

Hermans, L. W. A., Nano, M. M., Leufkens, T. R., van Gilst, M. M., & Overeem, S. (2020). Sleep onset (mis)perception in relation to sleep fragmentation, time estimation and pre-sleep arousal. *Sleep Medicine, X 2*, 1-6. https://doi.org/10.1016/j.sleepx.2020.100014

Hertenstein, E., Benz, F., Schneider, C. L., & Baglioni, C. (2023). Insomnia - A risk factor for mental disorders. *Journal of Sleep Research, 32*(6), e13930. https://doi.org/10.1111/jsr.13930

Hertenstein, E., Feige, B., Gmeiner, T., Kienzler, C., Spiegelhalder, K., Johann, A., Jansson-Frojmark, M., Palagini, L., Rucker, G., Riemann, D., & Baglioni, C. (2019). Insomnia as a predictor of mental disorders: A systematic review and meta-analysis. *Sleep Medicine Reviews, 43*, 96-105. https://doi.org/10.1016/j.smrv.2018.10.006

Herzog, R., Crosbie, F., Aloulou, A., Hanif, U., Chennaoui, M., Leger, D., & Andrillon, T. (2025). A continuous approach to explain insomnia and subjective-objective sleep discrepancy. *Communications Biology, 8*(1), 423. https://doi.org/10.1038/s42003-025-07794-6

Hewitt, P. L. (2020). Perfecting, belonging, and repairing: A dynamic-relational approach to perfectionism. *Canadian Psychology / Psychologie canadienne, 61*(2), 101-110. https://doi.org/10.1037/cap0000209

Hewitt, P. L., & Flett, G. L. (1991). Perfectionism in the self and social contexts: Conceptualisation, assessment, and association with psychopathology. *Journal of Personality and Social Psychology, 60*(3), 456-470. https://doi.org/10.1037/0022-3514.60.3.456

Hewitt, P. L., & Flett, G. L. (n.d.). *Multidimensional perfectionism scale*. https://hewittlab.psych.ubc.ca/measures-3/multidimensional-perfectionism-scale-2/

Hewitt, P. L., Flett, G. L., Turnbull-Donovan, W., & Mikail, S. F. (1991). The Multidimensional Perfectionism Scale: Reliability, validity, and psychometric properties in psychiatric samples. *Psychological Assessment: A Journal of Consulting Clinical Psychology, 3*(3), 464-468. https://doi.org/10.1037/1040-3590.3.3.464

Hirshkowitz, M., Whiton, K., Albert, S. M., Alessi, C., Bruni, O., DonCarlos, L., Hazen, N., Herman, J., Katz, E. S., Kheirandish-Gozal, L., Neubauer, D. N., O'Donnell, A. E., Ohayon, M., Peever, J., Rawding, R., Sachdeva, R. C., Setters, B., Vitiello, M. V., Ware, J. C., & Adams Hillard, P. J. (2015). National Sleep Foundation's sleep time

duration recommendations: Methodology and results summary. *Sleep Health, 1*(1), 40-43. https://doi.org/10.1016/j.sleh.2014.12.010

Hu, S., Shi, L., Li, Z., Ma, Y., Li, J., Bao, Y., Lu, L., & Sun, H. (2024). First-night effect in insomnia disorder: A systematic review and meta-analysis of polysomnographic findings. *Journal of Sleep Research, 33*(1), e13942. https://doi.org/10.1111/jsr.13942

Ip, V. (2025). Cognitive behavioural therapy outcomes for clinical perfectionism: A scoping review. *Technology in Medicine, 102*(1), 7-17. https://doi.org/10.33137/utmj.v102i1.42426

Ishii, T., Taweesedt, P. T., Chick, C. F., O'Hara, R., & Kawai, M. (2024). From macro to micro: Slow-wave sleep and its pivotal health implications. *Frontiers in Sleep, 3*. https://doi.org/10.3389/frsle.2024.1322995

Jansson-Frojmark, M., & Linton, S. J. (2007). Is perfectionism related to pre-existing and future insomnia? A prospective study. *British Journal of Clinical Psychology, 46*(1), 119-124. https://doi.org/10.1348/014466506x158824

Jean, A., Murphy, H., Sullivan, G., Swarr, L., Siegan, S., Aldebyan, A., & Steinman, S. A. (2025). Nobody's "Prfect"! The effect of manipulating perfectionism on social anxiety symptoms. *Anxiety Stress Coping, 38*(3), 301-312. https://doi.org/10.1080/10615806.2025.2463959

Jiang, Y., & Jiang, C. (2025). The impact of maladaptive perfectionism on college students' bedtime procrastination: The chain mediating effects of nomophobia and physical exercise. *Acta Psychologica (Amst), 260*, 105504. https://doi.org/10.1016/j.actpsy.2025.105504

Johann, A. F., Feige, B., Hertenstein, E., Nissen, C., Benz, F., Steinmetz, L., Baglioni, C., Riemann, D., Spiegelhalder, K., & Akram, U. (2023). The effects of cognitive

behavioral therapy for insomnia on multidimensional perfectionism. *Behaviour Therapy, 54*(2), 386-399. https://doi.org/10.1016/j.beth.2022.10.001

Johann, A. F., Hertenstein, E., Kyle, S. D., Baglioni, C., Feige, B., Nissen, C., Riemann, D., & Spiegelhalder, K. (2017). Perfectionism and polysomnography-determined markers of poor sleep. *Journal of Clinical Sleep Medicine, 13*(11), 1319-1326. https://doi.org/10.5664/jcsm.6806

Johann, A. F., Riemann, D., & Spiegelhalder, K. (2018). Does perfectionism icrease the risk for dropout from Cognitive Behavioral Therapy for Insomnia? *Journal of Clinical Sleep Medicine, 14*(3), 487-488. https://doi.org/10.5664/jcsm.7012

Johns, M. W. (1991). A new mehod for measuring daytime sleepiness: The Epworth Sleepiness Scale. *Sleep, 14*(6), 540-545. https://doi.org/10.1093/sleep/14.6.540

Joiner, W. J. (2016). Unraveling the evolutionary determinants of sleep. *Current Biology, 26*(20), R1073-R1087. https://doi.org/10.1016/j.cub.2016.08.068

Kaida, K., Mori, I., Kihara, K., & Kaida, N. (2023). The function of REM and NREM sleep on memory distortion and consolidation. *Neurobioogy of Learning and Memory, 204*, 107811. https://doi.org/10.1016/j.nlm.2023.107811

Kales, A., Caldwell, A. B., Preston, T. A., Healey, S., & Kales, J. D. (1976). Personality patterns in insomnia. Theoretical implications. *Archives of General Psychiatry, 33*, 1128-1134. https://doi.org/10.1001/archpsyc.1976.01770090118013

Katz, E., & Lazersfeld, F. (1955). *Personal Influence. The part played by people in the flow of mass communication.* Free Press. https://doi.org/10.1007/978-3-658-21742-6_67

Keklund, G., & Akerstedt, T. (1997). Objective components of individual differences in subjective sleep quality. *Journal of Sleep Research, 6*(4), 217-220. https://doi.org/10.1111/j.1365-2869.1997.00217.x

Kennedy, D., & Norman, C. (2005). What don't we know? *Science, 309*(5731), 75. https://doi.org/10.1126/science.309.5731.75

Kianersi, S., Redline, S., Mongraw-Chaffin, M., & Huang, T. (2023). Associations of slow-wave sleep with prevalent and incident type 2 Diabetes in the multi-ethnic study of atherosclerosis. *Journal of Clinical Endocrinology & Metabolism, 108*(10), e1044-e1055. https://doi.org/10.1210/clinem/dgad229

Koffel, E., Bramoweth, A. D., & Ulmer, C. S. (2018). Increasing access to and utilization of cognitive behavioral therapy for insomnia (CBT-I): A narrative review. *Journal of General Internal Medicine, 33*(6), 955-962. https://doi.org/10.1007/s11606-018-4390-1

Kothari, R., Barker, C., Pistrang, N., Rozental, A., Egan, S., Wade, T., Allcott-Watson, H., Andersson, G., & Shafran, R. (2019). A randomised controlled trial of guided internet-based cognitive behavioural therapy for perfectionism: Effects on psychopathology and transdiagnostic processes. *Journal of Behavior Therapy and Experimental Psychiatry, 64*, 113-122. https://doi.org/10.1016/j.jbtep.2019.03.007

Koval, P., Hinton, J., Dozo, N., Gellson, J., Alvarez, M., Harrison, A., Vu, D., Susanto, R., Jayaputera, G., & Sinnott, R. (2019). *SEMA3: Smartphone Ecological Momentary Assessment, version 3.* In http://www.sema3.com

Križan, Z., & Hisler, G. (2019). Personality and sleep: Neuroticism and conscientiousness predict behaviourally recorded sleep years later. *European Journal of Personality, 33*(2), 133-153. https://doi.org/10.1002/per.2191

Kudo, M., Ayabe, N., Takeshima, M., Ogasawara, M., Itoh, Y., Yoshizawa, K., Kitamura, S., & Mishima, K. (2024). Association between sleep state misperception and bedtime behavior in patients with chronic insomnia. *Scientific Reports, 14*(1), 13991. https://doi.org/10.1038/s41598-024-64355-3

Kudrnacova, M., & Kudrnac, A. (2023). Better sleep, better life? Testing the role of sleep on quality of life. *PLoS One, 18*(3), e0282085. https://doi.org/10.1371/journal.pone.0282085

Kuskens, A., Stricker, J., Hertrampf, L. S., Peitrowsky, R., & Gieselmann, A. (2023). Perfectionism, perceived stress, and pre-sleep arousal in insomnia: Effects on sleep quality in a daily life study. *Journal of Clinical Sleep Medicine, 20*(3), 433-443. https://doi.org/10.5664/jcsm.10910.

Kwon, S., Kim, H., & Yeo, W. H. (2021). Recent advances in wearable sensors and portable electronics for sleep monitoring. *iScience, 24*(5), 102461. https://doi.org/10.1016/j.isci.2021.102461

Lecci, S., Cataldi, J., Betta, M., Bernardi, G., Heinzer, R., & Siclari, F. (2020). Electroencephalographic changes associated with subjective under- and overestimation of sleep duration. *Sleep, 43*(11). https://doi.org/10.1093/sleep/zsaa094

Lee, S., Kim, J. H., & Chung, J. H. (2021). The association between sleep quality and quality of life: A population-based study. *Sleep Medicine, 84*, 121-126. https://doi.org/10.1016/j.sleep.2021.05.022

Leger, D., Gauriau, C., Tonetti, L., Lantin, M., Filardi, M., Philip, P., Faraut, B., & Natale, V. (2018). Using actigraphy to assess sleep and wake rhythms of narcolepsy type 1 patients: A comparison with primary insomniacs and healthy controls. *Sleep Medicine, 52*, 88-91. https://doi.org/10.1016/j.sleep.2018.07.024

Leger, D., Mutti, C., Rouen, A., & Parrino, L. (2025). Polysomnography in transition: Reassessing its role in the future of sleep medicine. *Journal of Sleep Research, 34*(6), e70217. https://doi.org/10.1111/jsr.70217

Lehrer, H. M., Yao, Z., Krafty, R. T., Evans, M. A., Buysse, D. J., Kravitz, H. M., Matthews, K. A., Gold, E. B., Harlow, S. D., Samuelsson, L. B., & Hall, M. H. (2022).

Comparing polysomnography, actigraphy, and sleep diary in the home environment: The Study of Women's Health Across the Nation (SWAN) Sleep Study. *Sleep Advances, 3*(1), zpac001. https://doi.org/10.1093/sleepadvances/zpac001

Li, W., Ma, L., Yang, G., & Gan, W. B. (2017). REM sleep selectively prunes and maintains new synapses in development and learning. *Nature Neuroscience, 20*(3), 427-437. https://doi.org/10.1038/nn.4479

Liao, J., Zhu, S., & Li, X. (2018). Anxiety and depression in paradoxical insomnia: A case-control study. *Neuropsychiatric Disease and Treatment, 14*, 231-238. https://doi.org/10.2147/NDT.S156058

Liguori, C., Mombelli, S., Fernandes, M., Zucconi, M., Plazzi, G., Ferini-Strambi, L., Logroscino, G., Mercuri, N. B., & Filardi, M. (2023). The evolving role of quantitative actigraphy in clinical sleep medicine. *Sleep Medicine Reviews, 68*, 101762. https://doi.org/10.1016/j.smrv.2023.101762

Lilienfeld, L. R. R., Stein, D., Bulik, C. M., et al. (2000). Personality traits among currently eating disordered, and never ill first-degree female relatives of bulimics and control women. *Psychological Medicine, 30*(6), 1399-1410. https://doi.org/10.1017/s0033291799002792

Limburg, K., Watson, H. J., Hagger, M. S., & Egan, S. J. (2017). The relationship between perfectionism and psychopathology: A meta-analysis. *Journal of Clinical Psychology, 73*(10), 1301-1326. https://doi.org/10.1002/jclp.22435

Lin, R. M., Xie, S. S., Yan, Y. W., Chen, Y. H., & Yan, W. J. (2017). Perfectionism and adolescent sleep quality: The mediating role of repetitive negative thinking. *Journal of Health Psychology, 24*(12), 1626-1636. https://doi.org/10.1177/1359105317693914

Liu, J., Chen, D., Xia, T., Zeng, S., Xue, G., & Hu, X. (2025). Slow-wave sleep and REM sleep differentially contribute to memory representational transformation. *Communications Biology, 8*(1), 1407. https://doi.org/10.1038/s42003-025-08812-3

Liu, Q., Yang, H., Peng, W., Liu, Z., Wang, J., Chu, J., Liu, J., Li, F., & Zhong, M. (2022). Factorial validity and factorial invariance across gender of the Frost Multidimensional Perfectionism Scale-Chinese version in undergraduates. *Psychology Reports, 125*(4), 2232-2248. https://doi.org/10.1177/00332941211018402

Lloyd, S., Schmidt, U., Khondoker, M., & Tchanturia, K. (2015). Can psychological interventions reduce perfectionism? A systematic review and meta-analysis. *Behavioural and Cognitive Psychotherapy, 43*(6), 7.5-731. https://doi.org/10.1017/S1352465814000162

Lockley, S. W., Skene, D. J., & Arendt, J. (1999). Comparison between subjective and actigraphic measurement of sleep and sleep rhythms. *Journal of Sleep Research, 8*(3), 175-183. https://doi.org/10.1046/j.1365-2869.1999.00155.x

Lombardo, C., Mallia, L., Battagliese, G., Grano, C., & Violani, C. (2013). Perfectionism mediates the relationship between insomnia and depressive symptoms. *Sleep and Biological Rhythms, 11*(2), 90-98. https://doi.org/10.1111/sbr.12009

Lovibond, S. H., & Lovibond, P. F. (1995). *Manual for the Depression Anxiety Stress Scales* (2nd ed. ed.). Psychology Foundation. https://doi.org/10.1037/t01004-000

Lundh, L. G., & Broman, J. E. (2000). Insomnia as an interaction between sleep-interfering and sleep-interpreting. *Journal of Psychomatic Research, 49*, 299-310. https://doi.org/10.1016/S0022-3999(00)00150-1

Lundh, L. G., Broman, J. E., Hetta, J., & Saboonchi, F. (1994). Perfectionism and insomnia. *Scandinavian Journal of Behaviour Therapy, 23*(1), 3-18. https://doi.org/10.1080/16506079409455949

Lundh, L. G., Lundqvist, K., Broman, J. E., & Hetta, J. (1991). Vicious cycles of sleeplessness, sleep phobia, and sleep-incompatible behaviours in patients with persistent insomnia. *Scandinavian Journal of Behaviour Therapy, 20*(3-4), 101-114. https://doi.org/10.1080/16506079109456289

Lunn, J., Greene, D., Callaghan, T., & Egan, S. J. (2023). Associations between perfectionism and symptoms of anxiety, obsessive-compulsive disorder and depression in young people: A meta-analysis. *Cognive Behaviour Therapy, 52*(5), 460-487. https://doi.org/10.1080/16506073.2023.2211736

Maas, C. J. M., & Hox, J. J. (2005). Sufficient sample sizes for multilevel modeling. *Methodology, 1*(3), 86-92. https://doi.org/10.1027/1614-2241.1.3.86

Mackinnon, S. P., Battista, S. R., Sherry, S. B., & Stewart, S. H. (2014). Perfectionistic self-presentation predicts social anxiety using daily diary methods. *Personality and Individual Differences, 56*, 143-148. https://doi.org/10.1016/j.paid.2013.08.038

Mackinnon, S. P., Kehayes, I. L., Leonard, K. E., Fraser, R., & Stewart, S. H. (2017). Perfectionistic concerns, social negativity, and subjective well-being: A test of the social disconnection model. *Journal of Personality and Social Psychology, 85*(3), 326-340. https://doi.org/10.1111/jopy.12243

Mackinnon, S. P., Ray, C. M., Firth, S. M., & O'Connor, R. M. (2019). Perfectionism, negative motives for drinking, and alcohol-related problems: A 21-day diary study. *Journal of Research in Personality, 78*, 177-188. https://doi.org/10.1016/j.jrp.2018.12.003

Maia, B. R., Soares, M. J., Pereira, A. T., Marques, M., Bos, S. C., Gomes, A., Valente, J., Azevedo, M. H., & Macedo, A. (2011). Affective state dependence and trait stability of perfectionism in sleep disturbances. *Revista Brasileira de Psiquiatria, 33*(3), 252-260. https://doi.org/10.1590/s1516-44462011005000014

Maltezos, A., Perrault, A. A., Walsh, N. A., Phillips, E. M., Gong, K., Tarelli, L., Smith, D., Cross, N. E., Pomares, F. B., Gouin, J. P., & Dang-Vu, T. T. (2024). Methodological approach to sleep state misperception in insomnia disorder: Comparison between multiple nights of actigraphy recordings and a single night of polysomnography recording. *Sleep Medicine, 115*, 21-29. https://doi.org/10.1016/j.sleep.2024.01.027

Manber, R., & Carney, C. E. (2015). *Treatment plans and interventions for insomnia: A case formulation approach*. The Guilford Press.

Manconi, M., Ferri, R., Sagrada, C., Punjabi, N. M., Tettamanzi, E., Zucconi, M., Oldani, A., Castronovo, V., & Ferini-Strambi, L. (2010). Measuring the error in sleep estimation in normal subjects and in patients with insomnia. *Journal of Sleep Research, 19*(3), 478-486. https://doi.org/10.1111/j.1365-2869.2009.00801.x

Marino, M., Li, Y., Rueschman, M. N., Winkelman, J. W., Ellenbogen, J. M., Solet, J. M., Dulin, H., Berkman, L. F., & Buxton, O. M. (2013). Measuring sleep: accuracy, sensitivity, and specificity of wrist actigraphy compared to polysomnography. *Sleep, 36*(11), 1747-1755. https://doi.org/10.5665/sleep.3142

Markov, K., Elgendi, M., & Menon, C. (2024). EEG-based headset sleep wearable devices. *npj Biosensing, 1*(1). https://doi.org/10.1038/s44328-024-00013-y

Marks, G. A., Shaffery, J. P., Oksenberg, A., Speciale, S. G., & Roffwarg, H. P. (1995). A functional role for REM sleep in brain maturation. *Behavioral Brain Research, 69*, 1-11. https://doi.org/10.1016/0166-4328(95)00018-O

Martin, J. L., & Hakim, A. D. (2011). Wrist actigraphy. *Chest, 139*(6), 1514-1527. https://doi.org/10.1378/chest.10-1872

McCullough, K. M., Missig, G., Robble, M. A., Foilb, A. R., Wells, A. M., Hartmann, J., Anderson, K. J., Neve, R. L., Nestler, E. J., Ressler, K. J., & Carlezon, W. A., Jr. (2021). Nucleus accumbens medium spiny neuron subtypes differentially regulate

stress-associated alterations in sleep architecture. *Biological Psychiatry, 89*(12), 1138-1149. https://doi.org/10.1016/j.biopsych.2020.12.030

Mead, M. P., Persich, M. R., Duggan, K. A., Veronda, A., & Irish, L. A. (2021). Big 5 personality traits and intraindividual variability in sleep duration, continuity, and timing. *Sleep Health, 7*(2), 238-245. https://doi.org/10.1016/j.sleh.2020.11.008

Meaklim, H., Jackson, M. L., Bartlett, D., Saini, B., Falloon, K., Junge, M., Slater, J., Rehm, I. C., & Meltzer, L. J. (2020). Sleep education for healthcare providers: Addressing deficient sleep in Australia and New Zealand. *Sleep Health, 6*(5), 636-650. https://doi.org/10.1016/j.sleh.2020.01.012

Means, M. K., Edinger, J. D., Glenn, D. M., & Fins, A. I. (2003). Accuracy of sleep perceptions among insomnia sufferers and normal sleepers. *Sleep Medicine, 4*(4), 285-296. https://doi.org/10.1016/s1389-9457(03)00057-1

Medic, G., Wille, M., & Hemels, M. E. (2017). Short- and long-term health consequences of sleep disruption. *Nature and Science of Sleep, 9*, 151-161. https://doi.org/10.2147/NSS.S134864

Mercer, J. D., Bootzin, R. R., & Lack, L. C. (2002). Insomniacs' perception of wake instead of sleep. *Sleep, 25*(5), 564-571. https://doi.org/ 10.1093/sleep/25.5.559

Merwin, K. E., Mackinnon, S. P., O'Connor, R. M., & Flett, G. L. (2022). Socially prescribed perfectionism predicts next-day binge eating behaviors over 20-days. *Journal of Counseling Psychology, 69*(4), 554-564. https://doi.org/10.1037/cou0000600

Messman, B. A., Wiley, J. F., Feldman, E., Dietch, J. R., Taylor, D. J., & Slavish, D. C. (2024). Irregular sleep is linked to poorer mental health: A pooled analysis of eight studies. *Sleep Health, 10*(4), 493-499. https://doi.org/10.1016/j.sleh.2024.03.004

Metse, A. P., & Bowman, J. A. (2020). Prevalence of self-reported suboptimal sleep in Australia and receipt of sleep care: Results from the 2017 National Social Survey. *Sleep Health, 6*(1), 100-109. https://doi.org/10.1016/j.sleh.2019.08.010

Mike, T. B., Shaw, D. S., Forbes, E. E., Sitnick, S. L., & Hasler, B. P. (2016). The hazards of bad sleep-Sleep duration and quality as predictors of adolescent alcohol and cannabis use. *Drug and Alcohol Dependence, 168*, 335-339. https://doi.org/10.1016/j.drugalcdep.2016.08.009

Mistlberger, R. E. (2005). Circadian regulation of sleep in mammals: Role of the suprachiasmatic nucleus. *Brain Research Review, 49*(3), 429-454. https://doi.org/10.1016/j.brainresrev.2005.01.005

Molnar, D. S., Janssen, W. F., & Sirois, F. M. (2020). Sleeping perfectly? Trait perfectionism, perceived stress, and sleep quality. *Personality and Individual Differences, 167*. https://doi.org/10.1016/j.paid.2020.110244

Molnar, D. S., Thai, S., Blackburn, M., Zinga, D., Flett, G. L., & Hewitt, P. L. (2023). Dynamic changes in perfectionism dimensions and psychological distress among adolescents assessed before and during the COVID-19 pandemic. *Child Development, 94*(1), 254-271. https://doi.org/10.1111/cdev.13855

Monk, T. H., Reynolds III, C. F., Kupfer, D. J., Buysse, D. J., Coble, P. A., Hayes, A. J., Machen, M. A., Petrie, S. R., & Ritenour, A. M. (1994). The Pittsburgh Sleep Diary. *Journal of Sleep Research, 3*(2), 111-120. https://doi.org/10.1111/j.1365-2869.1994.tb00114.x

Moore, R. Y. (2001). Suprachiasmatic nucleus. In N. J. Smelser & P. B. Baltes (Eds.), *International Encyclopedia of the Social & Behavioral Sciences* (pp. 15290-15294). Pergamon. https://doi.org/10.1016/B0-08-043076-7/03472-0

Moore, R. Y. (2007). Suprachiasmatic nucleus in sleep-wake regulation. *Sleep Medicine, 8*, 27-33. https://doi.org/10.1016/j.sleep.2007.10.003

Morin, C. M. (1993). *Insomnia: Psychological assessment and management*. Guilford Press.

Morin, C. M., Belleville, G., Belanger, L., & Ivers, H. (2011). The Insomnia Severity Index: Psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep, 34*(5), 601-608. https://doi.org/10.1093/sleep/34.5.601

Morin, C. M., & Espie, C. A. (2007). *Insomnia: A clinical guide to assessment and treatment*. Springer Science & Business Media.

Morin, C. M., Vallieres, A., & Iver, H. (2007). Dysfunctional Beliefs and Attitudes about Sleep (DBAS): Validation of a brief version (DBAS-16). *Sleep, 30*(11), 1547-1554. https://doi.org/10.1093/sleep/30.11.1547

Moulder, Z., Sweetman, A., Lovato, N., Micic, G., Lack, L., & Scott, H. (2024). Sleep-wake state discrepancy does not impair the efficacy of cognitive behavioural therapy for insomnia: Findings from a large clinic sample. *Journal of Sleep Research, 33*(5), e14142. https://doi.org/10.1111/jsr.14142

Muench, A., Vargas, I., Grandner, M. A., Ellis, J. G., Posner, D., Bastien, C. H., Drummond, S. P., & Perlis, M. L. (2022). We know CBT-I works, now what? *Facultad Review, 11*, 4. https://doi.org/10.12703/r/11-4

Mukai, Y., & Yamanaka, A. (2023). Functional roles of REM sleep. *Neuroscience Research, 189*, 44-53. https://doi.org/10.1016/j.neures.2022.12.009

Naito, K., Iwamoto, K., Miyata, S., Okada, I., Kawai, K., Fujimoto, A., Kogo, Y., Mori, D., Matsuyama, N., Ando, M., Ozaki, N., & Ikeda, M. (2026). Effect of lemborexant on sleep-wake state discrepancy in participants with insomnia disorder. *Psychopharmacology (Berl), 243*(1), 133-143. https://doi.org/10.1007/s00213-025-06845-4

Nakajima, S., Kaneko, Y., Fujii, N., Kizuki, J., Saitoh, K., Nagao, K., Kawamura, A., Yoshiike, T., Kadotani, H., Yamada, N., Uchiyama, M., Kuriyama, K., & Suzuki, M. (2023). Transdiagnostic association between subjective insomnia and depressive symptoms in major psychiatric disorders. *Frontiers in Psychiatry, 14*, 1114945. https://doi.org/10.3389/fpsyt.2023.1114945

Natale, V., Leger, D., Martoni, M., Bayon, V., & Erbacci, A. (2014). The role of actigraphy in the assessment of primary insomnia: A retrospective study. *Sleep Medicine, 15*(1), 111-115. https://doi.org/10.1016/j.sleep.2013.08.792

Nguyen, H., & Morris, E. M. J. (2024). The role of clinical perfectionism and psychological flexibility in distress and wellbeing. *Clinical Psychologist, 28*(3), 207-220. https://doi.org/10.1080/13284207.2024.2362440

Nicassio, P. M., Mendlowitz, D. R., Fussell, J. J., & Petras, L. (1985). The phenomenology of the pre-sleep state: The development of the pre-sleep arousal scale. *Behavior Research and Therapy, 23*(3), 263-271. https://doi.org/10.1016/0005-7967(85)90004-X

O'Rourke, H. P., & MacKinnon, D. P. (2018). Reasons for testing mediation in the absence of an intervention effect: A research imperative in prevention and intervention research. *Journal of Studies on Alcoholism and Drugs, 79*(2), 171-181. https://doi.org/10.15288/jsad.2018.79.171

Oh, S. Y., Meaklim, H., Nicholas, C. L., Cunnington, D., Patrick, C. J., Schenker, M., & Phillips, L. J. (2026). Bidirectional associations between daily symptoms of perfectionism and poor sleep: The mediating role of stress. *Behavioural Sleep Medicine*, 1-14. https://doi.org/10.1080/15402002.2026.2657920

Oh, S. Y., Meaklim, H., Nicholas, C. L., Cunnington, D., Schenker, M., Patrick, C. J., Windred, D., & Phillips, L. J. (2024). Perfect enough to sleep? Perfectionism and

actigraphy-determined markers of insomnia. *Behavioral Sleep Medicine*, 1-16. https://doi.org/10.1080/15402002.2024.2355476

Ong, J. C., Ulmer, C. S., & Manber, R. (2012). Improving sleep with mindfulness and acceptance: A metacognitive model of insomnia. *Behaviour Research and Therapy, 50*(11), 651-660. https://doi.org/10.1016/j.brat.2012.08.001

Ottenstein, C., & Werner, L. (2022). Compliance in ambulatory assessment studies: Investigating study and sample characteristics as predictors. *Assessment, 29*(8), 1765-1776. https://doi.org/10.1177/10731911211032718

Ozer, D. J., & Benet-Martinez, V. (2006). Personality and the prediction of consequential outcomes. *Annual Review of Psychology, 57*, 401-421. https://doi.org/10.1146/annurev.psych.57.102904.190127

Palagini, L., Cipriani, E., Miniati, M., Bramante, A., Gemignani, A., Geoffroy, P. A., & Riemann, D. (2024). Insomnia, poor sleep quality and perinatal suicidal risk: A systematic review and meta-analysis. *Journal of Sleep Research, 33*(2), e14000. https://doi.org/10.1111/jsr.14000

Palagini, L., Hertenstein, E., Riemann, D., & Nissen, C. (2022). Sleep, insomnia and mental health. *Journal of Sleep Research, 31*(4), e13628. https://doi.org/10.1111/jsr.13628

Palagini, L., Mauri, M., Dell'Osso, L., Riemann, D., & Drake, C. L. (2016). Trait- and pre-sleep-state-dependent arousal in insomnia disorders: What role may sleep reactivity and sleep-related metacognitions play? A pilot study. *Sleep Medicine, 25*, 42-48. https://doi.org/10.1016/j.sleep.2016.07.020

Paller, K. A., Creery, J. D., & Schechtman, E. (2021). Memory and sleep: How sleep cognition can change the waking mind for the better. *Annual Review of Psychology, 72*, 123-150. https://doi.org/10.1146/annurev-psych-010419-050815

Park, S., Park, K., Shim, J. S., Youm, Y., Kim, J., Lee, E., & Kim, H. C. (2020). Psychosocial factors affecting sleep misperception in middle-aged community-dwelling adults. *PLoS One, 15*(10), e0241237. https://doi.org/10.1371/journal.pone.0241237

Peever, J., & Fuller, P. M. (2017). The biology of REM Sleep. *Current Biology, 27*(22), R1237-R1248. https://doi.org/10.1016/j.cub.2017.10.026

Perlis, M., Grandner, M., Posner, D., Spiegelhalder, K., & Riemann, D. (2025). Sleep diaries and other subjective measures are essential for the assessment of insomnia. *Journal of Sleep Research, 34*(1), e14313. https://doi.org/10.1111/jsr.14313

Perlis, M. L., Giles, D. E., Mendelson, W. B., Bootzin, R. R., & Wyatt, J. K. (1997). Psychophysiological insomnia: The behavioural model and a neurocognitive perspective. *Journal of Sleep Research, 6*(3), 179-188. https://doi.org/10.1046/j.1365-2869.1997.00045.x

Pétrin-Pomerleau, P., Andrade, G., Verner-Filion, J., Schellenberg, B. J. I., & Gaudreau, P. (2025). Exploring social disconnection through the lens of the model of excellencism and perfectionism. *Journal of Social and Clinical Psychology, 44*(2), 149-183. https://doi.org/10.1521/jscp.2025.44.2.149

Phillips, E. M., Goldberg, E. L., Brock, R. L., Hamburger, E. R., Nelson, J. M., Mason, W. A., Espy, K. A., & Nelson, T. D. (2025). Adolescent sleep as a transdiagnostic factor: Associations between actigraphy-derived night-to-night sleep metrics and adolescent psychopathology. *Journal of the American Academy of Child & Adolescent Psychiatry 3*(3), 701-712. https://doi.org/10.1016/j.jaacop.2024.06.001

Piotrowski, K., & Bojanowska, A. (2019). Factor structure and psychometric properties of a Polish adaptation of the Frost Multidimensional Perfectionism Scale. *Current Psychology, 40*, 2754-2763. https://doi.org/10.1007/s12144-019-00198-w

Poluektov, M. G. (2021). Sleep and Immunity. *Neuroscence and Behavioral Physiology, 51*(5), 609-615. https://doi.org/10.1007/s11055-021-01113-2

Porcacchia, A. S., Pires, G. N., Andersen, M. L., & Tufik, S. (2024). A cross-sectional analysis of the association between sleep disorders and cancer using data from the National Health and Nutrition Examination Survey (NHANES) 2005-2014. *Journal of Clinical Sleep Medicine, 20*(4), 515-520. https://doi.org/10.5664/jcsm.10932

Porras-Segovia, A., Perez-Rodriguez, M. M., Lopez-Esteban, P., Courtet, P., Barrigon, M. M., Lopez-Castroman, J., Cervilla, J. A., & Baca-Garcia, E. (2019). Contribution of sleep deprivation to suicidal behaviour: A systematic review. *Sleep Medicine Reviews, 44*, 37-47. https://doi.org/10.1016/j.smrv.2018.12.005

Preacher, K. J., Zyphur, M. J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods, 15*(3), 209-233. https://doi.org/10.1037/a0020141

Rajaratnam, S. M., & Arendt, J. (2001). Health in a 24-h society. *Lancet, 358*(9286), 999-1005. https://doi.org/10.1016/S0140-6736(01)06108-6

Rasch, B., & Born, J. (2013). About sleep's role in memory. *Physiological Reviews, 93*(2), 681-766. https://doi.org/10.1152/physrev.00032.2012

Rechtschaffen, A. (1998). Current perspectives on the function of sleep. *Perspectives in Biology and Medicine, 41*(3), 359-390. https://doi.org/10.1353/pbm.1998.0051

Redfern, P. H., Watehouse, J. M., & Minors, D. S. (1991). Circadian rhythms: Principles and measurement. *Pharmacology & Therapeutics, 49*(3), 311-327. https://doi.org/10.1016/0163-7258(91)90061-P

Reid, M. J., Wilson, D. A., & Lee, H. H. (2022). Right inferior parietal lobule causally contributes to stimulus encoding for temporal order and duration perception:

Evidence from stimulus–stimulant transcranial magnetic stimulation. *Timing & Time Perception, 10*(3), 181-193. https://doi.org/10.1163/22134468-bja10048

Reither, E. N., Barnet, J. H., Palta, M., Liu, Y., Hagen, E. W., & Peppard, P. E. (2021). Polysomnographic indicators of restorative sleep and body mass trajectories in the Wisconsin Sleep Cohort Study. *Sleep, 44*(8). https://doi.org/10.1093/sleep/zsab031

Rezaie, L., Vakili-Amini, Y., Paschall, E., & Khazaie, H. (2020). Personality profiles in paradoxical insomnia: A case-control study. *Sleep Science, 13*(4), 242-248. https://doi.org/10.5935/1984-0063.20190148

Rice, K. G., & Aldea, M. A. (2006). State dependence and trait stability of perfectionism: A short-term longitudinal study. *Journal of Counseling Psychology, 53*(2), 205-213. https://doi.org/10.1037/0022-0167.53.2.205

Rice, K. G., & Dellwo, J. P. (2001). Within-semester stability and adjustment correlates of the Multidimensional Perfectionism Scale. *Measurement and Evaulation in Counseling and Development, 34*(3), 146-156. https://doi.org/10.1080/07481756.2002.12069031

Rice, K. G., Richardson, C. M., & Clark, D. (2012). Perfectionism, procrastination, and psychological distress. *Journal of Counseling Psychology, 59*(2), 288-302. https://doi.org/10.1037/a0026643

Richardson, C., & Gradisar, M. (2020). Perfectionism and insomnia in adolescents: The role of vulnerability to stress and gender. *Journal of Adolescence, 85*, 70-79. https://doi.org/10.1016/j.adolescence.2020.10.003

Richardson, C. E., Magson, N. R., Fardouly, J., Oar, E. L., Johnco, C. J., Freeman, J., & Rapee, R. M. (2024). Sleepless in the pursuit of perfection: A longitudinal investigation of bidirectional relationships between insomnia and perfectionism in

adolescent males and females. *Sleep Medicine, 124*, 289-298. https://doi.org/10.1016/j.sleep.2024.09.036

Riemann, D., Benz, F., Dressle, R. J., Espie, C. A., Johann, A. F., Blanken, T. F., Leerssen, J., Wassing, R., Henry, A. L., Kyle, S. D., Spiegelhalder, K., & Van Someren, E. J. W. (2022). Insomnia disorder: State of the science and challenges for the future. *Journal of Sleep Research, 31*(4), e13604. https://doi.org/10.1111/jsr.13604

Riemann, D., Spiegelhalder, K., Feige, B., Voderholzer, U., Berger, M., Perlis, M., & Nissen, C. (2010). The hyperarousal model of insomnia: A review of the concept and its evidence. *Sleep Medicine Reviews, 14*(1), 19-31. https://doi.org/10.1016/j.smrv.2009.04.002

Riley, C., & Shafran, R. (2005). Clinical perfectionism: A preliminary qualitative analysis. *Behavioural and Cognitive Psychotherapy, 33*(3), 369-374. https://doi.org/10.1017/s1352465805002122

Robbins, R., Grandner, M. A., Buxton, O. M., Hale, L., Buysse, D. J., Knutson, K. L., Patel, S. R., Troxel, W. M., Youngstedt, S. D., Czeisler, C. A., & Jean-Louis, G. (2019). Sleep myths: An expert-led study to identify false beliefs about sleep that impinge upon population sleep health practices. *Sleep Health, 5*(4), 409-417. https://doi.org/10.1016/j.sleh.2019.02.002

Rodriguez-Campayo, M., Rojo-Moren, L., Ortega-Toro, E., & Sepulevda, A. (2009). Validation of the multidimensional perfectionism scale: Assessment of perfectionism in Spanish university students. *Ansiedad y Estres, 15*, 13-27. https://www.ansiedadyestres.es/sites/default/files/rev/ucm/2009/anyes2009a2.pdf

Rodriguez-Seijas, C., Eaton, N. R., & Krueger, R. F. (2015). How transdiagnostic factors of personality and psychopathology can inform clinical assessment and intervention.

Journal of Personality Assessment, 97(5), 425-435. https://doi.org/10.1080/00223891.2015.1055752

Roffwarg, H. P., Muzio, J. N., & Dement, W. C. (1966). Ontogenetic development of the human sleep-dream cycle. *Science, 152*(3722). https://doi.org/10.1126/science.152.3722.604

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software, 48*(2), 1-36. https://doi.org/10.18637/jss.v048.i02.

Saboonchi, F., & Lundh, L. G. (2010). State perfectionism and its relation to trait perfectionism, type of situation, priming, and being observed. *Scandinavian Journal of Behaviour Therapy, 28*(4), 154-166. https://doi.org/10.1080/028457199439900

Sadeh, A. (2011). The role and validity of actigraphy in sleep medicine: An update. *Sleep Medicine Reviews, 15*(4), 259-267. https://doi.org/10.1016/j.smrv.2010.10.001

Sadeh, A., & Acebo, C. (2002). The role of actigraphy in sleep medicine. *Sleep Medicine Reviews, 6*(2), 113-124. https://doi.org/10.1053/smrv.2001.0182

Samson, D. R., Yetish, G. M., Crittenden, A. N., Mabulla, I. A., Mabulla, A. Z. P., & Nunn, C. L. (2016). What is segmented sleep? Actigraphy field validation for daytime sleep and nighttime wake. *Sleep Health, 2*(4), 341-347. https://doi.org/10.1016/j.sleh.2016.09.006

Sansom, K., Reynolds, A., McVeigh, J., Mazzotti, D. R., Dhaliwal, S. S., Maddison, K., Walsh, J., Singh, B., Eastwood, P., & McArdle, N. (2023). Estimating sleep duration: performance of open-source processing of actigraphy compared to in-laboratory polysomnography in the community. *Sleep Advances, 4*(1), zpad028. https://doi.org/10.1093/sleepadvances/zpad028

Schinkelshoek, M. S., de Wit, K., Bruggink, V., Fronczek, R., & Lammers, G. J. (2020). Daytime sleep state misperception in a tertiary sleep centre population. *Sleep Medicine, 69*, 78-84. https://doi.org/10.1016/j.sleep.2019.12.026

Schmidt, R. E., Courvoisier, D. S., Cullati, S., Kraehenmann, R., & der Linden, M. V. (2018). Too imperfect to fall asleep: Perfectionism, pre-sleep counterfactual processing, and insomnia. *Frontiers in Psychology, 9*, 1288. https://doi.org/10.3389/fpsyg.2018.01288

Shafran, R., Cooper, Z., & Fairburn, C. G. (2002). Clinical perfectionism: A cognitive–behavioural analysis. *Behaviour Research and Therapy, 40*(7), 773-791. https://doi.org/10.1016/s0005-7967(01)00059-6

Shah, A. S., Pant, M. R., Bommasamudram, T., Nayak, K. R., Roberts, S. S. H., Gallagher, C., Vaishali, K., Edwards, B. J., Tod, D., Davis, F., & Pullinger, S. A. (2025). Effects of sleep deprivation on physical and mental health outcomes: An umbrella review. *American Journal of Lifestyle Medicine*, 15598276251346752. https://doi.org/10.1177/15598276251346752

Shirota, A., Kamimura, M., Katagiri, A., Taniike, M., & Kato, T. (2023). Subjective sleep assessments are correlated with EEG-related sleep measurements of the first sleep cycle in healthy young adults. *Sleep and Biological Rhythms, 21*(2), 211-219. https://doi.org/10.1007/s41105-022-00437-x

Simon, P. D., Salanga, M. G. C., & Aruta, J. (2025). The distinct link of perfectionism with positive and negative mental health outcomes. *Frontiers in Psychiatry, 16*, 1492466. https://doi.org/10.3389/fpsyt.2025.1492466

Sinclair, S. J., Siefert, C. J., Slavin-Mulford, J. M., Stein, M. B., Renna, M., & Blais, M. A. (2012). Psychometric evaluation and normative data for the depression, anxiety, and stress scales-21 (DASS-21) in a nonclinical sample of U.S. adults. *Eval Health Prof, 35*(3), 259-279. https://doi.org/10.1177/0163278711424282

Singh, K. K., Ghosh, S., Bhola, A., Verma, P., Amist, A. D., Sharma, H., Sachdeva, P., & Sinha, J. K. (2025). Sleep and immune system crosstalk: Implications for nnflammatory homeostasis and disease pathogenesis. *Annals of Neurosciences, 32*(3), 196-206. https://doi.org/10.1177/09727531241275347

Sirois, F. M., Molnar, D. S., & Hirsch, J. K. (2017). A meta–analytic and conceptual update on the associations between procrastination and multidimensional perfectionism. *European Journal of Personality, 31*(2), 137-159. https://doi.org/10.1002/per.2098

Sleep Health Foundation. (2021). *Rise and try to shine: The social and eocnomic cost of sleep disorders in Australia*. https://www.sleephealthfoundation.org.au/special-sleep-reports/rise-and-try-to-shine-the-social-and-economic-costs-of-sleep-disorders

Smith, M. M., Sherry, S. B., Chen, S., Saklofske, D. H., Mushquash, C., Flett, G. L., & Hewitt, P. L. (2018). The perniciousness of perfectionism: A meta-analytic review of the perfectionism-suicide relationship. *Journal of Personality, 86*(3), 522-542. https://doi.org/10.1111/jopy.12333

Smith, M. M., Sherry, S. B., Ge, S. Y. J., Hewitt, P. L., Flett, G. L., & Baggley, D. L. (2022). Multidimensional perfectionism turns 30: A review of known knowns and known unknowns. *Canadian Psychology / Psychologie canadienne, 63*(1), 16-31. https://doi.org/10.1037/cap0000288

Smith, M. T., McCrae, C. S., Cheung, J., Martin, J. L., Harrod, C. G., Heald, J. L., & Carden, K. A. (2018). Use of Actigraphy for the Evaluation of Sleep Disorders and Circadian Rhythm Sleep-Wake Disorders: An American Academy of Sleep Medicine Clinical Practice Guideline. *J Clin Sleep Med, 14*(7), 1231-1237. https://doi.org/10.5664/jcsm.7230

Song, C., Zhang, R., Wang, C., Fu, R., Song, W., Dou, K., & Wang, S. (2021). Sleep quality and risk of cancer: Findings from the English longitudinal study of aging. *Sleep, 44*(3). https://doi.org/10.1093/sleep/zsaa192

Sperry, S. H., & Kwapil, T. R. (2022). Variability in sleep Is associated with trait-based and daily measures of bipolar spectrum psychopathology. *Behavioral Sleep Medicine, 20*(1), 90-99. https://doi.org/10.1080/15402002.2021.1890076

Spiegelhalder, K., Regen, W., Kyle, S. D., Endres, D., Nissen, C., Feige, B., & Riemann, D. (2012). Time will tell: A retrospective study investigating the relationship between insomnia and objectively defined punctuality. *Journal of Sleep Research, 21*(3), 264-269. https://doi.org/10.1111/j.1365-2869.2011.00970.x

Spina, M. A., Andrillon, T., Quin, N., Wiley, J. F., Rajaratnam, S. M. W., & Bei, B. (2023). Does providing feedback and guidance on sleep perceptions using sleep wearables improve insomnia? Findings from "Novel Insomnia Treatment Experiment": A randomized controlled trial. *Sleep, 46*(9). https://doi.org/10.1093/sleep/zsad167

Sprajcer, M., Dawson, D., Kosmadopoulos, A., Sach, E. J., Crowther, M. E., Sargent, C., & Roach, G. D. (2023). How tired is too tired to drive? A systematic review assessing the use of prior sleep duration to detect driving impairment. *Nature and Science of Sleep, 15*, 175-206. https://doi.org/10.2147/NSS.S392441

Ståhlberg, J., Tuominen, H., Pulkka, A. T., & Niemivirta, M. (2020). Students' perfectionistic profiles: Stability, change, and associations with achievement goal orientations. *Psychology in the Schools, 58*(1), 162-184. https://doi.org/10.1002/pits.22444

Stark, A. L., Geukes, C., & Dockweiler, C. (2022). Digital Health Promotion and Prevention in Settings: Scoping Review. *J Med Internet Res, 24*(1), e21063. https://doi.org/10.2196/21063

Stephan, A. M., & Siclari, F. (2023). Reconsidering sleep perception in insomnia: From misperception to mismeasurement. *Journal of Sleep Research, 32*(6), e14028. https://doi.org/10.1111/jsr.14028

Stober, J. (1998). The Frost Multidimensional Perfectionism Scale revisited: More perfect with four (instead of six) dimensions. *Personality and Individual Differences, 24*(4), 48- 491. https://doi.org/10.1016/s0191-8869(97)00207-9

Stoeber, J. (2018). The psychology of perfectionism. In J. Stoeber (Ed.), *The psychology of perfectionism: Theory, research, applicaitons* (1st ed., Vol. 1, pp. 3-17). Routledge/Taylor & Francis Group. https://doi.org/10.4324/9781315536255-2

Stoeber, J., & Gaudreau, P. (2017). The advantages of partialling perfectionistic strivings and perfectionistic concerns: Critical issues and recommendations. *Personality and Individual Differences, 104*, 379-386. https://doi.org/10.1016/j.paid.2016.08.039

Stoeber, J., & Otto, K. (2006). Positive conceptions of perfectionism: Approaches, evidence, challenges. *Personality and Social Psychology Review, 10*(4), 295-319. https://doi.org/10.1207/s15327957pspr1004_2

Stoeber, J., & Stoeber, F. S. (2009). Domains of perfectionism: Prevalence and relationships with perfectionism, gender, age, and satisfaction with life. *Personality and Individual Differences, 46*(4), 530-535. https://doi.org/10.1016/j.paid.2008.12.006

Stone, J. E., McGlashan, E. M., Facer-Childs, E. R., Cain, S. W., & Phillips, A. J. K. (2020). Accuracy of the GENEActiv Device for Measuring Light Exposure in Sleep and Circadian Research. *Clocks Sleep, 2*(2), 143-152. https://doi.org/10.3390/clockssleep2020012

Stone, K. L., & Ancoli-Israel, S. (2017). Actigraphy. In M. Kryger, T. Roth, & W. C. Dement (Eds.), *Principles and practice of sleep medicine* (6th ed., pp. 1671-1678.e1674). Elsevier. https://doi.org/10.1016/b978-0-323-24288-2.00171-9

Streatfeild, J., Smith, J., Mansfield, D., Pezzullo, L., & Hillman, D. (2021). The social and economic cost of sleep disorders. *Sleep, 44*(11). https://doi.org/10.1093/sleep/zsab132

Stricker, J., Kroger, L., Johann, A. F., Kuskens, A., Gieselmann, A., & Pietrowsky, R. (2023). Multidimensional perfectionism and poor sleep: A meta-analysis of bivariate associations. *Sleep Health, 9*(2), 228-235. https://doi.org/10.1016/j.sleh.2022.09.015

Stuck, B. A., Maurer, J. T., Schlarb, A. A., Schredl, M., & WeeB, H.-G. (2021). *Practice of sleep medicine: Sleep disorders in children and adults.* Springer.

Suh, H., Sohn, H., Kim, T., & Lee, D. G. (2019). A review and meta-analysis of perfectionism interventions: Comparing face-to-face with online modalities. *Journal of Counseling Psychology, 66*(4), 473-486. https://doi.org/10.1037/cou0000355

Suh, S., Nowakowski, S., Bernert, R. A., Ong, J. C., Siebern, A. T., Dowdle, C. L., & Manber, R. (2012). Clinical significance of night-to-night sleep variability in insomnia. *Sleep Medicine, 13*(5), 469-475. https://doi.org/10.1016/j.sleep.2011.10.034

Sun, W., Cheung, F. T. W., Chan, N. Y., Zhang, J., Chan, J. W. Y., Chan, K. C. C., Wing, Y. K., & Li, S. X. (2024). The impacts of intra-individual daily sleep variability on daytime functioning and sleep architecture in healthy young adults: An experimental study. *Journal of Sleep Research, 33*(3), e13967. https://doi.org/10.1111/jsr.13967

Tamminen, J., Lambon Ralph, M. A., & Lewis, P. A. (2017). Targeted memory reactivation of newly learned words during sleep triggers REM-mediated integration of new memories and existing knowledge. *Neurobiolgoy of Learning and Memory, 137*, 77-82. https://doi.org/10.1016/j.nlm.2016.11.012

Tang, N. K., & Harvey, A. G. (2004). Correcting distorted perception of sleep in insomnia: A novel behavioural experiment? *Behaviour Research and Therapy, 42*(1), 27-39. https://doi.org/10.1016/s0005-7967(03)00068-8

Tang, N. K., & Harvey, A. G. (2005). Time estimation ability and distorted perception of sleep in insomnia. *Behavioral Sleep Medicine, 3*(3), 134-150. https://doi.org/10.1207/s15402010bsm0303_2

Tang, N. K., & Harvey, A. G. (2006). Altering misperception of sleep in insomnia: Behavioral experiment versus verbal feedback. *Journal of Consulting and Clinical Psychology, 74*(4), 767-776. https://doi.org/10.1037/0022-006X.74.4.767

Taub, J. M., & Hawkins, D. R. (1979). Aspects of personality associated with irregular sleep habits in young adults. *Journal of Clinical Psychology, 35*(2), 296-304. https://doi.org/10.1002/1097-4679(197904)35:2<296::aid-jclp2270350214>3.0.co;2-x

Tononi, G., & Cirelli, C. (2003). Sleep and synaptic homeostasis: A hypothesis. *Brain Research Bulletin, 62*(2), 143-150. https://doi.org/10.1016/j.brainresbull.2003.09.004

Toussaint, L., Nguyen, Q. A., Roettger, C., Dixon, K., Offenbacher, M., Kohls, N., Hirsch, J., & Sirois, F. (2021). Effectiveness of progressive muscle relaxation, deep breathing, and guided imagery in promoting psychological and physiological states of relaxation. *Evidence-Based Complementary and Alternative Medicine, 2021*, 5924040. https://doi.org/10.1155/2021/5924040

Trajanovic, N. N., Radivojevic, V., Kaushansky, Y., & Shapiro, C. M. (2007). Positive sleep state misperception - a new concept of sleep misperception. *Sleep Medicine, 8*(2), 111-118. https://doi.org/10.1016/j.sleep.2006.08.013

Trudel-Fitzgerald, C., Savard, J., Slim, L. M., Roy, R. C., Flett, G. L., Hewitt, P. L., & Ivers, H. (2017). The relationship of perfectionism with psychological symptoms in cancer patients and the contributing role of hyperarousability and coping. *Psychology & Health, 32*(4), 381-401. https://doi.org/10.1080/08870446.2016.1273354

Tryon, W. W. (1991). *Activity measurement in psychology and medicine*. Plenum Press.

Valko, P. O., Hunziker, S., Graf, K., Werth, E., & Baumann, C. R. (2021). Sleep-wake misperception. A comprehensive analysis of a large sleep lab cohort. *Sleep Medicine, 88*, 96-103. https://doi.org/10.1016/j.sleep.2021.10.023

van de Laar, M., Verbeek, I., Peveragie, D., Aldenkamp, A., & Overeem, S. (2010). The role of personality traits in insomnia. *Sleep Medicine Reviews, 14*, 61-68. https://doi.org/10.1016/j.smrv.20

Van Den Berg, J. F., Van Rooij, F. J., Vos, H., Tulen, J. H., Hofman, A., Miedema, H. M., Neven, A. K., & Tiemeier, H. (2008). Disagreement between subjective and actigraphic measures of sleep duration in a population-based study of elderly persons. *Journal of Sleep Research, 17*(3), 295-302. https://doi.org/10.1111/j.1365-2869.2008.00638.x

van Hees, V., Fang, Z., Zhao, J., Heywood, J., Mirkes, E., Sabia, S., & Migueles, J. (2022). *GGIR - Raw Accelerometer Data Analysis.* In *R* (Version 2.8-1) https://CRAN.R-project.org/package=GGIR

van Hees, V. T., Sabia, S., Anderson, K. N., Denton, S. J., Oliver, J., Catt, M., Abell, J. G., Kivimaki, M., Trenell, M. I., & Singh-Manoux, A. (2015). A novel, open access method to assess sleep duration using a wrist-worn accelerometer. *PLoS One, 10*(11), e0142533. https://doi.org/10.1371/journal.pone.0142533

Van Veen, M. M., Lancel, M., Beijer, E., Remmelzwaal, S., & Rutters, F. (2021). The association of sleep quality and aggression: A systematic review and meta-analysis of observational studies. *Sleep Medicine Reviews, 59*, 101500. https://doi.org/10.1016/j.smrv.2021.101500

Van Veen, M. M., Lancel, M., Sener, O., Verkes, R. J., Bouman, E. J., & Rutters, F. (2022). Observational and experimental studies on sleep duration and aggression: A

systematic review and meta-analysis. *Sleep Medicine Reviews, 64*, 101661. https://doi.org/10.1016/j.smrv.2022.101661

Vecchione, M., & Marsicano, G. (2023). Mean-level change of perfectionism in late childhood: A 2-year longitudinal investigation. *Current Psychology, 43*(14), 12321-12334. https://doi.org/10.1007/s12144-023-05317-2

Vincent, N. K., & Walker, J. R. (2000). Perfectionism and chronic insomnia. *Journal of Psychosomatic Research, 49*, 349-354. https://doi.org/10.1016/s0022-3999(00)00175-6

Wagner, U., Hallschmid, M., Rasch, B., & Born, J. (2006). Brief sleep after learning keeps emotional memories alive for years. *Biological Psychiatry, 60*(7), 788-790. https://doi.org/10.1016/j.biopsych.2006.03.061

Walker, A. (2024). Sleep and its impact on brain function: A neuroscientific perspective. *Neuroscience and Psychiatry, 7*(6), 287-289. https://doi.org/10.47532/npoa.2024.7(6).287-289

Walker, J., Muench, A., Perlis, M. L., & Vargas, I. (2022). Cognitive Behavioral Therapy for Insomnia (CBT-I): A primer. *Kliničeskaâ i Special'naâ Psihologiâ, 11*(2), 123-137. https://doi.org/10.17759/cpse.2022110208

Walker, M. (2017). *Why we sleep: Unlocking the power of sleep and dreams.* Scribner.

Walker, M. P., & van der Helm, E. (2009). Overnight therapy? The role of sleep in emotional brain processing. *Psychology Bulletin, 135*(5), 731-748. https://doi.org/10.1037/a0016570

Walton, T. F., Ree, M. J., Fueggle, S. N., & Bucks, R. S. (2024). A scoping review of sleep discrepancy methodology: What are we measuring and what does it mean? *Sleep Medicine, 126*, 32-66. https://doi.org/10.1016/j.sleep.2024.11.016

Warton, D. I., & Hui, F. K. C. (2011). The arcsine is asinine: The analysis of proportions in ecology. *Ecology, 90*(1), 3-10. https://doi.org/https://doi.org/10.1890/10-0340.1

Watson, N. F., Badr, M. S., Belenky, G., Bliwise, D. L., Buxton, O. M., Buysse, D., Dinges, D. F., Gangwisch, J., Grandner, M. A., Kushida, C., Malhotra, R. K., Martin, J. L., Patel, S. R., Quan, S. F., Tasali, E., Non-Participating, O., Twery, M., Croft, J. B., Maher, E., American Academy of Sleep Medicine, S., Barrett, J. A., Thomas, S. M., & Heald, J. L. (2015). Recommended amount of sleep for a healthy adult: A joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society. *Journal of Clinical Sleep Medicine, 11*(6), 591-592. https://doi.org/10.5664/jcsm.4758

Wegerer, M. (2024). Cognitive-behavioral treatment of perfectionism: An overview of the state of research and practical therapeutical procedures. *Verhaltenstherapie, 34*(1), 1-10. https://doi.org/10.1159/000532044

West, B. T., Welch, K. B., & Galecki, A. T. (2014). *Linear mixed models: A practical guide to using statistical software* (2nd ed.). CRC Press. https://ebookcentral.proquest.com/lib/unimelb/detail.action?docID=1640582

Wheeler, H. A., Blankstein, K. R., Antony, M. M., McCabe, R. E., & Bieling, P. J. (2011). Perfectionism in anxiety and depression: Comparisons across disorders, relations with symptom severity, and role of comorbidity. *International Journal of Cognitive Therapy, 4*(1), 66-91. https://doi.org/10.1521/ijct.2011.4.1.66

Williams, M. T., Lewthwaite, H., Fraysse, F., Gajewska, A., Ignatavicius, J., & Ferrar, K. (2021). Compliance with mobile Ecological Momentary Assessment of self-reported health-related behaviors and psychological constructs in adults: Systematic review and meta-analysis. *Journal of Medical Internet Research, 23*(3), e17023. https://doi.org/10.2196/17023

Wilson, S. J., Nutt, D. J., Alford, C., Argyropoulos, S. V., Baldwin, D. S., Bateson, A. N., Britton, T. C., Crowe, C., Dijk, D. J., Espie, C. A., Gringras, P., Hajak, G., Idzikowski, C., Krystal, A. D., Nash, J. R., Selsick, H., Sharpley, A. L., & Wade, A. G. (2010). British Association for Psychopharmacology consensus statement on evidence-based treatment of insomnia, parasomnias and circadian rhythm disorders. *Journal of Psychopharmacology, 24*(11), 1577-1601. https://doi.org/10.1177/0269881110379307

Xie, Y., Kong, Y., Yang, J., & Chen, F. (2019). Perfectionism, worry, rumination, and distress: A meta-analysis of the evidence for the perfectionism cognition theory. *Personality and Individual Differences, 139*, 301-312. https://doi.org/10.1016/j.paid.2018.11.028

Yang, Y., Schroeder, F., & Rodger, M. (2023). The role of perfectionism in music performance anxiety within university piano majors in China. In D. Raposo, J. Neves, R. Silva, L. Correia Castilho, & R. Dias (Eds.), *Advances in design, music and arts II.* Springer, Cham. https://doi.org/10.1007/978-3-031-09659-4_48

Zeng, L. N., Zong, Q. Q., Yang, Y., Zhang, L., Xiang, Y. F., Ng, C. H., Chen, L. G., & Xiang, Y. T. (2020). Gender difference in the prevalence of insomnia: A meta-analysis of observational studies. *Frontiers in Psychiatry, 11*, 577429. https://doi.org/10.3389/fpsyt.2020.577429

Zhang, L., Liu, L., Wang, P., Wu, X., & Wang, W. (2025). Parents' behavioural control affects Chinese college students' school burnout and perceived employment stress: Different effects via self-oriented, other-oriented, and socially prescribed perfectionism. *Emerging Adulthood, 13*(2), 395-409. https://doi.org/10.1177/21676968241312263

Zhao, W., Van Someren, E. J. W., Xu, Z., Ren, Z., Tang, L., Li, C., & Lei, X. (2024). Identifying the insomnia-related psychological issues associated with hyperarousal: A network perspective. *International Journal of Psychophysiology, 195*, 112276. https://doi.org/10.1016/j.ijpsycho.2023.112276

Chapter 10

Appendices

10.1 Ethics approval letter

-----Original Message-----
From: themisPROD-noreply@unimelb.edu.au <themisPROD-noreply@unimelb.edu.au>
Sent: Wednesday, 26 February 2020 8:57 AM
To: Christian Nicholas <cln@unimelb.edu.au>
Subject: Ethics Application 1955374

Dear Dr Nicholas

I am pleased to advise that the Psychology Health and Applied Sciences Human Ethics Sub-Committee has approved the following Project:

Project Title: Perfect enough to sleep? Perfectionism and actigraphy-determined markers of insomnia
Researchers: Ms H Meaklim, S Oh, Prof L J Phillips, Dr C L Nicholas Ethics ID: 1955374

The Project has been approved for the period: 26-Feb-2020 to 31-Dec-2020

A signed letter confirming this approval will be emailed to you shortly. You will also find a copy in the Themis attachments.

It is your responsibility to ensure that all people associated with the Project are made aware of what has actually been approved.

Research projects are normally approved to 31 December of the year of approval. Projects may be renewed yearly for up to a total of five years upon receipt of a satisfactory annual report. If a project is to continue beyond five years a new application will normally need to be submitted.

Please note that the following conditions apply to your approval. Failure to abide by these conditions may result in suspension or discontinuation of approval and/or disciplinary action.

(a) Limit of Approval: Approval is limited strictly to the research as submitted in your Project application.

(b) Variation to Project: Any subsequent variations or modifications you might wish to make to the Project must be notified formally to the Human Ethics Sub-Committee for further consideration and approval. If the Sub-Committee considers that the proposed changes are significant, you may be required to submit a new application for approval of the revised Project.

(c) Incidents or adverse effects: Researchers must report immediately to the Sub-Committee anything which might affect the ethical acceptance of the protocol including adverse effects on participants or unforeseen events that might affect continued ethical acceptability of the Project. Failure to do so may result in suspension or cancellation of approval.

(d) Monitoring: All projects are subject to monitoring at any time by the Human Research Ethics Committee.

(e) Annual Report: Please be aware that the Human Research Ethics Committee requires that researchers submit an annual report on each of their projects at the end of the year, or at the conclusion of a project if it continues for less than this time. Failure to submit an annual report will mean that ethics approval will lapse.

(f) Auditing: All projects may be subject to audit by members of the Sub-Committee.

If you have any queries on these matters, or require additional information, please contact me using the details below.

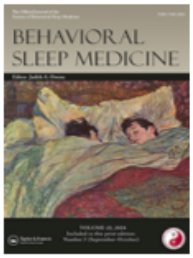
Please quote the ethics ID number and the title of the Project in any future correspondence.

On behalf of the Sub-Committee I wish you well in your research.

Mr Tony Callahan
Secretary, Psychology Health and Applied Sciences HESC
Phone: 8344 2067, Email: t.callahan@unimelb.edu.au

10.2 Appendix A: Study 1

10.2.1 Published Manuscript Study 1



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Perfect Enough to Sleep? Perfectionism and Actigraphy-Determined Markers of Insomnia

Susie Y. Oh, Hailey Meaklim, Christian L. Nicholas, David Cunnington, Maya Schenker, Cameron J. Patrick, Daniel Windred & Lisa J. Phillips

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Perfect Enough to Sleep? Perfectionism and Actigraphy-Determined Markers of Insomnia

Susie Y. Oh [a,b], Hailey Meaklim [a,c], Christian L. Nicholas [a], David Cunnington [d], Maya Schenker [a], Cameron J. Patrick [e], Daniel Windred [b], and Lisa J. Phillips [a]

[a]Melbourne School of Psychological Sciences, The University of Melbourne, Parkville, Australia; [b]Turner Institute for Brain and Mental Health, Monash University Healthy Sleep Clinic, Monash University, Clayton, Australia; [c]Institute for Breathing and Sleep, Austin Health, Victoria, Australia; [d]Sunshine Coast Respiratory and Sleep, Sunshine Coast, Australia; [e]Statistical Consulting Centre, School of Mathematics and Statistics, The University of Melbourne, Parkville, Australia

ABSTRACT

Objectives: Perfectionism is an important factor in insomnia development and maintenance. Previous studies exploring the relationship between perfectionism and insomnia have predominantly relied on self-reported sleep measures. Therefore, this study sought to assess whether actigraphy-measured sleep parameters were associated with perfectionism.

Methods: Sixty adults (85% females, mean age 30.18 ± 11.01 years) were sampled from the Australian general population. Actigraphy-derived objective sleep measures, subjective sleep diary measures, the Frost Multidimensional Perfectionism Scale (FMPS), Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS) and Depression, Anxiety and Stress Scale 21 (DASS-21) were collected.

Results: High perfectionism levels were associated with poor sleep, but these relationships differed between objective and subjective measures. Perfectionism via FMPS total score and subscales of Concern over Mistakes, Doubts about Actions, Personal Standards and Self-oriented Perfectionism correlated with subjective sleep onset latency and sleep efficiency with moderate effects ($r = .26$ to $.88$). In contrast, perfectionism via HFMPS total score and subscales of Socially Prescribed Perfectionism and Parental Expectations predicted objective sleep onset latency and sleep efficiency. Additionally, stress mediated the relationships between objective sleep efficiency and Concern over Mistakes and Doubts about Actions.

Conclusions: Perfectionism demonstrated stronger associations with subjective than objective sleep measures. Higher Parental Expectations and Socially Prescribed Perfectionism may increase one's vulnerability to objectively measured poor sleep. Therefore, perfectionism may be important in preventing and treating insomnia.

Introduction

Insomnia is a prevalent and significant sleep disorder. Insomnia and inadequate sleep affect almost 15% and 45% of Australians respectively (Adams et al., 2017; Reynolds et al., 2019). Sleep problems can affect mood, memory, energy level and general wellbeing, leading to increased use of healthcare services, higher personal and economic costs (Attard et al., 2019; Bin et al., 2012; Deloitte Access Economics, 2017). Insomnia symptoms include difficulty initiating and/or maintaining sleep, and/or early morning awakening despite adequate sleep opportunity. Insomnia symptoms are listed as

CONTACT Susie Y. Oh susie.oh@student.unimelb.edu.au Melbourne School of Psychological Sciences, The University of Melbourne, 12th floor Redmond Barry Building, Parkville Campus, Melbourne, VIC, 3052, Australia

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a diagnostic criterion for a variety of disorders (e.g., depression, post-traumatic stress disorder) in the Diagnostic and Statistical Manual of Mental Disorders; however, insomnia can also be classified as a sleep-wake disorder in its own right (American Psychiatric Association, 2022). Furthermore, insomnia is identified as a transdiagnostic factor in mental health given its bidirectional relationship and high comorbidity with disorders (e.g., depression, anxiety, bipolar disorder, alcohol use disorder, post-traumatic stress disorder, schizophrenia and psychosis), contributing to their onset, maintenance, and relapse (Dolsen et al., 2014; Harvey, 2008; Hertenstein et al., 2019).

Perfectionism is an important factor in various etiological models of insomnia that propose cognitive, emotional, and physiological arousals disrupt the automatic process of sleep onset (Espie et al., 2006; Harvey, 2002; Harvey et al., 2014; Riemann et al., 2010; van de Laar et al., 2010). Perfectionism, a multidimensional construct defined by excessive high standards and self-criticism, is commonly measured by the Frost Multidimensional Perfectionism Scale (FMPS, Frost et al., 1990) and/or the Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS, Hewitt & Flett, 1991). The FMPS measures six dimensions of perfectionism: Concern over Mistakes (reacting negatively to and viewing mistakes as failures), Doubts about Actions (doubting one's own performance), Parental Expectations (perceiving parents as setting very high goals), Parental Criticism (perceiving parents as being highly critical), Personal Standards (setting high standards for self-evaluation) and Organisation (preferring order and organization). The HFMPS measures three dimensions of perfectionism: Self-oriented Perfectionism (setting high standards for oneself), Socially Prescribed Perfectionism (perceiving others set high standards for oneself), and Other-oriented Perfectionism (setting high standards for others).

Evidence for cross-sectional and longitudinal relationships between insomnia and dimensions of perfectionism is presented in Table 1. Notably, there is a paucity of research in this area in Australia. Lundh et al. (1994) found that Concern over Mistakes, Doubts about Actions and Personal Standards were higher in patients with insomnia, and were positively correlated with sleep problems in a general population sample. The authors theorized that perfectionism amplifies the negative mood and performance worries caused by common negative life events, which increases the risk of transient sleep problems. The impact of transient sleep problems on daytime performance subsequently becomes another source of worry. Subsequent rumination then drives dysfunctional sleep beliefs and perpetuates sleep initiation and maintenance difficulties in a vicious cycle that often results in chronic insomnia (Lundh & Broman, 2000). As a transdiagnostic process in the development and maintenance of psychopathology, treating perfectionism may be clinically relevant to improving the efficacy of cognitive-behavioral therapy for insomnia (CBT-I) in individuals who have insomnia and are highly perfectionistic (Akram et al., 2023; Egan et al., 2011; Johann et al., 2018; Limburg et al., 2017; Rodriguez-Seijas et al., 2015). Perfectionism may therefore play an important role in the sleep interpretation process relevant to both insomnia development and treatment. Furthermore, this relationship may be mediated by factors such as depression and/or anxiety, arousability, stress perception, emotional regulation, and counterfactual thoughts (Table 1).

Most studies examining the relationship between perfectionism and insomnia rely on self-reported sleep measures. Notable exceptions include three studies that assessed perfectionism and insomnia measures using polysomnography. Using punctuality as a proxy for perfectionism in a sample of clinical patients, Spiegelhalder et al. (2012) found that shorter total sleep time, lower sleep efficiency and higher wake after sleep onset were associated with arriving early at a sleep laboratory. Johann et al. (2017) found significant associations between perfectionism (e.g., FMPS-total, Concern over Mistakes and Personal Standards) and markers of poor sleep (e.g., nocturnal awakenings, arousal index; and wake after sleep onset) in the first but not second sleep laboratory night in a sample of clinical patients. The authors explained the unpleasantness of spending the first night in a sleep laboratory as an acute stressor and suggested perfectionistic individuals may be predisposed to developing insomnia when facing acute stressors. In contrast, a recent study by Johann et al. (2023) found FMPS-total, Concern over Mistakes and Personal Standards to be negatively associated with wake after sleep onset, while total sleep time and sleep efficiency were positively associated with Personal Standards. These findings

Table 1. Overview of studies examining perfectionism and insomnia and/or sleep difficulties using subjective sleep measures.

Study	Sample	Scale used	Key findings
Akram et al. (2020)	624 community adults and students in the United Kingdom	FMPS	DA, PC and PE: Positive association with and predict insomnia but mediated by anxiety and dysfunctional beliefs. O: Negative association and predicts insomnia.
Akram et al. (2017)	39 adults with insomnia and 39 normal sleepers in the United Kingdom	FMPS HFMPS	CM and DA: Insomnia group score higher than normal sleepers. Predict insomnia but mediated by anxiety. PC: Insomnia group score higher than normal sleepers. Predict insomnia, but partially mediated by anxiety.
Akram et al. (2015)	76 community adults in the United Kingdom	FMPS HFMPS	DA and PC: Positive association with insomnia but mediated by depression and anxiety. Baseline insomnia predicts future DA but mediated by baseline anxiety and current insomnia. Baseline insomnia predicts future PC.
Andersson et al. (2005)	256 tinnitus patients in Sweden	FMPS	CM and PC: Positive association with ISI.
Azevedo et al. (2010)	870 university students in Portugal	HFMPS	SPP: Insomnia group score higher than good sleepers group score at T1 and T2. Baseline SPP predicts difficulties initiating sleep and difficulties maintaining sleep at T1 and T2.
Azevedo et al. (2009)	1163 university students in Portugal	HFMPS	HFMPS, SOP and SPP: Positive association with difficulties initiating sleep, difficulties maintaining sleep and sleep disturbance index.
Brand et al. (2015)	346 university students in Switzerland	FMPS	CM: Positive association with ISI, SOL and NOA but mediated by stress and emotional regulation. DA and PS: Positive association with ISI and NOA but mediated by stress and emotional regulation.
Jansson-Frojmark and Linton (2007)	1936 community adults in Sweden	FMPS: CM and PS only	CM: Positive association with pre-existing insomnia and future insomnia but mediated by emotional distress.
Lombardo et al. (2013)	819 community adults in Italy	FMPS	CM, DA, PC and O: Positive association with current and future insomnia.
Lundh et al. (1994)	383 community adults and 70 insomnia patients in Sweden	FMPS: Only CM, DA and PS	CM and DA: Positive association with sleeping problems.
Maia et al. (2011)	870 university students in Portugal	HFMPS	SOP: Inconsistent pattern found with small correlations. SPP: Positive association with difficulties initiating sleep and difficulties maintaining sleep across T1, T2 and T3.
Molnar et al. (2020)	335 university students in Canada 296 community adults in America	HFMPS	SOP: Positive associations with good sleep quality. SPP: Positive association with poor sleep quality.
Richardson and Gradisar (2020)	281 adolescents in Australia	Child Adolescent Perfectionism Scale	SOP: Positive association with insomnia but mediated by vulnerability to stress. SPP: Positive association with insomnia.
Schmidt et al. (2018)	180 university students in Switzerland	FMPS	CM and DA: Positive association with and predict insomnia severity but mediated by counterfactual processing. O: Negative association with and predicts insomnia severity but mediated by counterfactual processing.
Trudel-Fitzgerald et al. (2017)	853 cancer patients in Canada	FMPS	CM and DA: Positive association with insomnia in men. PC: Positive association with insomnia in women and men but mediated by arousability.
Vincent and Walker (2000)	32 community adults with insomnia and 26 as healthy controls in Canada	FMPS HFMPS	CM and DA: Clinical group score higher than healthy control group score. PC: Clinical group score higher than healthy control group score. Positive association with SOL in clinical group. PC: Positive association with sleep quality in healthy control group.

ISI, Insomnia Severity Index; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; FMPS, Frost Multidimensional Perfectionism Scale; CM, Concern over Mistakes; DA, Doubts about Actions; PE, Parental Expectations; PC, Parental Criticism; O, Organisation; PS, Personal Standards; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; SOP, Self-oriented Perfectionism; OOP, Other-oriented Perfectionism; SPP, Socially Prescribed Perfectionism.

indicate that perfectionism may play a role in the etiology of objectively measured sleep disturbances, but further investigation with objective sleep measures is required.

Actigraphy allows for the estimation of sleep in participants' natural sleep environment for extended periods of time and is an economical alternative to polysomnography (Martin & Hakim, 2011). Actigraphy-derived longitudinal objective sleep measures may aid in understanding of the relationship between perfectionism and parameters of insomnia and sleep continuity, and may have clinical implications since actigraphy is recommended for insomnia monitoring and treatment evaluation (Akram, 2018; Liguori et al., 2023; Smith et al., 2018). It is currently unknown whether it is the perception of poor sleep or actual physiological and physical markers of poor sleep that are related to perfectionism. It is also unknown if and how the perception of poor sleep progresses into physical markers of poor sleep in the development of insomnia in highly perfectionistic individuals. To our knowledge, no actigraphy study in this research area exists despite potential theoretical and clinical significance.

The aim of this study is to investigate the association between perfectionism and sleep disturbances by: 1) replicating and extending previous findings between perfectionism and subjective sleep measures with an Australian general population sample, 2) exploring if relationships between each dimension of perfectionism and subjective sleep are replicated using actigraphy-derived objective sleep measures, and 3) exploring if depression, anxiety and stress mediate the relationships between perfectionism and actigraphy-derived objective sleep measures. It is hypothesized that high levels of perfectionism will be associated with subjective measures of sleep. No *a priori* hypothesis is made relating to objective sleep measures given limited past research findings.

Materials and methods

Participants

Adult participants, aged 18 years and above, were recruited from the Research Experience Program (REP) at the University of Melbourne, via social media and word-of-mouth or referred by their treating sleep physician at the Melbourne Sleep Disorder Centre with diagnosis of insomnia. REP participants were undergraduate psychology students, who received course credit for participation and self-selected to the study in response to an online advertisement at the University of Melbourne, Australia. All potential participants regardless of recruitment pathway completed an online screening survey via Qualtrics (https://www.qualtrics.com) to determine eligibility. Exclusion criteria include: (a) current diagnosis of mental illness; (b) central nervous disorder (c) prior head injury; (d) shift work, defined as paid work starting before 7:00AM or after 2:00PM, rotating or including work outside of 7:00AM to 6:00PM; (e) symptoms indicative of sleep disorders other than insomnia (e.g., obstructive sleep apnea, narcolepsy). In this study, no clinical insomnia diagnosis was required, and participants included both clinical and general population participants who were assessed for their insomnia symptomology.

A total of 1132 screening responses were obtained. There were 243 eligible participants after removing incomplete and duplicate responses, and those who declined to participate. Sixty-five participants agreed to participate in the two-week actigraphy sleep component. A final sample of 60 participants were included in this study, after exclusions of participants with incomplete questionnaires and/or actigraphy recording errors.

All participants provided informed written consent online and received an online gift voucher worth $25 upon completion of the actigraphy sleep component. Approval for this research study was granted by the Human Research Ethics Committee at the University of Melbourne.

Sleep measures

Throughout the 14-day actigraphy period, participants completed the Pittsburgh Sleep Diary (PSD; Monk et al., 1994), which was delivered daily to participants' smartphones via the Smartphone

Ecological Momentary Assessment app (SEMA3, Koval et al., 2019). The PSD captured self-reported daily bedtime, lights out time, minutes to sleep, waketime, etc. Subjective total sleep time (TST), sleep onset latency (SOL), wake after sleep onset (WASO), number of awakenings (NOA) and sleep efficiency (SE) were calculated from diary data. Objective daily sleep was assessed using a wrist worn GENEActiv accelerometer (Activinsights, Cambridge, United Kingdom). The accelerometer was set to a sample frequency of 40 Hz. Accelerometer data was extracted using GENEActiv PC Software (version 3.3) and processed with GGIR (version 2.6.0) using R (version 4.0.5). Sleep recordings were extracted using GGIR parameters set to T3A10 where a period of sustained inactivity, as measured by a lack of change in arm angle above 10-degrees for at least 3-minutes, was detected as sleep. This setting was chosen based on GGIR's validation study against polysomnography showing that shorter time window and higher angle threshold provided better sensitivity in detecting sleep when compared to its default setting (van Hees et al., 2015).

Sleep recordings were evaluated to derive objective WASO, TST, NOA and SE. Objective SOL was derived using a combination of subjective information supplied by participants' sleep diaries (e.g., lights out time) and objective data extracted from GENEActiv. While data collection was scheduled for 14 days, some participants had missing or unusable data. Therefore, the average score for each variable for each participant was calculated over the number of nights where usable sleep data were recorded. Participants also completed the Insomnia Severity Index (ISI) at the end of the two-week actigraphy sleep study (Bastien et al., 2001; Morin, 1993). The ISI is a self-reported questionnaire that measures the nature, severity, and impact of insomnia over the past fortnight. It consists of seven items that are rated on a 5-point Likert scale from 0 (no problem) to 4 (very severe problem) with a total score range of 0 to 28. These items assess sleep onset and maintenance difficulties, early morning awakenings, sleep satisfaction, and distress, daytime dysfunction and noticeability by others resulting from sleep problem. The ISI has excellent internal consistency with Cronbach's alphas of .90 for community sample and .91 for clinical sample, and an optimal cutoff score of 10 for detecting insomnia in community sample with sensitivity at 86.1% and specificity at 87.7% (Morin et al., 2011).

Assessment

To assess the different dimensions of perfectionism, both the Frost Multidimensional Perfectionism Scale (FMPS; Frost et al., 1990) and Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS; Hewitt & Flett, 1991) were utilized. The FMPS consists of 35 items, each rated on a Likert scale from 1 (disagree strongly) to 5 (agree strongly). There are six subscales in the FMPS, each with maximum scores as follows: Concern over Mistakes 45, Doubts about Actions 20, Parental Expectations 25, Parental Criticism 20, Personal Standards 35 and Organisation 30. Total FMPS score ranges from 29 to 145 as it excludes the Organisation subscale which comprises 6 items. Higher levels of perfectionism are reflected by higher scores. Internal consistency for each subscale of the FMPS was good with Cronbach's alphas ranging .77 to .93 and reliability coefficients ranging .77 to .94 (Frost et al., 1990).

The HFMPS consists of 45 items, each rated on a Likert scale from 1 (disagree) to 7 (agree). There are three subscales in the HFMPS: Self-oriented Perfectionism, Other-oriented Perfectionism and Socially Prescribed Perfectionism. The maximum total score of each subscale is 105 with higher scores representing higher levels of perfectionism. Internal consistency for each subscale of the HFMPS was good with Cronbach's alphas ranging from .74 to .88 (Hewitt et al., 1991).

Participants also completed the Depression, Anxiety and Stress Scale 21 (DASS-21; Lovibond & Lovibond, 1995). The DASS-21 consists of three scales with each comprising seven items measuring levels of Depression, Anxiety, and Stress and rated on a 4-point Likert-type scale from 0 (Did not apply to me at all) to 3 (Applied to me very much or most of the time). Internal consistency is high with Cronbach's alphas reported as: .91 for Depression, .80 for Anxiety and .84 for Stress (Sinclair et al., 2012).

Study protocol

Prior to the start of the actigraphy component, participants attended a consent meeting with the lead researcher (S.O.) either in-person or online via Zoom (https://zoom.us). During this meeting, explanations about the actigraphy watch and study protocol were provided, and participants completed the FMPS and HFMPS. Over the 14-day actigraphy study period, participants wore the accelerometer on their non-dominant wrist 24 hours a day, but removal was permitted during contact sports, swimming or if required by work. Actigraphy watches were distributed during the in-person consent meeting, or via post prior to the online consent meeting.

Participants also completed the PSD daily when prompted by SEMA3, which sent out reminders via notifications within each data collection input timeframes. At the end of the 14-day actigraphy study period, participants attended a debrief to return the actigraphy watch, complete the DASS-21 and ISI, and received remuneration.

Statistical analysis

The statistical software package R (version 4.3.0; http://www.R-project.org/) was used for all analyses. The relationships between perfectionism and sleep were assessed with correlation, regression, and mediation analyses. Firstly, the associations between perfectionism and ISI, subjective and objective sleep parameters were analysed using Pearson correlations, which is consistent with past research (Akram et al., 2015; Brand et al., 2015; Lundh et al., 1994; Schmidt et al., 2018). Correlations of .10 indicate small effect, .30 medium effect and .50 large effect (Cohen, 1988).

Prior to further analysis, SOL, WASO and NOA were log transformed due to data skewness. Since SE was a proportion between 0 and 1, a logit transform was applied to stabilize the variance of residuals (Warton & Hui, 2011). A series of regression models were then conducted for each combination of perfectionism variable (FMPS-total and HFMPS-total and subscale scores as independent variable) and actigraphy derived objective sleep parameter (TST, logSOL, logWASO, logNOA and logitSE as dependent variable) with age and gender as covariates.

Finally, using Depression, Anxiety, and Stress scores obtained from DASS-21 as mediators, a series of mediation analyses were conducted for each selected combination of perfectionism subscale (Concern over Mistakes, Doubts about Actions, Parental Criticism, Personal Standards and Socially Prescribed Perfectionism) and actigraphy derived objective sleep parameters. Notably, all mediation analyses were conducted even in the absence of a significant total effect as per O'Rourke and MacKinnon (2018).

The alpha level for the two-tailed analyses was set at $p < .05$. Model assumptions and effects, which included and excluded outliers, were visually inspected and compared. Overall, model assumptions were met and there was no meaningful change in model effects with or without outliers, so outliers were included in the current analyses (see Tables A3 to A10 in the Appendix for models excluding outliers).

Results

Descriptive data

The final sample included 60 participants aged 18–66 years ($M = 30.18$, $SD = 11.01$), of whom 85.0% identified as female. Participants reported ISI scores ranging from 0 to 25 ($M = 7.48$, $SD = 5.92$). Just over a third of the sample ($n = 23$, 38.3%) were categorised as a "poor sleeper", with an ISI score exceeding 9 (Morin et al., 2011). Mean and standard deviations of subjective and objective sleep measures, and perfectionism and DASS-21 are presented in Tables 2 and 3 respectively. As shown in Table 2, there were significant differences between all subjective and objective sleep measures, except for NOA.

Table 2. Mean scores and standard deviations for objective and subjective sleep measures.

	Objective		Subjective		Paired t-test		Effect size
	M	SD	M	SD	t	p	Cohen's d
TST, mins	424.30	72.65	447.90	59.43	−2.58	.012*	−0.35 (small)
SOL, mins	7.36	8.23	22.97	21.74	−5.24	<.001**	−0.95 (large)
WASO, mins	49.02	34.01	18.65	22.69	5.50	<.001**	1.05 (large)
NOA, no.	1.25	1.48	1.43	0.97	−0.72	.474	−0.14 (negligible)
SE, %	87.52	9.50	91.49	7.45	−2.51	.015*	−0.46 (small)

TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency. *$p < .05$. **$p < .01$.

Table 3. Mean scores, standard deviations, and sample range for measures of perfectionism, depression, anxiety, and stress.

	M	*SD*	Sample range (Score range)
FMPS	86.93	19.69	41–141 (29–145)
Concern over Mistakes	26.92	8.18	11–45 (9–45)
Doubts about Actions	11.87	3.77	5–20 (4–20)
Parental Criticism	9.37	4.04	4–20 (4–20)
Parental Expectation	13.20	4.54	6–25 (5–25)
Organisation	24.58	3.43	15–30 (6–30)
Personal Standards	25.58	5.65	9–35 (7–35)
HFMPS	177.20	29.85	100–238 (45–315)
Self-oriented Perfectionism	72.30	14.90	33–105 (15–105)
Other-oriented Perfectionism	52.48	13.36	23–81 (15–105)
Socially Prescribed Perfectionism	52.47	13.37	28–105 (15–105)
Depression	4.37	4.74	0–21 (0–21)
Anxiety	3.35	3.57	0–18 (0–21)
Stress	6.47	4.75	0–19 (0–21)

FMPS, Frost Multidimensional Perfectionism Scale; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale.

Correlation analyses between sleep measures and perfectionism

There were significant positive correlations of medium to large effects between ISI and all subscales of perfectionism, except for Parental Expectations, Organisation and Other-oriented Perfectionism (Cohen, 1988; see Table A1 in Appendix). Results in Tables 4 and 5 showed that the number and strength of significant correlations between subjective sleep and perfectionism measures were generally higher than those found between objective sleep and perfectionism measures. Specifically, significant positive correlations were found between subjective logSOL and FMPS-total ($p = .006$), Concern over Mistakes ($p = .008$), Doubts about Actions ($p = .012$), Personal Standards ($p = .004$) and Self-oriented Perfectionism ($p = .020$); and between objective logSOL and Parental Expectations ($p = .029$). Significant negative correlations were found between subjective logistSE and FMPS-total ($p = .016$), Personal Standards ($p = .006$) and Self-oriented Perfectionism ($p = .042$); and between objective logitSE and Parental Expectations ($p = .047$) and Socially Prescribed Perfectionism ($p = .009$). Overall, these relationships were considered to have medium effects (Cohen, 1988).

Regression analyses of objective sleep measures and perfectionism

Regression analyses indicated that Parental Expectations predicted TST, logSOL and logit SE, while HFMPS-total predicted logSOL; and Socially Prescribed Perfectionism predicted logitSE as shown in Table 6. No other perfectionism scale or subscales were significant predictors of the various objective sleep measures.

Table 4. Correlations between log transformed subjective sleep measures and perfectionism.

n = 60	L1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. TST #															
2. logSOL	−.15*														
3. logWASO	−.27	.50**													
4. logNOA	−.04	.16	.68**												
5. logitSE	.36**	−.87**	−.80**	−.31*											
6. FMPS	−.08	.35**	.17	−.02	−.31*										
7. CM	−.02	.34**	.11	.01	−.25	.88**									
8. DA	−.09	.32*	−.02	−.17	−.21	.71**	.62**								
9. PC	−.16	.15	.15	.12	−.18	.71**	.48**	.42**							
10. PE	−.15	.04	.13	.00	−.12	.62**	.30*	.19	.72**						
11. O	.03	.13	−.05	−.07	−.03	.09	.07	.08	−.16	.03					
12. PS	.06	.37**	.22	−.04	−.35**	.74**	.62**	.44**	.20	.29*	.26*				
13. HFMPS	−.07	.20	.14	.03	−.20	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.			
14. SOP	.03	.30*	.13	−.03	−.26*	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.76**		
15. OOP	−.01	−.14	.03	.11	.08	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.56**	.02	
16. SPP	−.17	.25	.13	−.02	−.23	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.83**	.57**	.22

log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; FMPS, Frost Multidimensional Perfectionism Scale; CM, Concern over Mistakes; DA, Doubts about Actions; PE, Parental Expectations; PC, Parental Criticism; O, Organisation; PS, Personal Standards; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; SOP, Self-oriented Perfectionism; OOP, Other-oriented Perfectionism; SPP, Socially Prescribed Perfectionism, N.A., not available. *$p < .05$. **$p < .01$. # TST was the only sleep variable that was not log-transformed.

Table 5. Correlations between log transformed objective sleep measures and perfectionism.

n = 60	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. TST #															
2. logSOL	−.36**														
3. logWASO	−.46**	.57**													
4. logNOA	-.37**	.43**	0.80**												
5. logitSE	.61**	−.32**	−.80**	−.74**											
6. FMPS	.04	.23	.14	.07	−.16										
7. CM	.13	.13	.11	.04	−.08	.88**									
8. DA	.15	.03	.19	.05	−.07	.71**	.62**								
9. PC	−.23	.15	.14	.09	−.19	.71**	.48**	.42**							
10. PE	−.24	.28*	.13	.08	−.26*	.62**	.30*	.19	.72**						
11. O	.09	.25	−.07	−.09	.16	.09	.07	.08	−.16	.03					
12. PS	.21	.25	.07	.02	−.04	.74**	.62**	.44**	.20	.29*	.26*				
13. HFMPS	.01	.23	.18	.02	−.20	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.			
14. SOP	.13	.25	.12	.01	−.07	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.76**		
15. OOP	−.01	.02	−.03	−.09	−.03	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.56**	.02	
16. SPP	−.12	.21	.28	.12	−.33**	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.83**	.57**	.22

log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; FMPS, Frost Multidimensional Perfectionism Scale; CM, Concern over Mistakes; DA, Doubts about Actions; PE, Parental Expectations; PC, Parental Criticism; O, Organisation; PS, Personal Standards; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; SOP, Self-oriented Perfectionism; OOP, Other-oriented Perfectionism; SPP, Socially Prescribed Perfectionism, N.A., not available. *$p < .05$. **$p < .01$. # TST was the only sleep variable that was not log-transformed.

Mediation analyses using depression, anxiety and stress as mediators in the relationships between objective sleep measures and selected measures of perfectionism

Results in the mediation analyses were broadly consistent with results from the regression analyses. None of the mediation analyses using Depression and Anxiety as mediators were significant (see Tables A5 and A6 in Appendix). Significant results presented in Table 7 indicated that while the total effect of Concern over Mistakes on logitSE was not significant, the mediation effect of stress on the relationship between Concern over Mistakes and logitSE was significant, such that an increase in Concern over Mistakes led to a decrease in sleep efficiency via stress as a mediator. A similar pattern was found in the relationship between Doubts about Actions and sleep efficiency. However, when outliers were removed, this result was no longer significant, suggesting they were driven by the outliers (for full results of mediation analyses using stress as a mediator with and without outliers, see Tables

Table 6. Regression coefficients between objective sleep measures and perfectionism.

n = 60	TST #			logSOL			logWASO			logNOA			LogitSE		
	β	CI	p	exp β	CI	p	exp β	CI	p	expβ	CI	p	expβ	CI	p
FMPS	0.06	−0.92–1.05	.90	1.31	0.96–1.79	.09	1.06	0.91–1.23	.44	1.06	0.70–1.59	.78	0.88	0.72–1.08	.23
CM	1.07	−1.32–3.45	.37	1.19	0.86–1.64	.29	1.04	0.89–1.20	.63	1.01	0.66–1.52	.98	0.95	0.78–1.17	.66
DA	2.39	−2.72–7.50	.35	1.02	0.74–1.40	.91	1.03	0.89–1.19	.70	1.03	0.68–1.55	.89	0.95	0.77–1.16	.59
PC	−4.30	−0.88–0.28	.07	1.19	0.87–1.63	.26	1.07	0.93–1.24	.33	1.13	0.76–1.69	.53	0.87	0.71–1.05	.15
PE	−4.18	−8.27–−0.10	.045*	1.39	1.03–1.89	.033*	1.06	0.92–1.23	.43	1.10	0.73–1.64	.65	0.82	0.67–0.99	.043*
O	1.04	−4.66–6.74	.72	1.32	0.97–1.80	.07	0.95	0.82–1.10	.50	0.84	0.56–1.26	.39	1.09	0.89–1.34	.40
PS	2.48	−0.84–5.81	.14	1.32	0.97–1.80	.07	1.03	0.89–1.19	.69	1.00	0.67–1.50	.99	0.95	0.78–1.16	.63
HFMPS	0.05	−0.61–0.71	.88	1.38	1.01–1.88	.043*	1.09	0.94–1.26	.27	1.00	0.66–1.52	.98	0.89	0.73–1.09	.25
SOP	0.50	−0.79–1.79	.44	1.32	0.97–1.80	.08	1.05	0.91–1.22	.48	0.98	0.65–1.47	.90	0.94	0.77–1.15	.53
OOP	0.21	−1.26–1.68	.78	0.10	−0.23–0.42	.55	0.98	0.85–1.14	.82	0.88	0.58–1.33	.53	1.03	0.84–1.27	.75
SPP	−0.62	−2.09–0.85	.40	1.36	1.00–1.87	.05	1.16	1.00–1.34	.05	1.18	0.78–1.79	.42	0.80	0.65–0.97	.027*

exp, standardized exponentiated regression coefficient, for example, a 1.00 standard deviation increase in PE leads to a ratio change of 1.39 or a 39%increase in logSOL, and a 1.00 standard deviation increase in HFMPS leads to a ratio change of 1.38 or a 38% increase in logSOL. log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; FMPS, Frost Multidimensional Perfectionism Scale; CM, Concern over Mistakes; DA, Doubts about Actions; PE, Parental Expectations; PC, Parental Criticism; O, Organisation; PS, Personal Standards; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; SOP, Self-oriented Perfectionism; OOP, Other-oriented Perfectionism; SPP, Socially Prescribed Perfectionism. *$p < .05$. # TST was the only sleep variable that was not log-transformed.

Table 7. Significant results from exponentiated regression coefficients of mediation analysis using stress as a mediator in the relationship between selected log transformed objective sleep measures and selected subscales of perfectionism (n = 60, simulations = 10,000).

Sleep measure perfectionism	logitSE		
	Estimate	*CI*	*P*
Concern over Mistakes			
- Average causal mediated effect	0.86	0.71–0.99	.036*
- Average direct effect	1.12	0.87–1.43	.40
- Total effect	0.95	0.77–1.20	.68
Doubts about Actions			
- Average causal mediated effect	0.90	0.77–1.00	.042*
- Average direct effect	1.06	0.84–1.32	.61
- Total effect	0.95	0.76–1.19	.63

*$p < .05$. Only significant results presented above. For full results, see Table A9 in Appendix.

A7 and A12 in Appendix). Furthermore, considering the number of analyses involved in the current study, which could give rise to spurious findings, there was little evidence to support these relationships. Therefore, these results were likely inconclusive.

Discussion

This study explored the relationship between facets of multidimensional perfectionism and insomnia as measured by self-reported subjective and actigraphy-derived objective sleep measures. It also explored whether this relationship is mediated by depression, anxiety, and stress. Results showed individuals who self-reported higher levels of insomnia also reported higher levels of perfectionism. Specifically, those who reported longer sleep onset latency and lower sleep efficiency also tend to report higher total perfectionism (via FMPS-total), Concern over Mistakes, Doubts about Actions, Personal Standards and Self-oriented Perfectionism. These results support the hypothesis that higher level of perfectionism is associated with self-reported sleep measures of poor sleep. Notably, the relationship between perfectionism and insomnia differed between objective and subjective sleep measures. Participants who reported higher levels of Parental Expectations had longer objective sleep onset latency and those who reported higher levels of Parental Expectations and Socially Prescribed Perfectionism had lower objective sleep efficiency. Furthermore, Parental Expectations and total score on the HFMPS were significant predictors of objective sleep onset latency, while Parental Expectations and Socially Prescribed Perfectionism were significant predictors of objective sleep efficiency. Finally, there is inconclusive evidence to indicate that the associations between Concern over Mistakes and Doubts about Actions with objective sleep efficiency were mediated by stress. Overall, these results suggest certain aspects of perfectionism relate to markers of poor sleep, but some of those relationships differ across objective and subjective markers of poor sleep.

Subjective measures of sleep

Evidence for subjective measures of insomnia being related to perfectionism is further supported by this study with an Australian general population sample. The finding of relationships between subjective measures of insomnia and perfectionism dimensions of Concern over Mistakes, Doubts about Actions, Parental Criticism and Personal Standards is consistent with past literature (Akram et al., 2015, 2017, 2020; Andersson et al., 2005; Brand et al., 2015; Jansson-Frojmark & Linton, 2007; Lombardo et al., 2013; Lundh et al., 1994; Richardson & Gradisar, 2020; Trudel-Fitzgerald et al., 2017; Vincent & Walker, 2000). The current findings relating self-reported insomnia measures to Self-oriented Perfectionism and Socially Prescribed Perfectionism add evidence to support similar findings by Azevedo et al. (2010); Azevedo et al. (2009); Maia et al. (2011) and Molnar et al. (2020) but contradict findings by Akram et al. (2017); Akram et al. (2015) and Vincent and Walker (2000).

Notably, these relationships were previously found in large samples (e.g., 335 students by Molnar et al. (2020)), yet they were significant in the current study with a sample size of 60. Overall, this study adds to evidence in the literature supporting theoretical suggestions that perfectionism plays an etiological role in the development of insomnia.

Objective measures of sleep derived from actigraphy

The current study extends the literature as it examined objective measures of sleep using actigraphy over two weeks. Results suggest Parental Expectations is associated with longer sleep onset latency and lower sleep efficiency, while Socially Prescribed Perfectionism is associated with lower sleep efficiency. These results are largely in line with findings by Johann et al. (2017) where higher levels of total perfectionism (via FMPS-total), Concern over Mistakes and Personal Standards were associated with higher levels of nocturnal awakenings and wake after sleep onset. However, the current results differ from the negative associations of total perfectionism (via FMPS-total), Concern over Mistakes and Personal Standards with wake after sleep onset; and positive associations of total sleep time and sleep efficiency with Personal Standards found by Johann et al. (2023). These discrepancies may be due to sampling and methodological differences. The current sample was assessed using actigraphy and comprised of members of the general population with or without insomnia, but without other sleep disorders. In contrast, Johann et al. (2017) sampled clinical patients of various sleep disorders and Johann et al. (2023) sampled clinical patients with insomnia disorder and both assessed sleep using polysomnography. While Johann et al. (2017) suggested that perfectionism may predispose one to objective sleep disturbances in the context of acute stressors, current findings suggest perfectionism may also be a contributing factor to objective sleep disturbances in the context of ongoing stressors arising from the perceived expectations from others.

Both Parental Expectations and Socially Prescribed Perfectionism relate to the perception of meeting others' expectations of perfectionism, and Socially Prescribed Perfectionism has also been associated with Parental Expectations and Parental Criticism (Frost et al., 1990). Furthermore, the perception of these external demands of high standards in Socially Prescribed Perfectionism extends beyond demands from family and friends to those from acquaintances and society at large (Hewitt, 2020). One possible explanation for the current findings is that individuals with such perfectionistic tendencies attempt to meet those external sleep expectations by spending more time in bed, which inadvertently causes longer sleep onset latency and lower sleep efficiency to worsen sleep in a vicious cycle.

There have been recent calls to increase awareness about the importance of sleep and encourage ways to reduce inadequate sleep to improve sleep health in Australia (Adams et al., 2017; Attard et al., 2019; Australian Government, 2023; Deloitte Access Economics, 2017). However, media messaging about sleep is complex, often presenting good sleep as an ideal to strive for and is ironically, overly idealistic (Breheny et al., 2023). Furthermore, the proliferation of messages about sleep in the media may promote and perpetuate common dysfunctional sleep beliefs and myths (Katz & Lazersfeld, 1955; Robbins et al., 2019). Consequently, increasing awareness about the impact of inadequate sleep through public health messaging combined with a low level of sleep health education can be detrimental to those who have unrealistic expectations about needing to have "perfect" sleep as it can cause some level of distress leading to insomnia (Ekirch, 2015; Meaklim et al., 2020). The current findings suggest this process may be exacerbated in those who are highly perfectionistic, particularly those high in Socially Prescribed Perfectionism. This is because such individuals may be more vulnerable to the perceived demands at societal levels, particularly with excessive exposure to social media, which is increasingly a part of digital technologies employed in public health promotion (Flett et al., 2022; Stark et al., 2022).

In contrast to previous research (Akram et al., 2015, 2017, 2020; Jansson-Frojmark & Linton, 2007), neither depression nor anxiety mediated relationships between perfectionism and sleep in this study. These differences may be explained by the different measures used to assess

depression and anxiety between this study and earlier studies. Furthermore, the exclusion criterion of a current mental illness diagnosis excluded participants with comorbid depression and anxiety disorders. Given the divergent severity in symptoms between general and clinical populations, this could have contributed to the lack of a mediation effect in the current study, which could indicate a conservative finding. Although the current evidence is inconclusive, the mediation effect of stress on the relationship between sleep difficulties and perfectionism, specifically in Concern about Mistakes and Doubts about Actions, suggests stress may play a role in the relationship between perfectionism and insomnia. This is in line with the finding by Brand et al. (2015) that perceived stress, as measured by the Perceived Stress Scale, may be an underlying psychological mechanism in the relationship between poor sleep and perfectionism. The current finding strengthens that line of thinking because the same relationships were found despite using different measures of stress and sleep.

Theoretical and clinical implications

Results from the current study support theoretical conceptualizations and empirical literature that perfectionism may increase one's vulnerability to insomnia. Perfectionism is suggested to amplify common negative life events and cause arousals to disrupt the automatic sleep process, which becomes another source of stress and/or worry that leads to insomnia development (Akram et al., 2023; Lundh & Broman, 2000). The current study builds upon past research by replicating previous findings of the relationship between insomnia and perfectionism using subjective sleep measures obtained from an Australian general population sample, and adding to preliminary evidence that perfectionism may also play a role in the etiology of objectively measured sleep disturbances. Specifically, we suggest individuals who have high Socially Prescribed Perfectionism and Parental Expectations may be more prone to developing chronic insomnia as they increase sleep efforts to try to meet sleep expectations prescribed by others and perceived to be important, even if overly idealistic. Moreover, stress may be an underlying mechanism linking perfectionism to poor sleep such that individuals high on Concern for Mistakes and Doubts about Actions may be more prone to experiencing poor sleep when stressed, which then can lead to the development of dysfunctional sleep beliefs and unhelpful behaviors that cause insomnia (Espie et al., 2006; Morin et al., 1993).

Consequently, modifications to CBT-I to incorporate both perfectionism and stress reactivity as therapy targets should be considered in future trials. A recent CBT-I trial of clinical sample with perfectionism by Johann et al. (2023) indicated both perfectionism and insomnia were positively related to sleep efforts, pre-sleep arousal, and dysfunctional beliefs about sleep and that upon completion of CBT-I, levels of Organisation and Parental Expectations were elevated. Although the treatment was successful, the authors noted perfectionism may undermine sleep restriction therapy, a core component of CBT-I, because it can initially cause excessive daytime sleepiness, fatigue, and low mood and lead to dropouts. The current study findings suggest it may be important to address stress reactivity, Concern about Mistakes and Doubts about Actions prior to sleep restriction therapy to minimize the risk of dropout from CBT-I. Efficacy and impact of incorporating techniques from CBT for perfectionism into CBT-I could be explored in future research.

The current study findings also highlight the importance of improving sleep health education in Australia and taking a nuanced approach in public health messaging about sleep to prevent the proliferation of misperception, dysfunctional beliefs, and myths about sleep. Applying the suggestions relevant to public health messaging for Socially Prescribed Perfectionism by Flett et al. (2022), it may help to shift the focus from average to a range of sleep duration guidelines and normalize the occasional experiences of poor sleep to reduce the likelihood of overaction when one falls short of those expectations. For example, emphasizing that 6 to 10 hours of sleep may be appropriate for adults aged 26 to 64 years to feel good and

function well, in addition to or even replacing the usual recommendation of 7 to 9 hours. Overall, public sleep health messaging should be developed with consideration of impact upon insomnia development and maintenance.

Strengths, limitations, and future directions

This is the first study to examine the relationships between perfectionism and markers of poor sleep relating to insomnia using actigraphy. Although actigraphy allows the collection of ecological sleep data, it provides only binary sleep/wake detection and does not measure sleep architecture or capture physiological sleep data, such as, brain activity, eye movement, or muscle tone. With technological advances and the introduction of new wearable devices to measure sleep (e.g., Somfit by Compumedics, Melbourne, Australia), future studies could explore if there are ecological physiological markers of poor sleep related to perfectionism. While it was noted there were significant differences between objective and subjective sleep measures in the current sample, no further analysis was done. It remains unknown if sleep-wake state discrepancy might explain the differences found in those relationships between perfectionism and sleep, and whether dysfunctional beliefs play a role in those differences and interrelationships. Another key limitation of the current study relates to its cross-sectional data, which does not allow for causality to be determined and calls for future longitudinal studies. Additionally, the small sample size of the current study is a limitation, and confirmatory work will be required to investigate any specific hypotheses that were generated. Lastly, this study used an actigraphy setting optimized to detect sleep. Other actigraphy settings which may be more optimal for detecting wake can be investigated in future studies.

Conclusions

Research into perfectionism as an important factor in insomnia has been lacking. The current study indicates having high Parental Expectations and Socially Prescribed Perfectionism may increase one's vulnerability to objectively measured poor sleep and insomnia. Additionally, stress may be a mechanism linking perfectionism and insomnia for individuals with high levels of Concern for Mistakes and Doubts about Action. These findings indicate that perfectionism may be an important factor in preventing and treating insomnia.

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ORCID

Susie Y. Oh http://orcid.org/0009-0008-8145-9038
Hailey Meaklim http://orcid.org/0000-0003-0448-3567
Christian L. Nicholas http://orcid.org/0000-0002-3837-3609
David Cunnington http://orcid.org/0000-0002-8403-0420
Maya Schenker http://orcid.org/0000-0003-3811-2940
Cameron J. Patrick http://orcid.org/0000-0002-4677-535X
Daniel Windred http://orcid.org/0000-0002-7461-7498
Lisa J. Phillips http://orcid.org/0000-0003-1060-6068

References

Adams, R., Appleton, S., Taylor, A., Gill, T. K., Lang, C., McEvoy, D., & Antic, N. (2017). Sleep health of Australian adults in 2016: Results of the 2016 Sleep Health Foundation national survey. *Sleep Health*, *3*(1). https://doi.org/10.1016/j.sleh.2016.11.005

Akram, U. (2018). Objective sleep and personality. *Journal of Clinical Sleep Medicine*, *14*(3), 485–486. https://doi.org/10.5664/jcsm.7010

Akram, U., Ellis, J. G., & Barclay, N. L. (2015). Anxiety mediates the relationship between perfectionism and insomnia symptoms: A longitudinal study. *Public Library of Science ONE*, *10*(10), e0138865. https://doi.org/10.1371/journal.pone.0138865

Akram, U., Ellis, J. G., Myachykov, A., Chapman, A. J., & Barclay, N. L. (2017). Anxiety mediates the relationship between multidimensional perfectionism and insomnia disorder. *Personality & Individual Differences*, *104*, 82–86. https://doi.org/10.1016/j.paid.2016.07.042

Akram, U., Gardani, M., Riemann, D., Akram, A., Allen, S. F., Lazuras, L., & Johann, A. F. (2020). Dysfunctional sleep-related cognition and anxiety mediate the relationship between multidimensional perfectionism and insomnia symptoms. *Cognitive Processing*, *21*(1), 141–148. https://doi.org/10.1007/s10339-019-00937-8

Akram, U., Stevenson, J. C., Gardani, M., Allen, S., & Johann, A. F. (2023). Personality and insomnia: A systematic review and narrative synthesis. *Journal of Sleep Research*, *32*(6), e14031. https://doi.org/10.1111/jsr.14031

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders* (5th edition, text revision). American Psychiatric Association.

Andersson, G., Airikka, M.-L., Buhrman, M., & Kaldo, V. (2005). Dimensions of perfectionism and tinnitus distress. *Psychology, Health and Medicine*, *10*(1), 78–87. https://doi.org/10.1080/13548500512331315389

Attard, K. P., Adams, R. J. T., Vakulin, A., & Reynolds, A. C. (2019). Sleep and help seeking behaviors in Australia: A narrative review. *OBM Neurobiology*, *3*(2), 1–1. https://doi.org/10.21926/obm.neurobiol.1902029

Australian Government. (2023). *Australian Government response to the House of Representatives Standing Committee on health, aged care and sport report: Bedtime reading: Inquiry into sleep health awareness in Australia*. https://www.health.gov.au/resources/publications/bedtime-reading-inquiry-into-sleep-health-awareness-in-australia?language=en

Azevedo, M. H., Bos, S. C., Soares, M. J., Marques, M., Pereira, A. T., Maia, B., Gomes, A. A., & Macedo, A. (2010). Longitudinal study on perfectionism and sleep disturbance. *The World Journal of Biological Psychiatry*, *11*(2 Pt 2), 476–485. https://doi.org/10.3109/15622970903304467

Azevedo, M. H., Soares, M. J., Bos, S. C., Gomes, A. A., Maia, B., Marques, M., Pereira, A. T., & Macedo, A. (2009). Perfectionism and sleep disturbance. *The World Journal of Biological Psychiatry*, *10*(3), 225–233. https://doi.org/10.1080/15622970701367930

Bastien, C. H., Vallieres, A., & Morin, C. M. (2001). Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Medicine*, *2*(4), 297–307. https://doi.org/10.1016/S1389-9457(00)00065-4

Bin, Y. S., Marshall, N. S., & Glozier, N. (2012). The burden of insomnia on individual function and healthcare consumption in Australia. *Australian and New Zealand Journal of Public Health*, *36*(5), 462–468. https://doi.org/10.1111/j.1753-6405.2012.00845.x

Brand, S., Kirov, R., Kalak, N., Gerber, M., Puhse, U., Lemola, S., Correll, C. U., Cortese, S., Meyer, T., & Holsboer-Trachsler, E. (2015). Perfectionism related to self-reported insomnia severity, but not when controlled for stress and emotion regulation. *Neuropsychiatry Disease and Treatment*, *11*, 263–271. https://doi.org/10.2147/NDT.S74905

Breheny, M., Ross, I., Ladyman, C., Signal, L., Dew, K., & Gibson, R. (2023). "It's just [complicated] sleep": Discourses of sleep and ageing in the media. *The Gerontologist*. https://doi.org/10.1093/geront/gnad058

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge Academic.

Deloitte Access Economics. (2017). *Asleep on the Job - Costs of Inadequate Sleep in Australia*. Sleep Health Foundation. https://assets-global.website-files.com/64b4b7e38dda973fdbb7faf2/65025d4dbfb53143f206f321_Asleep%20on%20the%20Job-%20Costs%20of%20Inadequate%20Sleep%20in%20Australia.pdf

Dolsen, E. A., Asarnow, L. D., & Harvey, A. G. (2014). Insomnia as a transdiagnostic process in psychiatric disorders. *Current Psychiatry Reports*, *16*(9), 471. https://doi.org/10.1007/s11920-014-0471-y

Egan, S. J., Wade, T. D., & Shafran, R. (2011). Perfectionism as a transdiagnostic process: A clinical review. *Clinical Psychology Review*, *31*(2), 203–212. https://doi.org/10.1016/j.cpr.2010.04.009

Ekirch, A. R. (2015). The modernization of western sleep: Or, does insomnia have a history? *Past & Present*, *226*(1), 149–192. https://doi.org/10.1093/pastj/gtu040

Espie, C. A., Broomfield, N. M., MacMahon, K. M., Macphee, L. M., & Taylor, L. M. (2006). The attention-intention-effort pathway in the development of psychophysiologic insomnia: A theoretical review. *Sleep Medicine Reviews*, *10*(4), 215–245. https://doi.org/10.1016/j.smrv.2006.03.002

Flett, G. L., Hewitt, P. L., Nepon, T., Sherry, S. B., & Smith, M. (2022). The destructiveness and public health significance of socially prescribed perfectionism: A review, analysis, and conceptual extension. *Clinical Psychology Review*, *93*, 102130. https://doi.org/10.1016/j.cpr.2022.102130

Frost, R. O., Marten, P., Lahart, C., & Rosenblate, R. (1990). The dimensions of perfectionism. *Cognitive Therapy and Research*, *14*(5), 449–468. https://doi.org/10.1007/BF01172967

Harvey, A. G. (2002). A cognitive model of insomnia. *Behavior Research and Therapy*, *40*(8), 869–893. https://doi.org/10.1016/S0005-7967(01)00061-4

Harvey, A. G. (2008). Insomnia, psychiatric disorders, and the transdiagnostic perspective. *Current Directions in Psychological Science*, *17*(5), 299–303. https://doi.org/10.1111/j.1467-8721.2008.00594.x

Harvey, C. J., Gehrman, P., & Espie, C. A. (2014). Who is predisposed to insomnia: A review of familial aggregation, stress-reactivity, personality and coping style. *Sleep Medicine Reviews*, *18*(3), 237–247. https://doi.org/10.1016/j.smrv.2013.11.004

Hertenstein, E., Feige, B., Gmeiner, T., Kienzler, C., Spiegelhalder, K., Johann, A., Jansson-Frojmark, M., Palagini, L., Rucker, G., Riemann, D., & Baglioni, C. (2019). Insomnia as a predictor of mental disorders: A systematic review and meta-analysis. *Sleep Medicine Reviews*, *43*, 96–105. https://doi.org/10.1016/j.smrv.2018.10.006

Hewitt, P. L. (2020). Perfecting, belonging, and repairing: A dynamic-relational approach to perfectionism. *Canadian Psychology*, *61*(2), 101–110. https://doi.org/10.1037/cap0000209

Hewitt, P. L., & Flett, G. L. (1991). Perfectionism in the self and social contexts: Conceptualization, assessment, and association with psychopathology. *Journal of Personality & Social Psychology*, *60*(3), 456–470. https://doi.org/10.1037/0022-3514.60.3.456

Hewitt, P. L., Flett, G. L., Turnbull-Donovan, W., & Mikail, S. F. (1991). The multidimensional perfectionism scale: Reliability, validity, and psychometric properties in psychiatric samples. *Psychological Assessment: A Journal of Consulting Clinical Psychology*, *3*(3), 464–468. https://doi.org/10.1037/1040-3590.3.3.464

Jansson-Frojmark, M., & Linton, S. J. (2007). Is perfectionism related to pre-existing and future insomnia? A prospective study. *British Journal of Clinical Psychology*, *46*(1), 119–124. https://doi.org/10.1348/014466506X158824

Johann, A. F., Feige, B., Hertenstein, E., Nissen, C., Benz, F., Steinmetz, L., Baglioni, C., Riemann, D., Spiegelhalder, K., & Akram, U. (2023). The effects of cognitive behavioral therapy for insomnia on multidimensional perfectionism. *Behavior Therapy*, *54*(2), 386–399. https://doi.org/10.1016/j.beth.2022.10.001

Johann, A. F., Hertenstein, E., Kyle, S. D., Baglioni, C., Feige, B., Nissen, C., Riemann, D., & Spiegelhalder, K. (2017). Perfectionism and polysomnography-determined markers of poor sleep. *Journal of Clinical Sleep Medicine*, *13*(11), 1319–1326. https://doi.org/10.5664/jcsm.6806

Johann, A. F., Riemann, D., & Spiegelhalder, K. (2018). Does perfectionism increase the risk for dropout from cognitive behavioral therapy for insomnia? *Journal of Clinical Sleep Medicine*, *14*(3), 487–488. https://doi.org/10.5664/jcsm.7012

Katz, E., & Lazersfeld, F. (1955). *Personal influence. The part played by people in the flow of mass communication*. Free Press. https://doi.org/10.1007/978-3-658-21742-6_67

Koval, P., Hinton, J., Dozo, N., Gellson, J., Alvarez, M., Harrison, A., Vu, D., Susanto, R., Jayaputera, G., & Sinnott, R. (2019). *SEMA3: Smartphone Ecological Momentary Assessment, Version 3*. http://www.sema3.com

Liguori, C., Mombelli, S., Fernandes, M., Zucconi, M., Plazzi, G., Ferini-Strambi, L., Logroscino, G., Mercuri, N. B., & Filardi, M. (2023). The evolving role of quantitative actigraphy in clinical sleep medicine. *Sleep Medicine Reviews*, *68*, 101762. https://doi.org/10.1016/j.smrv.2023.101762

Limburg, K., Watson, H. J., Hagger, M. S., & Egan, S. J. (2017). The relationship between perfectionism and psychopathology: A meta-analysis. *Journal of Clinical Psychology*, *73*(10), 1301–1326. https://doi.org/10.1002/jclp.22435

Lombardo, C., Mallia, L., Battagliese, G., Grano, C., & Violani, C. (2013). Perfectionism mediates the relationship between insomnia and depressive symptoms. *Sleep and Biological Rhythms*, *11*(2), 90–98. https://doi.org/10.1111/sbr.12009

Lovibond, S. H., & Lovibond, P. F. (1995). *Manual for the depression anxiety stress scales* (2nd ed.). Psychology Foundation. https://doi.org/10.1037/t01004-000

Lundh, L.-G., & Broman, J.-E. (2000). Insomnia as an interaction between sleep-interfering and sleep-interpreting processes. *Journal of Psychosomatic Research*, *49*(5), 299–310. https://doi.org/10.1016/S0022-3999(00)00150-1

Lundh, L.-G., Broman, J.-E., Hetta, J., & Saboonchi, F. (1994). Perfectionism and Insomnia. *Scandinavian Journal of Behavior Therapy*, *23*(1), 3–18. https://doi.org/10.1080/16506079409455949

Maia, B. R., Soares, M. J., Pereira, A. T., Marques, M., Bos, S. C., Gomes, A., Valente, J., Azevedo, M. H., & Macedo, A. (2011). Affective state dependence and trait stability of perfectionism in sleep disturbances. *Revista Brasileira De Psiquiatria*, *33*(3), 252–260. https://doi.org/10.1590/S1516-44462011000300008

Martin, J. L., & Hakim, A. D. (2011). Wrist actigraphy. *Chest*, *139*(6), 1514–1527. https://doi.org/10.1378/chest.10-1872

Meaklim, H., Jackson, M. L., Bartlett, D., Saini, B., Falloon, K., Junge, M., Slater, J., Rehm, I. C., & Meltzer, L. J. (2020). Sleep education for healthcare providers: Addressing deficient sleep in Australia and New Zealand. *Sleep Health*, *6*(5), 636–650. https://doi.org/10.1016/j.sleh.2020.01.012

Molnar, D. S., Janssen, W. F., & Sirois, F. M. (2020). Sleeping perfectly? Trait perfectionism, perceived stress, and sleep quality. *Personality & Individual Differences*, *167*, 110244. https://doi.org/10.1016/j.paid.2020.110244

Monk, T. H., Reynolds Iii, C. F., Kupfer, D. J., Buysse, D. J., Coble, P. A., Hayes, A. J., Machen, M. A., Petrie, S. R., & Ritenour, A. M. (1994). The Pittsburgh sleep diary. *Journal of Sleep Research*, *3*(2), 111–120. https://doi.org/10.1111/j.1365-2869.1994.tb00114.x

Morin, C. M. (1993). *Insomnia: Psychological assessment and management*. Guilford Press.

Morin, C. M., Belleville, G., Belanger, L., & Ivers, H. (2011). The insomnia severity index: Psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep*, *34*(5), 601–608. https://doi.org/10.1093/sleep/34.5.601

Morin, C. M., Stone, J., Trinkle, D., Mercer, J., & Remsberg, S. (1993). Dysfunctional beliefs and attitudes about sleep among older adults with and without insomnia complaints. *Psychology and Aging*, *8*(3), 463–467. https://doi.org/10.1037/0882-7974.8.3.463

O'Rourke, H. P., & MacKinnon, D. P. (2018). Reasons for testing mediation in the absence of an intervention effect: A research imperative in prevention and intervention research. *Journal of Studies on Alcohol and Drugs*, *79*(2), 171–181. https://doi.org/10.15288/jsad.2018.79.171

Reynolds, A. C., Appleton, S. L., Gill, T. K., & Adams, R. J. (2019). *Chronic insomnia disorder in Australia: A report to the Sleep Health Foundation*. F. V. Communication. https://www.sleephealthfoundation.org.au/special-sleep-reports/chronic-insomnia-disorder-in-australia#:~:text=More%20than%20half%20of%20adult,is%20across%20the%20adult%20population

Richardson, C., & Gradisar, M. (2020). Perfectionism and insomnia in adolescents: The role of vulnerability to stress and gender. *Journal of Adolescence*, *85*(1), 70–79. https://doi.org/10.1016/j.adolescence.2020.10.003

Riemann, D., Spiegelhalder, K., Feige, B., Voderholzer, U., Berger, M., Perlis, M., & Nissen, C. (2010). The hyperarousal model of insomnia: A review of the concept and its evidence. *Sleep Medicine Reviews*, *14*(1), 19–31. https://doi.org/10.1016/j.smrv.2009.04.002

Robbins, R., Grandner, M. A., Buxton, O. M., Hale, L., Buysse, D. J., Knutson, K. L., Patel, S. R., Troxel, W. M., Youngstedt, S. D., Czeisler, C. A., & Jean-Louis, G. (2019). Sleep myths: An expert-led study to identify false beliefs about sleep that impinge upon population sleep health practices. *Sleep Health*, *5*(4), 409–417. https://doi.org/10.1016/j.sleh.2019.02.002

Rodriguez-Seijas, C., Eaton, N. R., & Krueger, R. F. (2015). How transdiagnostic factors of personality and psychopathology can inform clinical assessment and intervention. *Journal of Personality Assessment*, *97*(5), 425–435. https://doi.org/10.1080/00223891.2015.1055752

Schmidt, R. E., Courvoisier, D. S., Cullati, S., Kraehenmann, R., & der Linden, M. V. (2018). Too imperfect to fall asleep: Perfectionism, pre-sleep counterfactual processing, and insomnia. *Frontiers in Psychology*, *9*, 1288. https://doi.org/10.3389/fpsyg.2018.01288

Sinclair, S. J., Siefert, C. J., Slavin-Mulford, J. M., Stein, M. B., Renna, M., & Blais, M. A. (2012). Psychometric evaluation and normative data for the depression, anxiety, and stress scales-21 (DASS-21) in a nonclinical sample of U.S. adults. *Evaluations and the Health Professions*, *35*(3), 259–279. https://doi.org/10.1177/0163278711424282

Smith, M. T., McCrae, C. S., Cheung, J., Martin, J. L., Harrod, C. G., Heald, J. L., & Carden, K. A. (2018). Use of actigraphy for the evaluation of sleep disorders and circadian rhythm sleep-wake disorders: An American Academy of Sleep Medicine clinical practice guideline. *Journal of Clinical Sleep Medicine*, *14*(7), 1231–1237. https://doi.org/10.5664/jcsm.7230

Spiegelhalder, K., Regen, W., Kyle, S. D., Endres, D., Nissen, C., Feige, B., & Riemann, D. (2012). Time will tell: A retrospective study investigating the relationship between insomnia and objectively defined punctuality. *Journal of Sleep Research*, *21*(3), 264–269. https://doi.org/10.1111/j.1365-2869.2011.00970.x

Stark, A. L., Geukes, C., & Dockweiler, C. (2022). Digital health promotion and prevention in settings: Scoping review. *Journal of Medical Internet Research*, *24*(1), e21063. https://doi.org/10.2196/21063

Trudel-Fitzgerald, C., Savard, J., Slim, L. M., Roy, R. C., Flett, G. L., Hewitt, P. L., & Ivers, H. (2017). The relationship of perfectionism with psychological symptoms in cancer patients and the contributing role of hyperarousability and coping. *Psychology & Health*, *32*(4), 381–401. https://doi.org/10.1080/08870446.2016.1273354

van de Laar, M., Verbeek, I., Peveragie, D., Aldenkamp, A., & Overeem, S. (2010). The role of personality traits in insomnia. *Sleep Medicine Reviews*, *14*(1), 61–68. https://doi.org/10.1016/j.smrv.20

van Hees, V. T., Sabia, S., Anderson, K. N., Denton, S. J., Oliver, J., Catt, M., Abell, J. G., Kivimaki, M., Trenell, M. I., & Singh-Manoux, A. (2015). A novel, open access method to assess sleep duration using a wrist-worn accelerometer. *Public Library of Science ONE*, *10*(11), e0142533. https://doi.org/10.1371/journal.pone.0142533

Vincent, N. K., & Walker, J. R. (2000). Perfectionism and chronic insomnia. *Journal of Psychosomatic Research*, *49*(5), 349–354. https://doi.org/10.1016/S0022-3999(00)00175-6

Warton, D. I., & Hui, F. K. C. (2011). The arcsine is asinine: The analysis of proportions in ecology. *Ecology*, *90*(1), 3–10. https://doi.org/10.1890/10-0340.1

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10.2.3 Study 1 Supplementary Materials

Table A1

Correlations between Insomnia Severity Index and perfectionism

Perfectionism	r	p
Frost Multidimensional Perfectionism Scale	0.55	<.001**
Concern over Mistakes	0.48	<.001**
Doubts about Actions	0.48	<.001**
Parental Criticism	0.36	.004**
Parental Expectations	0.23	.076
Personal Standards	0.46	<.001**
Organisation	0.14	.288
Hewitt-Flett Multidimensional Perfectionism Scale	0.47	<.001**
Self-oriented Perfectionism	0.40	.002**
Other-oriented Perfectionism	0.06	.643
Socially Prescribed Perfectionism	0.54	<.001**

Note. $^{**}p < .01$.

Table A2

Correlations between subjective sleep measures and perfectionism

n = 60	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. TST															
2. SOL	-.24														
3. WASO	-.34**	.36**													
4. NOA	.02	.18	.22												
5. SE	.47**	-.76**	-.86**	-.20											
6. FMPS	-.08	.35**	.19	.02	-.32*										
7. CM	-.02	.37**	.11	.08	-.25	.88**									
8. DA	-.09	.36**	.14	-.06	-.29*	.71**	.62**								
9. PC	-.16	.15	.12	.04	-.19	.71**	.48**	.42**							
10. PE	-.15	.04	.11	-.01	-.12	.62**	.30*	.19	.72**						
11. O	.03	.11	.02	-.04	-.03	.09	.07	.08	-.16	.03					
12. PS	.06	.32*	.25	-.01	-.31*	.74**	.62**	.44**	.20	.29*	.26*				
13. HFMPS	-.07	.23	.20	.12	-.24	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.			
14. SOP	.03	.26*	.19	.08	-.24	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.76**		
15. OOP	-.01	-.011	.04	.15	.04	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.56**	.02	
16. SPP	-.17	.33*	.20	.03	-.31*	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.83**	.57**	.22

Notes. TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; FMPS, Frost Multidimensional Perfectionism Scale; CM, Concern over Mistakes; DA, Doubts about Actions; PE, Parental Expectations; PC, Parental Criticism; O, Organization; PS, Personal Standards; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; SOP, Self-oriented Perfectionism; OOP, Other-oriented Perfectionism; SPP, Socially Prescribed Perfectionism, N.A., not available. *$p < .05$, **$p < .01$.

Table A3

Correlations between objective sleep measures and perfectionism

n = 60	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. TST															
2. SOL	-.44**														
3. WASO	-.57**	.57**													
4. NOA	-.62**	.37*	.82**												
5. SE	-.64**	-.41**	-.76**	-.74**											
6. FMPS	.04	.14	.11	.07	-.16										
7. CM	.13	.07	.07	.00	-.08	.88**									
8. DA	.15	-.03	.07	.03	-.06	.71**	.62**								
9. PC	-.23	.15	.18	.18	-.22	.71**	.48**	.42**							
10. PE	-.24	.23	.15	.21	-.30*	.62**	.30*	.19	.72**						
11. O	.09	.15	-.07	-.10	.15	.09	.07	.08	-.16	.03					
12. PS	-.21	.12	-.01	-.05	-.01	.74**	.62**	.44**	.20	.29*	.26*				
13. HFMPS	.01	.19	.12	.06	-.16	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.			
14. SOP	.13	.15	.08	.01	-.04	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.76**		
15. OOP	-.01	.04	-.08	-.08	-.02	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.56**	.02	
16. SPP	-.12	.22	.25	.20	-.31*	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.83**	.57**	.22

Notes. TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; FMPS, Frost Multidimensional Perfectionism Scale; CM, Concern over Mistakes; DA, Doubts about Actions; PE, Parental Expectations; PC, Parental Criticism; O, Organization; PS, Personal Standards; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; SOP, Self-oriented Perfectionism; OOP, Other-oriented Perfectionism; SPP, Socially Prescribed Perfectionism, N.A., not available. *$p < .05$, **$p < .01$.

Table A4

Correlations between log transformed subjective sleep measures (except TST) and perfectionism with outliers removed

n = 58	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. TST #															
2. logSOL	-.17														
3. logWASO	-.27*	.50**													
4. logNOA	.01	.20	.69**												
5. logitSE	.37**	-.87**	-.80**	-.34*											
6. FMPS	-.13	.33*	.19	.08	-.31*										
7. CM	-.06	.31*	.11	.07	-.24	.87**									
8. DA	-.11	.32*	-.02	-.15	-.21	.72**	.62**								
9. PC	-.21	.16	.20	1.00	-.21	.71**	.47**	.42**							
10. PE	-.22	.02	.17	.11	-.13	.58**	.25	.17	.70**						
11. O	.03	.13	-.05	-.07	-.04	.10	.07	.08	-.17	.02					
12. PS	.02	.33*	.22	.04	-.33*	.72**	.60**	.44**	.19	.24	.28*				
13. HFMPS	-.08	.18	.13	.04	-.19	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.			
14.SOP	.00	.28*	.13	.01	-.25	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.76**		
15. OOP	.02	-.15	.00	.06	.10	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.57**	.03	
16. SPP	-.20	.25	.15	.02	-.24	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.84**	.57**	.27*

Notes. log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; FMPS, Frost Multidimensional Perfectionism Scale; CM, Concern over Mistakes; DA, Doubts about Actions; PE, Parental Expectations; PC, Parental Criticism; O, Organization; PS, Personal Standards; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; SOP, Self-oriented Perfectionism; OOP, Other-oriented Perfectionism; SPP, Socially Prescribed Perfectionism, N.A., not available. *$p < .05$, **$p < .01$, # TST was not log-transformed.

Table A5

Correlations between log transformed objective sleep measures (except TST) and perfectionism with outliers removed

n = 58	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. TST #															
2. logSOL	-.27*														
3. logWASO	-.25	.54**													
4. logNOA	-.26*	.38**	.79**												
5. logitSE	.48**	-.25	-.75**	-.71**											
6. FMPS	.06	.26*	.17	.07	-.17										
7. CM	.12	.17	.16	.06	-.12	.87**									
8. DA	.18	.03	.10	.05	-.07	.72**	.62**								
9. PC	-.15	.12	.05	.03	-.10	.71**	.47**	.42**							
10. PE	-.21	.29*	.08	.04	-.22	.58**	.25	.17	.70**						
11. O	.13	.25	-.10	-.10	.20	.10	.07	.08	-.17	.02					
12. PS	.16	.33*	.18	.07	-.12	.72**	.60**	.44**	.19	.24	.28*				
13. HFMPS	-.03	.25	.23	.03	-.24	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.			
14. SOP	.12	.28*	.18	.03	-.10	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.76**		
15. OOP	-.12	.06	.06	-.05	-.12	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.57**	.03	
16. SPP	-.07	.19	.26*	.09	-.32*	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	.84**	.57**	.27*

Notes. log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; FMPS, Frost Multidimensional Perfectionism Scale; CM, Concern over Mistakes; DA, Doubts about Actions; PE, Parental Expectations; PC, Parental Criticism; O, Organization; PS, Personal Standards; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; SOP, Self-oriented Perfectionism; OOP, Other-oriented Perfectionism; SPP, Socially Prescribed Perfectionism, N.A., not available. *$p < .05$, **$p < .01$, # TST was not log-transformed.

Table A6

Regression coefficients between objective sleep measures and perfectionism with outliers removed

n = 58	TST #			logSOL			logWASO			logNOA			logitSE		
	β	CI	P	exp β	CI	P	exp β	CI	P	exp β	CI	P	exp β	CI	P
FMPS	0.05	-0.80 – 0.90	.91	1.36	0.99 - 1.85	.05	1.00	1.00 - 1.01	.31	1.07	0.71 - 1.60	.75	0.88	0.73 - 1.06	.16
CM	0.72	-1.30 – 2.74	.48	1.23	0.90 - 1.70	.20	1.06	0.93 - 1.21	.36	1.04	0.69 - 1.57	.84	0.93	0.77 - 1.12	.44
DA	2.34	-1.86 – 6.55	.27	1.02	0.74 - 1.41	.89	1.03	0.90 - 1.18	.36	1.03	0.69 - 1.55	.87	0.94	0.78 - 1.14	.54
PC	-2.41	-6.40 - 1.57	.23	1.15	0.84 - 1.57	.39	1.02	0.90 - 1.16	.74	1.05	0.70 - 1.56	.82	0.93	0.77 - 1.11	.42
PE	-3.41	-6.99 – 0.18	.06	1.40	1.03 - 1.90	.032*	1.06	0.92 - 1.23	.43	1.04	0.70 - 1.56	.83	0.85	0.71 - 1.01	.07
O	1.11	-3.58 – 5.79	.64	1.29	0.94 - 1.77	.11	0.95	0.83 - 1.08	.43	0.83	0.55 - 1.25	.38	1.10	0.91 - 1.32	.33
PS	1.40	-1.53 – 4.35	.34	1.44	1.06 - 1.95	.020*	1.09	0.95 - 1.24	.20	1.08	0.72 - 1.62	.70	0.89	0.74 - 1.07	.22
HFMPS	-0.04	-0.58 – 0.51	.90	1.41	1.04 - 1.93	.030*	1.11	0.97 - 1.26	.13	1.03	0.68 - 1.55	.88	0.87	0.72 - 1.04	.13
SOP	0.30	-0.78 - 1.38	.58	1.37	1.00 - 1.87	.047*	1.08	0.95 - 1.23	.24	1.01	0.67 - 1.51	.97	0.91	0.76 - 1.10	.33
OOP	-0.31	-1.55 – 0.93	.61	0.14	-0.18 - 0.47	.39	1.02	0.90 - 1.17	.72	0.94	0.62 - 1.42	.75	0.97	0.80 - 1.17	.76
SPP	-0.26	-1.48 – 0.97	.67	1.34	0.97 - 1.84	.07	1.12	0.99 - 1.28	.08	1.13	0.75 - 1.71	.55	0.83	0.69 - 0.99	.043*

Notes. exp, standardised exponentiated regression coefficient, for example, a 1.00 standard deviation increase in PE leads to a ratio change of 1.40 or a 40% increase in logSOL, and a 1.00 standard deviation increase in HFMPS leads to a ratio change of 1.41 or a 41% increase in logSOL. log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; FMPS, Frost Multidimensional Perfectionism Scale; CM, Concern over Mistakes; DA, Doubts about Actions; PE, Parental Expectations; PC, Parental Criticism; O, Organisation; PS, Personal Standards; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; SOP, Self-oriented Perfectionism; OOP, Other-oriented Perfectionism; SPP, Socially Prescribed Perfectionism. *$p < .05$, # TST was not log-transformed.

Table A7

Regression coefficients of mediation analysis using depression as a mediator in the relationship between log transformed objective sleep measures and selected subscales of perfectionism (n = 60, simulations = 10,000)

Sleep Measures	TST #			logSOL			logWASO			logNOA			logitSE		
Perfectionism	Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p
CM															
- ACME	-1.40	-4.72 - 1.70	.37	0.99	0.76 - 1.30	.97	1.08	0.93 - 1.30	.29	1.15	0.84 - 1.58	.37	0.88	0.67 - 1.11	.28
- ADE	2.45	-0.60 – 5.51	.12	1.20	0.82 - 1.75	.36	0.95	0.77 - 1.19	.67	0.88	0.51 - 1.52	.65	1.09	0.83 - 1.43	.54
- Total effect	1.06	-1.75 – 3.70	.44	1.19	0.87 - 1.62	.29	1.04	0.87 - 1.23	.70	1.01	0.64 - 1.58	.97	0.95	0.76 - 1.21	.71
DA															
- ACME	-1.89	-7.66 – 2.91	.43	1.05	0.85 - 1.34	.62	1.06	0.95 - 1.22	.28	1.09	0.86 - 1.45	.47	0.91	0.75 - 1.07	.29
- ADE	4.32	-0.60 – 9.72	.12	0.97	0.67 - 1.40	.87	0.97	0.82 - 1.16	.73	0.94	0.55 - 1.58	.83	1.03	0.83 - 1.28	.77
- Total effect	1.06	-3.22 – 7.60	.37	1.02	0.75 - 1.39	.89	1.03	0.88 - 1.22	.74	1.03	0.66 - 1.58	.90	0.94	0.75 - 1.19	.64
PC															
- ACME	-0.03	-3.89 – 3.80	.99	1.01	0.85 - 1.21	.93	1.05	0.95 - 1.17	.37	1.05	0.88 - 1.30	.55	0.94	0.79 - 1.09	.43
- ADE	-4.24	-9.59 - 1.07	.11	1.19	0.81 - 1.72	.37	1.03	0.87 - 1.21	.76	1.07	0.70 - 1.62	.76	0.92	0.73 - 1.16	.47
- Total effect	-4.27	-10.04 – 1.54	.14	1.20	0.84 - 1.67	.31	1.07	0.91 - 1.27	.40	1.13	0.75 - 1.72	.57	0.86	0.69 - 1.08	.20
PS															
- ACME	-0.39	-2.40 - 1.04	.61	1.01	0.91 - 1.13	.85	1.02	0.97 - 1.11	.44	1.03	0.93 - 1.19	.56	0.97	0.856- 1.04	.43
- ADE	2.84	-1.11 – 6.76	.16	1.31	0.92 - 1.88	.13	1.01	0.83 - 1.23	.96	0.97	0.61 - 1.57	.90	0.98	0.77 - 1.26	.90
- Total effect	2.45	-1.71 – 6.63	.26	1.32	0.94 - 1.88	.11	1.03	0.84 - 1.26	.80	1.00	0.63 - 1.60	.99	0.95	0.73 - 1.23	.72
SPP															
- ACME	-0.19	-1.57 – 1.15	.77	0.98	0.80 - 1.20	.836	1.03	0.93 - 1.14	.58	1.05	0.86 - 1.30	.63	0.96	0.82 - 1.11	.55
- ADE	-0.43	-1.98 - 1.10	.58	1.39	0.99 - 1.95	.057	1.13	0.96 - 1.31	.14	1.13	0.76 - 1.68	.54	0.84	0.65 - 1.06	.14
- Total effect	0.62	-2.07 – 0.81	.40	1.36	1.06 - 1.75	.012*	1.15	1.00 - 1.34	.06	1.19	0.82 - 1.72	.37	0.80	0.63 - 1.01	.06

Notes. exp, standardised exponentiated regression coefficient, ACME, average causal mediated effect; ADE, average direct effect; log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; CM, Concern over Mistakes; DA, Doubts about Actions; PC, Parental Criticism; PS, Personal Standards; SPP, Socially Prescribed Perfectionism. *$p < .05$, # TST was not log-transformed.

Table A8

Regression coefficients of mediation analysis using anxiety as a mediator in the relationship between log transformed objective sleep measures and selected subscales of perfectionism (n = 60, simulations = 10,000)

	TST #			logSOL			logWASO			logNOA			logitSE		
Perfectionism	Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p
CM															
- ACME	-0.01	-0.05 – 0.02	.46	0.95	0.74 - 1.22	.71	1.01	0.94 - 1.08	.87	1.02	0.83 - 1.26	.88	0.94	0.80 - 1.07	.35
- ADE	0.03	-0.03 – 0.09	.30	1.25	0.89 - 1.75	.21	1.03	0.86 - 1.23	.74	0.99	0.59 - 1.65	.97	1.02	0.79 - 1.32	.87
- Total effect	0.02	-0.04 – 0.08	.51	1.19	0.86 - 1.63	.29	1.04	0.88 - 1.22	.68	1.01	0.64 - 1.55	.97	0.96	0.76 - 1.20	.70
DA															
- ACME	-0.85	-4.40 – 2.35	.60	1.01	0.79 - 1.30	.90	1.01	0.93 - 1.09	.83	1.01	0.80 - 1.27	.95	0.95	0.83 - 1.06	.37
- ADE	3.20	-1.60 – 7.91	.18	1.00	0.70 - 1.43	.99	1.02	0.85 - 1.22	.82	1.02	0.59 - 1.73	.93	1.00	0.79 - 1.25	.98
- Total effect	2.36	-2.01 – 6.66	.28	1.02	0.76 - 1.38	.91	1.03	0.89 - 1.20	.70	1.03	0.66 - 1.58	.89	0.94	0.77 - 1.16	.59
PC															
- ACME	1.31	-1.72 – 5.06	.40	0.97	0.77 - 1.20	.74	0.99	0.93 - 1.06	.85	0.98	0.80 - 1.17	.77	0.98	0.85 - 1.09	.66
- ADE	-5.60	-11.86 – 0.63	.07	1.23	0.84 - 1.80	.30	1.08	0.90 - 1.30	.41	1.16	0.73 - 1.82	.53	0.89	0.69 - 1.14	.34
- Total effect	-4.30	-9.68 – 1.25	.12	1.19	0.84 - 1.70	.34	1.07	0.90 - 1.27	.41	1.14	0.74 - 1.72	.55	0.87	0.68 - 1.09	.23
PS															
- ACME	-0.28	-1.79 – 1.00	.66	0.98	0.84 - 1.13	.76	1.01	0.97 - 1.05	.75	1.01	0.90 - 1.15	.87	0.97	0.89 - 1.04	.37
- ADE	2.72	-1.45 – 6.75	.20	1.35	0.95 - 1.93	.10	1.02	0.84 - 1.26	.81	0.99	0.61 – 1.62	.97	0.98	0.76 – 1.27	.89
- Total effect	2.45	-1.52 – 6.34	.22	1.32	0.94 - 1.86	.11	1.03	0.84 - 1.26	.75	1.00	0.63 - 1.58	1.00	0.95	0.73 – 1.22	.70
SPP															
- ACME	0.38	-1.16 – 2.10	.63	0.85	0.57 - 1.19	.345	0.93	0.83 - 1.04	.231	0.91	0.65 - 1.25	.57	1.03	0.85 - 1.26	.721
- ADE	-1.01	-3.05 – 1.01	.33	1.60	1.02 - 2.53	.044*	1.23	0.96 - 1.46	.017*	1.28	0.76 - 2.16	.35	0.77	0.61 - 0.99	.040*
- Total effect	-0.63	-2.07 – 0.79	.39	1.36	1.04 - 1.80	.027*	1.16	1.00 - 1.34	.044*	1.17	0.82 - 1.73	.40	0.79	0.63 - 1.02	.071

Notes. exp, standardised exponentiated regression coefficient, ACME, average causal mediated effect; ADE, average direct effect; log, log-trasnformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; CM, Concern over Mistakes; DA, Doubts about Actions; PC, Parental Criticism; PS, Personal Standards; SPP, Socially Prescribed Perfectionism. *$p < .05$, # TST was not log-transformed.

Table A9

Regression coefficients of mediation analysis using stress as a mediator in the relationship between log transformed objective sleep measures and selected subscales of perfectionism (n = 60, simulations = 10,000)

Sleep Measures	TST #			logSOL			logWASO			logNOA			logitSE		
Perfectionism	Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p
CM															
- ACME	-1.20	-3.31 – 0.62	.20	1.04	0.81 - 1.32	.76	1.05	0.94 - 1.20	.34	1.11	0.85 - 1.48	.42	0.86	0.71 - 0.99	.036*
- ADE	2.27	-0.88 – 5.41	.16	1.15	0.76 - 1.72	.51	0.98	0.79 - 1.22	.88	0.90	0.53 - 1.55	.72	1.12	0.87 - 1.43	.40
- Total effect	1.07	-1.45 – 3.59	.41	1.19	0.86 - 1.63	.29	1.03	0.87 - 1.22	.66	1.01	0.64 - 1.55	.98	0.95	0.77 - 1.20	.68
DA															
- ACME	-1.82	-5.58 – 1.01	.22	1.07	0.90 - 1.32	.42	1.04	0.96 - 1.15	.31	1.07	0.88 - 1.38	.47	0.90	0.77 – 1.00	.042*
- ADE	4.22	-0.65 – 9.15	.09	0.95	0.68 - 1.34	.75	0.99	0.82 - 1.19	.90	0.95	0.57 - 1.55	.85	1.06	0.84 - 1.32	.61
- Total effect	2.40	-2.30 – 6.96	.31	1.02	0.75 - 1.38	.90	1.03	0.88 - 1.21	.71	1.03	0.66 - 1.58	.91	0.95	0.76 - 1.19	.63
PC															
- ACME	-0.23	-2.41 – 1.87	.81	1.03	0.90 - 1.20	.65	1.02	0.98 - 1.09	.34	1.04	0.90 - 1.23	.58	0.93	0.84 – 1.00	.07
- ADE	-4.11	-9.41 - 1.31	.13	1.16	0.79 - 1.67	.43	1.05	0.89 - 1.23	.58	1.09	0.71 - 1.70	.72	0.93	0.76 - 1.15	.50
- Total effect	-4.34	-9.88 – 1.33	.12	1.19	0.84 - 1.67	.30	1.07	0.90 - 1.27	.42	1.14	0.75 - 1.73	.56	0.87	0.69 - 1.08	.21
PS															
- ACME	-0.86	-3.03 – 0.61	.28	1.02	0.89 - 1.19	.82	1.03	0.97 - 1.12	.36	1.05	0.91 - 1.27	.48	0.92	0.81 - 1.01	.09
- ADE	3.30	-1.06 – 7.70	.14	1.30	0.88 – 1.92	.19	1.00	0.80 - 1.25	.99	0.95	0.59 – 1.54	.83	1.03	0.79 - 1.34	.85
- Total effect	2.44	-1.53 – 6.45	.23	1.32	0.93 – 1.88	.12	1.03	0.84 – 1.26	.77	1.00	0.64 – 1.58	.99	0.95	0.74 – 1.22	.68
SPP															
- ACME	-0.25	-1.51 – 0.97	.67	0.97	0.76 - 1.23	.80	1.01	0.92 - 1.12	.86	1.04	0.79 - 1.36	.77	0.91	0.79 - 1.05	.21
- ADE	-0.37	-2.09 – 1.30	.68	1.40	1.02 - 1.93	.039*	1.15	0.98 - 1.35	.10	1.14	0.73 - 1.79	.56	0.87	0.68 - 1.11	.27
- Total effect	-0.62	-2.04 – 0.80	.40	1.36	1.07 - 1.75	.014*	1.15	0.99 - 1.35	.06	1.19	0.81 - 1.72	.38	0.79	0.62 - 1.02	.07

Notes. Highlighted was presented in main paper. exp, standardised exponentiated regression coefficient, ACME, average causal mediated effect; ADE, average direct effect; log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; CM, Concern over Mistakes; DA, Doubts about Actions; PC, Parental Criticism; PS, Personal Standards; SPP, Socially Prescribed Perfectionism. *$p < .05$, # TST was not log-transformed.

Table A10

Regression coefficients of mediation analysis using depression as a mediator in the relationship between log transformed objective sleep measures and selected subscales of perfectionism with outliers removed (n = 58, simulations = 10,000)

Sleep Measures	TST #			logSOL			logWASO			logNOA			logitSE		
Perfectionism	Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p
CM															
- ACME	0.16	-1.71 – 2.11	.87	0.90	0.68 - 1.17	.45	1.01	0.90 - 1.12	.91	1.01	0.77 - 1.34	.94	0.97	0.80 - 1.16	.77
- ADE	0.56	-1.52 – 2.62	.59	1.36	0.97 - 1.93	.08	1.05	0.89 - 1.26	.53	1.03	0.60 - 1.77	.92	0.96	0.76 - 1.21	.70
- Total effect	0.72	-1.18 – 2.62	.44	1.23	0.92 - 1.67	.17	1.06	0.92 - 1.22	.40	1.04	0.68 - 1.63	.86	0.93	0.77 - 1.13	.46
DA															
- ACME	0.09	-3.03 – 3.17	.95	1.01	0.79 - 1.28	.92	1.02	0.93 - 1.12	.68	1.01	0.79 - 1.31	.90	0.97	0.84 - 1.11	.65
- ADE	2.24	-2.52 – 6.96	.35	1.01	0.68 - 1.51	.95	1.02	0.85 - 1.21	.86	1.02	0.58 - 1.77	.96	0.97	0.78 - 1.20	.79
- Total effect	2.33	-1.85 – 6.54	.27	1.02	0.75 - 1.40	.89	1.03	0.89 - 1.21	.67	1.03	0.65 - 1.62	.91	0.94	0.76 - 1.16	.60
PC															
- ACME	0.96	-0.68 – 3.01	.26	0.99	0.86 - 1.14	.87	1.01	0.96 - 1.08	.61	1.01	0.89 - 1.15	.89	0.98	0.88 - 1.08	.69
- ADE	-3.36	-7.61 – 0.92	.12	1.16	0.81 - 1.68	.42	1.01	0.88 - 1.16	.92	1.04	0.69 - 1.55	.84	0.95	0.79 - 1.15	.57
- Total effect	-2.40	-4.76 – 4.19	.25	1.15	0.81 - 1.63	.44	1.02	0.89 - 1.19	.77	1.05	0.70 - 1.58	.82	0.93	0.78 - 1.12	.41
PS															
- ACME	-.13	-0.77 – 1.27	.70	0.99	0.88 - 1.11	.86	1.01	0.97 - 1.05	.80	1.00	0.90 - 1.13	.94	0.99	0.91 - 1.05	.76
- ADE	1.25	-2.30 – 3.69	.32	1.45	1.11 - 1.90	.006*	1.08	0.94 - 1.23	.26	1.07	0.68 - 1.70	.75	0.90	0.76 - 1.06	.22
- Total effect	1.38	-1.09 – 3.83	.28	1.43	1.11 - 1.86	.005*	1.08	0.95 - 1.25	.23	1.08	0.70 - 1.68	.73	0.90	0.75 - 1.06	.21
SPP															
- ACME	0.23	-0.47 – 0.98	.51	0.96	0.79 - 1.14	.62	1.00	0.94 - 1.06	.94	0.99	0.84 - 1.16	.93	1.00	0.91 - 1.11	.94
- ADE	-0.48	-1.91 – 0.99	.51	1.39	1.00 - 1.95	.05	1.13	0.98 - 1.30	.09	1.14	0.76 - 1.72	.52	0.83	0.67 - 1.03	.09
- Total effect	-0.26	-1.41 – 0.90	.68	1.34	1.04 - 1.72	.022*	1.13	0.99 - 1.28	.08	1.13	0.77 - 1.65	.51	0.83	0.67 - 1.02	.07

Notes. exp, standardised exponentiated regression coefficient, ACME, average causal mediated effect; ADE, average direct effect; log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; CM, Concern over Mistakes; DA, Doubts about Actions; PC, Parental Criticism; PS, Personal Standards; SPP, Socially Prescribed Perfectionism. *$p < .05$, # TST was not log-transformed.

Table A11

Regression coefficients of mediation analysis using anxiety as a mediator in the relationship between log transformed objective sleep measures and selected subscales of perfectionism with outliers removed (n = 58, simulations = 10,000)

Sleep Measures	TST #			logSOL			logWASO			logNOA			logitSE		
Perfectionism	Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p
CM															
- ACME	-0.01	-0.05 – 0.02	.50	0.96	0.74 - 1.22	.70	1.00	0.94 - 1.07	.91	1.01	0.83 - 1.26	.90	0.94	0.81 - 1.07	.35
- ADE	0.02	-0.02 – 0.07	.34	1.28	0.93 - 1.79	.12	1.06	0.90 - 1.23	.48	1.03	0.63 - 1.70	.91	0.99	0.79 - 1.25	.91
- Total effect	0.01	-0.23 – 0.05	.60	1.23	0.90 - 1.68	.18	1.06	0.92 - 1.22	.40	1.04	0.67 - 1.62	.86	0.93	0.77 - 1.13	.45
DA															
- ACME	-1.02	-4.56 – 2.03	.51	1.02	0.80 - 1.32	.82	1.01	0.94 - 1.09	.68	1.02	0.82 - 1.27	.87	0.94	0.82 - 1.05	.30
- ADE	3.36	-1.54 – 8.31	.18	1.00	0.7 - 1.43	.98	1.02	0.85 - 1.22	.85	1.01	0.59 - 1.75	.95	1.00	0.80 - 1.26	.97
- Total effect	2.35	-1.78 – 6.57	.26	1.02	0.75 - 1.4	.88	1.03	0.90 - 1.20	.68	1.03	0.66 - 1.60	.89	0.94	0.77 - 1.15	.57
PC															
- ACME	0.49	-2.44 – 3.81	.73	0.99	0.79 - 1.23	.90	1.02	0.96 - 1.08	.53	1.01	0.84 - 1.23	.92	0.95	0.83 - 1.04	.30
- ADE	-2.90	-7.22 – 1.44	.19	1.16	0.79 - 1.72	.46	1.00	0.87 - 1.16	.95	1.04	0.66 - 1.63	.88	0.98	0.81 - 1.19	.83
- Total effect	-2.41	-6.33 – 1,69	.25	1.15	0.79 - 1.65	.45	1.02	0.89 - 1.19	.77	1.05	0.69 - 1.57	.83	0.93	0.76 - 1.13	.45
PS															
- ACME	-0.22	-1.69 – 1.06	.72	0.98	0.85 - 1.12	.78	1.00	0.97 - 1.05	.83	1.01	0.90 - 1.14	.92	0.97	0.89 - 1.04	.42
- ADE	1.61	-1.18 – 4.47	.27	1.46	1.11 - 1.92	.006*	1.08	0.95 - 1.25	.24	1.07	0.68 - 1.73	.76	0.91	0.76 - 1.11	.37
- Total effect	1.39	-1.04 – 3.85	.26	1.43	1.11 - 1.86	.007*	1.08	0.96 - 1.23	.20	1.08	0.70 - 1.68	.73	0.90	0.76 - 1.06	.19
SPP															
- ACME	0.06	-1.46 – 1.58	.93	0.87	0.59 - 1.25	.45	0.96	0.86 - 1.06	.44	0.96	0.70 - 1.31	.79	0.99	0.83 - 1.19	.95
- ADE	-0.32	-2.07 – 1.42	.71	1.54	0.98 - 2.44	.07	1.17	0.99 - 1.38	.06	1.17	0.70 - 1.97	.54	0.84	0.66 - 1.04	.11
- Total effect	-0.26	-1.43 – 0.88	.65	1.34	1.01 - 1.79	.043*	1.13	0.99 - 1.28	.07	1.13	0.78 - 1.65	.53	0.83	0.66 - 1.03	.10

Notes. exp, standardised exponentiated regression coefficient, ACME, average causal mediated effect; ADE, average direct effect; log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; CM, Concern over Mistakes; DA, Doubts about Actions; PC, Parental Criticism; PS, Personal Standards; SPP, Socially Prescribed Perfectionism. *$p < .05$, # TST was not log-transformed.

Table A12

Regression coefficients of mediation analysis using stress as a mediator in the relationship between log transformed objective sleep measures and selected subscales of perfectionism with outliers removed (n = 58, simulations = 10,000)

	TST #			logSOL			logWASO			logNOA			logitSE		
Perfectionism	Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p	exp Estimate	CI	p
CM															
- ACME	-0.27	-1.87 – 1.27	.73	0.97	0.75 - 1.25	.82	1.00	0.91 - 1.09	.09	1.02	0.77 - 1.36	.86	0.90	0.78 - 1.03	.14
- ADE	0.99	-1.37 – 3.33	.40	1.27	0.88 - 1.84	.21	1.06	0.90 - 1.27	.24	1.01	0.58 - 1.72	.95	1.02	0.83 - 1.27	.83
- Total effect	0.73	-1.15 – 2.62	.45	1.23	0.91 - 1.67	.18	1.06	0.92 - 1.22	.20	1.04	0.66 - 1.60	.85	0.93	0.77 - 1.12	.43
DA															
- ACME	-0.52	-3.15 – 1.91	.67	1.04	0.87 - 1.27	.67	1.01	0.94 - 1.09	.09	1.02	0.82 - 1.28	.84	0.93	0.82 - 1.02	.12
- ADE	2.90	-1.71 – 7.46	.21	0.98	0.70 - 1.39	.92	1.02	0.86 - 1.22	.20	1.01	0.61 - 1.72	.96	1.02	0.83 - 1.26	.89
- Total effect	2.38	-1.73 – 6.43	.25	0.98	0.76 - 1.39	.88	1.03	0.89 - 1.20	.18	1.03	0.67 - 1.60	.88	0.94	0.77 - 1.15	.56
PC															
- ACME	0.31	-1.31 – 2.13	.68	1.01	0.89 - 1.16	.84	1.01	0.97 - 1.06	.06	1.01	0.88 - 1.19	.85	0.95	0.87 - 1.02	.17
- ADE	-2.74	-6.89 – 1.53	.20	1.13	0.77 - 1.63	.51	1.01	0.88 - 1.16	.15	1.03	0.67 - 1.58	.87	0.97	0.82 - 1.16	.77
- Total effect	-2.42	-6.44 – 1.63	.24	1.15	0.81 - 1.62	.44	1.02	0.89 - 1.17	.16	1.05	0.69 - 1.57	.83	0.93	0.77 - 1.12	.43
PS															
- ACME	-0.19	-1.86 – 1.35	.80	0.97	0.83 - 1.13	.70	1.00	0.94 - 1.06	.99	1.01	0.85 - 1.21	.92	0.95	0.85 - 1.03	.23
- ADE	1.57	-1.40 – 4.45	.29	1.48	1.13 - 1.95	.007*	1.08	0.94 - 1.25	.24	1.07	0.67 - 1.73	.78	0.94	0.79 - 1.13	.48
- Total effect	1.38	-1/12 – 3.84	.28	1.43	1.11 - 1.86	.007*	1.08	0.95 - 1.23	.21	1.08	0.70 - 1.70	.73	0.90	0.75 - 1.06	.20
SPP															
- ACME	0.14	-0.97 – 1.31	.80	0.94	0.74 - 1.17	.60	0.98	0.90 - 1.05	.05	0.99	0.77 - 1.27	.90	0.96	0.84 - 1.07	.47
- ADE	-0.40	-2.17 – 1.36	.66	1.42	1.03 - 1.95	.033*	1.15	1.00 - 1.34	.29	1.15	0.73 - 1.77	.54	0.86	0.70 - 1.07	.18
- Total effect	-0.24	-1.43 – 0.94	.67	1.34	1.05 - 1.72	.020*	1.13	0.99 - 1.28	.25	1.13	0.78 - 1.65	.52	0.83	0.67 - 1.02	.07

Notes. exp, standardised exponentiated regression coefficient, ACME, average causal mediated effect; ADE, average direct effect; log, log-transformed; TST, total sleep time; SOL, sleep onset latency; WASO, wake after sleep onset; NOA, number of awakenings; SE, sleep efficiency; CM, Concern over Mistakes; DA, Doubts about Actions; PC, Parental Criticism; PS, Personal Standards; SPP, Socially Prescribed Perfectionism. *$p < .05$, # TST was not log-transformed.

10.3 Appendix B: Study 2

10.3.1 Published Manuscript Study 2

brain sciences

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Perfectionism Contributes to Sleep-Wake State Discrepancy: The Mediating Role of Pre-Sleep Arousal

Susie Y. Oh [1,2], Christian L. Nicholas [1], Lisa J. Phillips [1], David Cunnington [3], Maya T. Schenker [1,2], Cameron J. Patrick [4], Daniel Windred [5] and Hailey Meaklim [1,5,*]

1 Melbourne School of Psychological Sciences, The University of Melbourne, Parkville, VIC 3010, Australia; ohsy@student.unimelb.edu.au (S.Y.O.); cln@unimelb.edu.au (C.L.N.); lisajp@unimelb.edu.au (L.J.P.); m.schenker@unimelb.edu.au (M.T.S.)
2 Monash University Healthy Sleep Clinic, Turner Institute for Brain and Mental Health, Monash University, Clayton, VIC 3168, Australia
3 Thompson Institute, University of the Sunshine Coast, Birtinya, QLD 4575, Australia
4 Statistical Consulting Centre, School of Mathematics and Statistics, The University of Melbourne, Parkville, VIC 3010, Australia; cameron.patrick@unimelb.edu.au
5 Flagship Sleep Health Program, Flinders Health and Medical Research Institute (FHMRI), Flinders University, Adelaide, SA 5042, Australia
* Correspondence: hailey.meaklim@flinders.edu.au

Abstract

Objectives: Sleep-wake state discrepancy, the discrepancy between self-reported and objective sleep measures, is commonly experienced in poor sleep and insomnia. While perfectionism is implicated in insomnia, its relationship to sleep-wake state discrepancy has not been investigated. This study aimed to assess the association between sleep-wake state discrepancy and perfectionism and explore whether dysfunctional sleep beliefs and pre-sleep arousal mediate that relationship. **Methods:** Sixty adult participants from community and clinical populations were conveniently sampled (85% females, mean age 30.28 ± 11.13 years, 38% with insomnia symptoms). Sleep-wake state discrepancy measures were calculated using data from actigraphy and sleep diary collected over 14 days. The Frost Multidimensional Perfectionism Scale (FMPS), Hewitt–Flett Multidimensional Perfectionism Scale (HFMPS), Dysfunctional Beliefs about Sleep (DBAS), and Pre-sleep Arousal Scale (PSAS) were also collected. **Results:** High perfectionism levels were associated with high levels of sleep-wake state discrepancy. Concern over Mistakes and Doubts about Actions correlated with sleep onset latency discrepancy with small effects (r = 0.26 and 0.29, respectively). Doubts about Actions was associated with sleep onset latency discrepancy. Furthermore, pre-sleep arousal and cognitive pre-sleep arousal mediated relationships between sleep onset latency discrepancy and Concern over Mistakes and Doubts about Actions. **Conclusions:** Concern over Mistakes and Doubts about Actions relate to a poorer perception of sleep relative to objective sleep measures. During sleep onset, cognitive pre-sleep arousal appears to mediate relationships between perfectionism and sleep-wake state discrepancy. Therefore, perfectionism may be an important cognitive-emotional factor to consider when assessing and treating sleep-wake state discrepancy that commonly accompanies insomnia.

Keywords: perfectionism; sleep-wake state discrepancy; sleep misperception; insomnia; actigraphy; sleep health

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1. Introduction

Poor sleep is a common and burdensome condition. Insomnia symptoms reflecting poor sleep can include difficulties initiating and/or maintaining sleep and/or dissatisfaction with sleep quality. While insomnia disorder is a formal diagnostic category requiring persistent sleep difficulties, significant daytime impairment, and occurring at least three times per week for a minimum of three months [1], the focus of this paper is on the broader experience of insomnia symptoms that reflect poor sleep, given their significant prevalence and impact even in the absence of a formal diagnosis. For example, in an Australian general population survey, 50% reported at least one insomnia symptom of difficulties initiating or maintaining sleep, while only 23% met diagnostic criteria for insomnia disorder [2]. Insomnia symptoms adversely affect general health and mental well-being, costing Australia an estimated USD 13.3 billion in 2019–2020 in lost productivity and healthcare-related costs [3,4]. It is therefore critical to identify the behavioural, emotional, and cognitive processes that contribute to poor sleep quality and insomnia symptoms.

Sleep quality can be measured by subjective reports or objectively using tools, such as polysomnography (PSG) and actigraphy. Subjective reports of poor sleep and insomnia symptoms rely on an individual's self-reported perception of sleep and daytime functioning. Objective measures include PSG, which relies on multiple signals to measure sleep (e.g., electroencephalogram, electromyography), and actigraphy, which uses an accelerometer to infer sleep from physical activity in a simple, portable wrist-worn device [5]. Despite the benefits of capturing one night of comprehensive sleep data via PSG, actigraphy offers significant cost advantages and facilitates the collection of multiple nights of ecological sleep data from participants' natural sleep environment [6].

The outcomes from self-reported sleep measures can differ from those obtained via objective measurement. It is estimated that 8 to 66% of people with insomnia self-reported their sleep to be worse (i.e., reporting less sleep and more wakefulness during the same sleep opportunity) compared to objective sleep measures [7]. On the other hand, good sleepers have been found to exhibit the opposite pattern of overestimating their sleep compared to objective sleep measures [8]. The discrepancy in sleep estimation between self-reported and objective measures of sleep is referred to by various names: sleep-state misperception, sleep misestimation, paradoxical insomnia, and subjective-objective sleep discrepancy. The term sleep-wake state discrepancy is used in this manuscript, adopting a recent recommendation that highlighted the importance of maintaining neutrality in the study of this discrepancy without implying the individual as inaccurate or incorrect, since its underlying mechanisms remain unknown [9,10]. While sleep-wake state discrepancy is not always a symptom of poor sleep, it is found with both PSG and actigraphy studies across various insomnia population groups [8,11–17]. Furthermore, compared to normal estimators, under- and over-estimators of sleeping time were found to report a lower quality of life [18]. Therefore, it is important to further our understanding of sleep-wake state discrepancy and any factors that may worsen this phenomenon.

Cognitive-emotional factors play an important role in insomnia and sleep-wake state discrepancy. Personality traits, rumination, anxiety and pre-sleep arousal all influence an individual's perception of sleep and wakefulness, as well as sleep duration [19–26]. Specifically, perfectionism is a cognitive-emotional personality construct that has been suggested as a predisposing and possible perpetuating factor for insomnia [27,28]. An individual with heightened perfectionism is broadly characterised by having unrelenting standards and being excessively critical of one's own performance and behaviours [29,30]. Past research has identified specific facets of perfectionism, including Concern over Mistakes (reacting adversely to and perceiving mistakes as failures), Doubts about Actions (having doubts or feeling uncertain about one's own behaviours) and Socially Prescribed

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Perfectionism (believing others expect one to be perfect), to be associated with both objective and self-reported markers of poor sleep [27,31–50]. Notably, our previous study showed that perfectionism relates more strongly to self-reported than objective markers of poor sleep, and those who self-reported higher levels of sleep onset latency and lower sleep efficiency also reported higher levels of perfectionism [44]. However, whether sleep-wake discrepancy exists in individuals with perfectionism and how perfectionism may play a role in sleep-wake state discrepancy remains unknown.

Poor sleep may be maintained by an interaction between cognitive sleep beliefs (e.g., "I must get eight hours of sleep to function properly") and hyperarousal with perfectionism. Riemann et al. [51] indicated that hyperarousal is a key feature in cognitive and/or neurobiological-based insomnia models, some of which attempt to account for the phenomenon of sleep-wake state discrepancy [10,52–58]. Pre-sleep arousal, a form of hyperarousal, can occur as somatic and/or cognitive activation during the transition to sleep, and is disruptive to sleep initiation and maintenance [59]. Somatic or physiological arousals relate to physical sensations experienced from a racing heart, bodily tensions, jitteriness or nervousness, while cognitive arousals relate to worries or a racing mind that is difficult to control. Hyperarousal and pre-sleep cognitive arousal have been found to be associated with sleep-related metacognitive processes in insomnia, which may contribute to sleep-wake state discrepancy [10,60]. Furthermore, dysfunctional beliefs about sleep, worry, and attentional bias have been suggested to perpetuate insomnia and are linked to sleep-wake state discrepancy [10,61]. Given that perfectionism is associated with higher physiological arousals and that individuals with perfectionistic concerns can become anxious about their sleep performance and subsequent effects of poor sleep to drive cognitive and emotional arousals, perfectionism is theorised to be a risk factor for poor sleep and may contribute to sleep-wake state discrepancy [51,57,62,63].

Additionally, anxiety and stress, dysfunctional beliefs about sleep, counterfactual processing and arousability have been identified as mediators in the relationship between perfectionism and poor sleep [32,33,38,44,46,48,50]. In a recent network analysis study, Zhao et al. [64] found direct associations between insomnia severity, dysfunctional beliefs and attitudes about sleep and hyperarousal. Furthermore, hyperarousal was identified as a key node linking insomnia and perfectionism, whereby Concern over Mistakes, Doubt about Actions, Parental Expectations and Personal Standards were positively associated with hyperarousal. In another study, it was suggested that potential interaction effects between perfectionism and pre-sleep arousal perpetuated insomnia symptoms based on the observation that individuals with high Concern over Mistakes and Doubts about Actions experienced poorer sleep on days of higher pre-sleep arousal [65]. To date, no study has explored whether and how perfectionism relates to hyperarousal or dysfunctional sleep beliefs and the impact this may have on sleep-wake state discrepancy.

This study extends our previous work, which found stronger relationships between perfectionism and self-reported sleep measures compared to objective sleep measures [44]. We aim to investigate whether sleep-wake state discrepancy plays a role in the relationships between perfectionism and poor sleep by (1) exploring the relationships between dimensions of perfectionism and measures of sleep-wake state discrepancy, and (2) investigating whether dysfunctional sleep beliefs and attitudes and pre-sleep arousal mediate the relationships between perfectionism and sleep-wake state discrepancy. No a priori hypothesis was made, given a lack of past research findings, and these aims are considered explorative.

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2. Materials and Methods

2.1. Participants

Participants, aged 18 years and above, were recruited from the University of Melbourne's Research Experience Program, through social media and word of mouth or referred from the Melbourne Sleep Disorder Centre by their sleep physician. Participants from the Research Experience Program were undergraduate psychology students who responded to an online advertisement at the University of Melbourne, Australia, to receive course credit for participation in the screening survey. Potential participants from all recruitment pathways were assessed for study eligibility by completing an online screening survey via Qualtrics (https://www.qualtrics.com, URL accessed on 09 January 2021). A diagnosis of clinical insomnia was not required for participation, but participants were required to self-report levels of insomnia symptomology using the Insomnia Severity Index (ISI) [66]. Therefore, the final sample consisted of participants from both clinical and general populations. Participants who reported the following were excluded: (a) current diagnosis of mental illness; (b) central nervous disorder; (c) prior head injury; (d) shift work, defined as paid employment with rotating shifts or including work hours outside of 7:00 AM to 6:00 PM, or starting work before 7:00 AM or after 2:00 PM; (e) symptoms consistent with sleep disorders other than insomnia (e.g., restless leg syndrome, obstructive sleep apnoea).

Initially, 1132 screening responses were obtained. After excluding duplicate or incomplete responses and those who declined to proceed with further study participation, 243 eligible participants were contacted for further study participation. Sixty-five participants agreed and participated in the two-week actigraphy sleep study, which resulted in a final sample of 60 after excluding participants with actigraphy recording errors (i.e., due to non-wear and/or data corruption) and/or incomplete survey responses. In the final sample, 7% were recruited from Melbourne Sleep Disorder Centre, 35% from the Research Experience Program, and 58% from social media or by word of mouth. Objective and self-reported sleep data from this current sample were previously analysed and published [44]. Using the same sample, the current study extends this work by investigating sleep-wake state discrepancy.

Informed written consent was obtained online from all participants. Upon completing the actigraphy sleep study, each participant received a $25 online gift voucher. The Human Research Ethics Committee at the University of Melbourne granted approval of this research study (HREC ID 1955374).

2.2. Sleep and Sleep-Related Measures

Collection of both self-reported and objective sleep measures occurred throughout the 14-day actigraphy study. The Pittsburgh Sleep Diary (PSD) [67] was delivered to participants' smartphones daily via the Smartphone Ecological Momentary Assessment app (SEMA3) [68]. The PSD facilitated calculation of self-reported total sleep time (TST), sleep onset latency (SOL) and wake after sleep onset (WASO) by capturing daily self-reports of bedtime, lights out time, minutes to sleep, waketime, etc. To measure objective sleep, participants wore GENEActiv devices (Activinsights, Cambridge, UK) on their non-dominant wrist, recording accelerometer data at 40 Hz. GENEActive PC Software (version 3.3) was used to extract the accelerometer data before being processed with GGIR (version 2.6.0) using R (version 4.0.5). Sleep recordings were extracted based on T3A10 GGIR parameters, which detected sleep by the absence of arm angle changes above 10-degrees for at least 3 min. This setting was chosen over its default T5A5 setting because GGIR's validation against polysomnography suggested that a reduced time window and increased angle threshold improved sensitivity in sleep detection [69]. Sleep recordings were evaluated and

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used to calculate objective TST and WASO. Objective SOL was calculated as the difference between participants' self-reported lights-out time and GGIR-defined sleep onset time.

SWSD calculations. Daily sleep-wake state discrepancies were calculated as the differences between self-reported and objective measures of SOL, WASO and TST, as these arithmetic differences are most commonly used as measures of sleep discrepancy [70]. Higher discrepancy values indicated higher self-reported estimates of each sleep measure compared to objective sleep. After adjusting for missing or unusable data, the score for each sleep-wake state discrepancy variable for each participant was calculated as an average over the number of nights where usable data were recorded over the 14 days.

Insomnia Severity Index. At the end of the 14-day actigraphy sleep study, participants completed the Insomnia Severity Index (ISI) [66], which is a self-reported questionnaire measuring the nature, severity and impact of insomnia over the past two weeks. The ISI has 7 items, which are rated on a 5-point Likert scale from 0 (no problem) to 4 (very severe problem), with a total score ranging from 0 to 28. It has a good sensitivity of 86.1% and specificity at 87.7% for identifying insomnia in a community sample using a cut-off score of 10, and excellent internal consistency with Cronbach alphas of 0.90 and 0.91 for community and clinical samples, respectively [71].

Dysfunctional Beliefs and Attitudes about Sleep Scale and Pre-Sleep Arousal Scale. Other sleep-related measures collected at the start of the actigraphy sleep study period were the abbreviated version of the Dysfunctional Beliefs and Attitudes about Sleep Scale (DBAS) [61] and the Pre-Sleep Arousal Scale (PSAS) [59]. The DBAS consists of 16 items assessing the degree of dysfunctional sleep/insomnia-related thoughts, where each item is rated on a Likert scale from 0 (strongly disagree) to 10 (strongly agree). The DBAS covers four subscales of sleep-related thoughts that include two items on expectations about sleep (DBAS-E), six items on worries about sleep (DBAS-W), five items on consequences of insomnia (DBAS-C) and three items on beliefs about sleep medication (DBAS-M). All its subscales and total score range from 0 to 10 (average across the items), with a higher score indicating a higher level of dysfunctional beliefs and attitudes about sleep/insomnia. The DBAS is both internally consistent and stable over time, with Cronbach alphas of 0.77 in the clinical sample and 0.79 in the research sample, and a test-retest correlation coefficient of 0.83 [61]. The PSAS measures the level of arousal experienced at bedtime when attempting to initiate sleep. It includes two subscales consisting of eight somatic arousal (PSAS-S) symptoms and eight cognitive arousal (PSAS-C) symptoms. Each item is rated on a 5-point Likert scale from 1 (not at all) to 5 (extremely), giving rise to subscale scores ranging from 8 to 40, where higher scores indicate higher levels of arousal before falling asleep. The PSAS has good internal consistency with Cronbach's alphas of PSAS-S and PSAS-C, ranging from 0.79 to 0.84 and 0.67 to 0.88 in college students, normal sleepers and insomniacs, respectively; as well as good temporal reliability with test-retest correlations of 0.76 for PSAS-S and 0.72 for PSAS-C [59].

2.3. Perfectionism Measures

The Frost Multidimensional Perfectionism Scale (FMPS) [29] and Hewitt–Flett Multidimensional Perfectionism Scale (HFMPS) [30] were used to assess the multidimensions of perfectionism. The FMPS has 35 items, which are rated on a Likert scale from 1 (disagree strongly) to 5 (agree strongly). These items form 6 subscales: Concern over Mistakes (reacting adversely to and perceiving mistakes as failures), Doubts about Actions (having uncertainty about one's performance), Parental Expectations (perceiving parents to set high standards for oneself), Parental Criticism (perceiving parents as being highly critical of oneself), Personal Standards (having high self-evaluation standards) and Organisation (preferring order and structure). Refer to Table 1 for the score range of each subscale and

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total FMPS, which excludes the Organisation subscale. Higher scores indicate higher levels of perfectionism. Each subscale has good internal consistency with Cronbach's alphas and reliability coefficients ranging from 0.77 to 0.93 and 0.77 to 0.94, respectively [29]. The HFMPS has 45 items, which are rated on a Likert scale from 1 (disagree) to 7 (agree), and three subscales: Self-oriented Perfectionism (expecting oneself to have high standards), Other-oriented Perfectionism (expecting others to have high standards) and Socially Prescribed Perfectionism (perceiving others to set high standards for oneself). Each subscale has a score range of 7 to 105, with higher levels of perfectionism indicated by higher scores. Each subscale has good internal consistency with Cronbach's alphas ranging from 0.74 to 0.88 [30].

Table 1. Mean scores, standard deviations, and sample range for measures of perfectionism, dysfunctional sleep beliefs and attitudes, and pre-sleep arousal for all participants.

	M	*SD*	**Sample Range (Score Range)**
FMPS	86.9	19.69	41–141 (29–145)
Concern over Mistakes	26.92	8.18	11–45 (9–45)
Doubts about Actions	11.87	3.77	5–20 (4–20)
Parental Criticism	9.37	4.04	4–20 (4–20)
Parental Expectation	13.2	4.54	6–25 (5–25)
Organisation	24.58	3.43	15–30 (6–30)
Personal Standards	25.58	5.65	9–35 (7–35)
HFMPS	177.2	29.85	100–238 (45–315)
Self-oriented Perfectionism	72.3	14.9	33–105 (15–105)
Other-oriented Perfectionism	52.48	13.36	23–81 (15–105)
Socially Prescribed Perfectionism	52.47	13.37	28–105 (15–105)
DBAS	4.68	1.91	0.44–10 (0–10)
DBAS-Expectations	6.46	2.70	0–10 (0–10)
DBAS-Worries	4.23	2.37	0–10 (0–10)
DBAS-Consequences	5.59	2.19	0.40–10 (0–10)
DBAS-Medication	2.88	2.18	0–10 (0–10)
PSAS	34.93	12.60	17–79 (16–80)
PSAS-Somatic	14.05	5.35	8–39 (8–40)
PSAS-Cognitive	20.88	8.32	8–10 (8–40)

Notes. FMPS, Frost Multidimensional Perfectionism Scale; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; DBAS, Dysfunctional Beliefs and Attitudes about Sleep; PSAS, Pre-Sleep Arousal Scale.

2.4. Study Protocol

After initial screening and prior to beginning the actigraphy study, the lead researcher (S.O.) met with each participant either in-person or online via Zoom (https://zoom.au, URL accessed on 21 April 2021). During this meeting, participants completed the FMPS, HFMPS, DBAS and PSAS; and were set up with or sent via post (prior to the online meeting) an actigraphy watch and given explanations about the actigraphy watch and study protocol. The accelerometer was worn by participants on their non-dominant wrist 24 h a day over the 14-day actigraphy study period. Removal of the accelerometer was allowed during swimming, contact sports and/or to meet work requirements. Over the 14 days, participants received daily notifications and reminders via SEMA3 within specific data collection input timeframes to fill in the PSD (e.g., participants were prompted and allowed to fill in the morning diary between 7:30 AM and 1:30 PM and the bedtime diary between 8:30 PM and 12:30 AM). At the end of the actigraphy study period, participants completed the ISI, were debriefed and thanked in a meeting, and received remuneration.

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2.5. Statistical Analysis

All analyses were conducted using the statistical software package R (version 4.3.0). Due to the exploratory nature of this study, the relationships between perfectionism and sleep were assessed by correlation, regression, and mediation analyses. Firstly, the associations between perfectionism and sleep-wake state discrepancy were analysed using Pearson correlations, which were deemed to have a small effect at 0.10, a medium effect at 0.30, or a large effect at 0.50 [72]. Prior to further analysis, sleep-wake state discrepancy measures SOL_D (discrepancy in sleep onset latency), WASO_D (discrepancy in wake after sleep onset) and TST_D (discrepancy in total sleep time), which were derived from diary-actigraphy differences (sleep diary minus actigraphy) were visually inspected. Overall, model assumptions of normality were met.

A series of regression models was conducted for each combination of perfectionism variable (FMPS-total, HFMPS-total and subscale scores as independent variables) and sleep-wake state discrepancy measure (SOL_D, WASO_D, TST_D) as dependent variable. Age and gender were included as covariates. Using DBAS and PSAS and subscale scores as mediators, a series of mediation analyses were conducted for each selected combination of perfectionism subscale (Concern over Mistakes, Doubts about Actions) and each sleep-wake state discrepancy measure (SOL_D, WASO_D and TST_D). As per O'Rourke and MacKinnon [73], mediation analyses were conducted despite the absence of a significant total effect. The alpha level for the two-tailed analyses was set at $p < 0.05$.

3. Results

3.1. Descriptive Statistics

Sixty participants were aged 18–66 years ($M = 30.28$, $SD = 11.13$), with 85.0% identifying as female. Means and standard deviations of FMPS, HFMPS, DBAS and PSAS scores are presented in Table 1. Participants' ISI scores ranged from 0 to 25 ($M = 7.48$, $SD = 5.92$), with 38.3% ($n = 23$) classed as a 'poor sleeper' based on an ISI score above 9, which classifies insomnia cases in community samples [71]. For the remainder of this paper, a 'poor sleeper' refers to participants with insomnia symptoms reporting an ISI score of greater than 9. Mean and standard deviation of sleep and discrepancy measures for the total sample, poor sleepers and good sleepers are presented in Figure 1.

Results in Table 2 show that, compared to actigraphy, participants classified as poor sleepers self-reported worse sleep than good sleepers. First, poor sleepers reported significantly higher SOL than good sleepers ($p < 0.01$) despite no significant difference in their actigraphy-derived SOL. Second, good sleepers, but not poor sleepers, significantly underestimated WASO compared to actigraphy ($p < 0.01$), even though their objective measures of WASO were not statistically different. Third, good sleepers reported significantly lower WASO than poor sleepers ($p = 0.020$). Therefore, good sleepers perceived better sleep with much less WASO across the night than was measured by actigraphy and when compared to poor sleepers, even though their objective WASO was not different to that of poor sleepers. Furthermore, good sleepers overestimated TST relative to actigraphy ($p < 0.01$) and reported higher TST ($p = 0.049$) despite having no difference in objective TST compared to poor sleepers. Given the lack of power, no further analysis was conducted on group differences in sleep discrepancy measures. Mean and standard deviation of self-reported and objective sleep parameters for all participants as a group can be found in the Supplementary Material Table S1.

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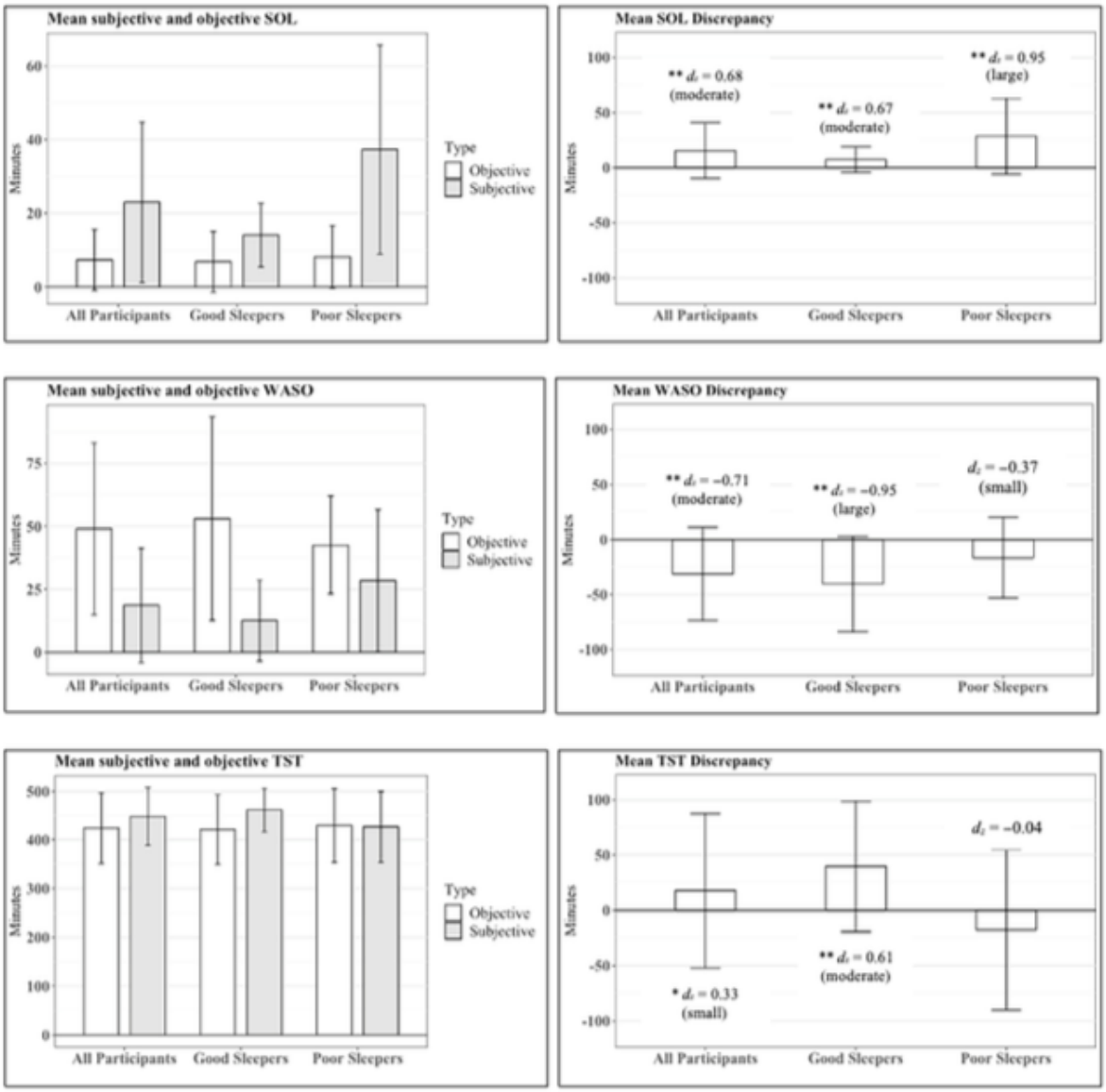


Figure 1. Sleep-wake state discrepancy measures across groups (mean and standard deviation). Notes. SOL = sleep onset latency; WASO = wake after sleep onset; TST = total sleep time. In discrepancy measures, a positive score denotes overestimation while a negative score denotes underestimation. Vertical lines depict standard deviation. Asterisk indicates a significant difference between self-reported and objective measures of sleep parameters, with Cohen's d_z effect size presented. * $p < 0.05$, ** $p < 0.01$.

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Table 2. Mean scores and standard deviations of sleep measures by groups with within and between-group differences.

	Self-Reported	**Objective**	**Within-Group Difference**
	SOL_S	SOL_O	SOL (*t*-value)
Good sleepers	14.07 ± 8.58	6.84 ± 8.17	4.09 **
Poor sleepers	37.28 ± 28.29	8.20 ± 8.44	4.57 **
Between-group difference (*t*-value)	3.83 **	0.62	
	WASO_S	WASO_O	WASO (*t*-value)
Good sleepers	12.58 ± 16.05	53.04 ± 40.27	−5.76 **
Poor sleepers	28.40 ± 28.25	42.54 ± 19.41	−1.77
Between-group difference (*t*-value)	2.45 *	−1.35	
	TST_S	TST_O	TST (*t*-value)
Good sleepers	461.20 ± 44.96	421.07 ± 71.53	3.68 **
Poor sleepers	426.51 ± 73.40	429.38 ± 75.73	−0.19
Between-group difference (*t*-value)	−2.04 *	−0.43	

Notes. SOL = sleep onset latency; WASO = wake after sleep onset; TST = total sleep time. * $p < 0.05$, ** $p < 0.01$.

3.2. Correlation and Regression Analyses of Sleep-Wake State Discrepancy Measures and Perfectionism

Results in Tables 3 and 4 show significant positive correlations were found between SOL_D (discrepancy in sleep onset latency) and Concern over Mistakes ($r = 0.26$, $p = 0.041$) and Doubts about Actions ($r = 0.29$, $p = 0.023$), which were considered to have small-to-medium effects [72]. However, only Doubts about Actions was associated with sleep onset discrepancy in regression analysis, as no other perfectionism scale or subscales were significant predictors of the various sleep-wake state discrepancy measures.

3.3. Mediation Analyses Using DBAS and PSAS as Mediators in the Relationships Between Sleep Discrepancy Measures and Selected Measures of Perfectionism

Results from the mediation analyses largely mirrored the results from the regression analyses. None of the mediation analyses using DBAS, DBAS subscales, or the PSAS somatic subscale as mediators were significant (see Tables S2–S9 in Supplementary Material). Given results relating to SOL_D are in line with sleep-wake state discrepancy typically found in insomnia; results relating to SOL_D are presented here. All mediation analysis results relating to WASO_D and TST_D can be found in Tables S2–S9 in the Supplementary Material. As shown in Figure 2, while the total effect of Concern over Mistakes on SOL_D was not significant, the mediation effect of PSAS and PSAS-Cognition on that relationship was significant. An increase in Concern over Mistakes is associated with a larger discrepancy in SOL (higher perceived SOL relative to objective SOL) via PSAS and PSAS-Cognition as mediators. Similarly, the relationship between Doubts about Actions and SOL_D was mediated by PSAS and PSAS-Cognition. Included in Figure 2 for comparison, the mediation analyses using DBAS as a mediator in the relationships between Concern over Mistakes and Doubts about Actions with SOL_D were not significant. Considering the number of analyses conducted in the current study, which could increase the risk of Type 1 error, results should be interpreted with caution.

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Table 3. Correlations between sleep discrepancy measures, perfectionism, sleep beliefs and attitude and pre-sleep arousal.

n = 60	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. SOL_D																					
2. WASO_D	0.32 *																				
3. TST_D	−0.66 **	−0.73 **																			
4. FMPS	0.23	0.01	−0.14																		
5. CM	0.26 *	0.01	−0.15	0.88 **																	
6. DA	0.29 *	0.02	−0.21	0.71 **	0.62 **																
7. PC	0.08	−0.06	−0.02	0.71 **	0.48 **	0.42 **															
8. PE	−0.05	−0.05	0.05	0.62 **	0.30 *	0.19	0.72 **														
9. O	0.01	0.03	0.03	0.09	0.07	0.08	−0.16	0.03													
10. PS	0.22	0.11	−0.18	0.74 **	0.62 **	0.44 **	0.20	0.29 *	0.26 *												
11. HFMPS	0.09	−0.01	−0.09	0.79 **	0.70 **	0.52 **	0.46 **	0.45 **	0.13	0.70 **											
12. SOP	0.14	−0.01	−0.09	0.72 **	0.67 **	0.53 **	0.25	0.23	0.29 *	0.82 **	0.76 **										
13. OOP	−0.13	0.08	−0.07	0.20	0.13	0.05	0.20	0.25	−0.08	0.13	0.56 **	0.02									
14. SPP	0.18	−0.09	−0.03	0.76 **	0.67 **	0.53 **	0.55 **	0.50 **	0.05	0.52 **	0.83 **	0.57 **	0.22								
15. DBAS	0.10	−0.03	0.06	0.47 **	0.39 **	0.36 **	0.34 **	0.33 *	0.32 *	0.31 *	0.42 **	0.37 **	0.03	0.49 **							
16. DBAS-E	−0.20	0.16	0.20	0.19	0.06	0.20	0.22	0.22	0.40 **	0.10	0.15	0.19	−0.01	0.13	0.60 **						
17. DBAS-W	0.13	0.04	−0.02	0.46 **	0.42 **	0.30 *	0.31 *	0.30 *	0.21	0.33 **	0.46 **	0.35 **	0.10	0.53 **	0.92 **	0.37 **					
18. DBAS-C	0.13	−0.09	0.09	0.41 **	0.33 *	0.43 **	0.29 *	0.23	0.30 *	0.29 *	0.33 *	0.33 **	0.02	0.34 **	0.86 **	0.57 **	0.66 **				
19. DBAS-M	0.12	0.06	0.02	0.33 **	0.29 *	0.19	0.25	0.30 *	0.21	0.18	0.27 *	0.24	−0.11	0.45 **	0.74 **	0.19	0.71 **	0.45 **			
20. PSAS	0.37 **	0.16	−0.32 *	0.51 **	0.54 **	0.51 **	0.22	0.13	0.01	0.39 **	0.48 **	0.49 **	−0.06	0.59 **	0.57 **	0.09	0.59 **	0.48 **	0.49 **		
21. PSAS-S	0.21	0.08	−0.19	0.40 **	0.42 **	0.41 **	0.28 *	0.12	−0.10	0.22	0.45 **	0.37 **	0.00	0.58 **	0.46 **	0.04	0.48 **	0.37 **	0.42 **	0.88 **	
22. PSAS-C	0.42 **	0.18	−0.36 **	0.51 **	0.54 **	0.51 **	0.16	0.13	0.08	0.44 **	0.44 **	0.50 **	−0.09	0.51 **	0.56 **	0.11	0.57 **	0.48 **	0.47 **	0.95 **	0.68 **

Notes. SOL_D = discrepancy in sleep onset latency; WASO_D = discrepancy in wake after sleep onset; TST_D = discrepancy in total sleep time; FMPS = Frost Multidimensional Perfectionism Scale; CM = Concern over Mistakes; DA = Doubts about Actions; PE = Parental Expectations; PC = Parental Criticism; O = Organisation; PS = Personal Standards; HFMPS = Hewitt–Flett Multidimensional Perfectionism Scale; SOP = Self-oriented Perfectionism; OOP = Other-oriented Perfectionism; SPP = Socially Prescribed Perfectionism; DBAS = Dysfunctional Beliefs and Attitudes about Sleep; DBAS-E = DBAS subscale Sleep Expectations; DBAS-W = DBAS subscale Worry about Sleep; DBAS-C = DBAS subscale Consequences of Insomnia; DBAS-M = DBAS subscale Medication; PSAS = Pre-sleep Arousal Scale; PSAS-S = Somatic subscale of the Pre-sleep Arousal Scale; PSAS-C = Cognitive subscale of the Pre-sleep Arousal Scale. * $p < 0.05$ ** $p < 0.01$.

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Table 4. Regression coefficients between sleep discrepancy measures and perfectionism.

n = 60	SOL_D			WASO_D			TST_D		
	β	95% *CI*	*p*	*β*	95% *CI*	*p*	*β*	95% *CI*	*p*
FMPS	0.28	−0.06, 0.62	0.11	0.08	−0.50, 0.66	0.78	−0.51	−1.45, 0.44	0.29
CM	0.75	−0.06, 1.57	0.07	0.23	−1.19, 1.64	0.75	−1.36	−3.66, 0.94	0.24
DA	1.87	0.14, 3.61	0.03 *	0.42	−2.60, 3.45	0.78	−3.87	−8.74, 1.00	0.12
PC	0.44	−1.22, 2.09	0.60	−0.58	−3.36, 2.19	0.67	−0.29	−4.86, 4.28	0.90
PE	−0.40	−1.88, 1.09	0.59	−0.35	−2.84, 2.14	0.78	0.90	−3.20, 5.00	0.66
O	0.07	−1.93, 2.07	0.95	0.23	−3.13, 3.59	0.89	1.38	−4.13, 6.90	0.62
PS	0.97	−0.19, 2.13	0.10	0.83	−1.16, 2.81	0.41	−2.01	−5.25, 1.23	0.22
HFMPS	0.06	−0.17, 0.29	0.60	0.04	−0.35, 0.42	0.85	−0.27	−0.90, 0.36	0.39
SOP	0.21	−0.24, 0.66	0.35	0.21	−0.24, 0.66	0.35	−0.37	−1.62, 0.88	0.56
OOP	−0.28	−0.79, 0.23	0.28	0.35	−0.51, 1.21	0.41	−0.57	−1.98, 0.85	0.43
SPP	0.31	−0.20, 0.82	0.23	−0.18	−1.04, 0.69	0.68	−0.34	−1.77, 1.08	0.63

Notes. SOL_D = discrepancy in sleep onset latency; WASO_D = discrepancy in wake after sleep onset; TST_D = discrepancy in total sleep time; FMPS = Frost Multidimensional Perfectionism Scale; CM = Concern over Mistakes; DA = Doubts about Actions; PE = Parental Expectations; PC = Parental Criticism; O = Organisation; PS = Personal Standards; HFMPS = Hewitt–Flett Multidimensional Perfectionism Scale; SOP = Self-oriented Perfectionism; OOP = Other-oriented Perfectionism; SPP = Socially Prescribed Perfectionism. * $p < 0.05$.

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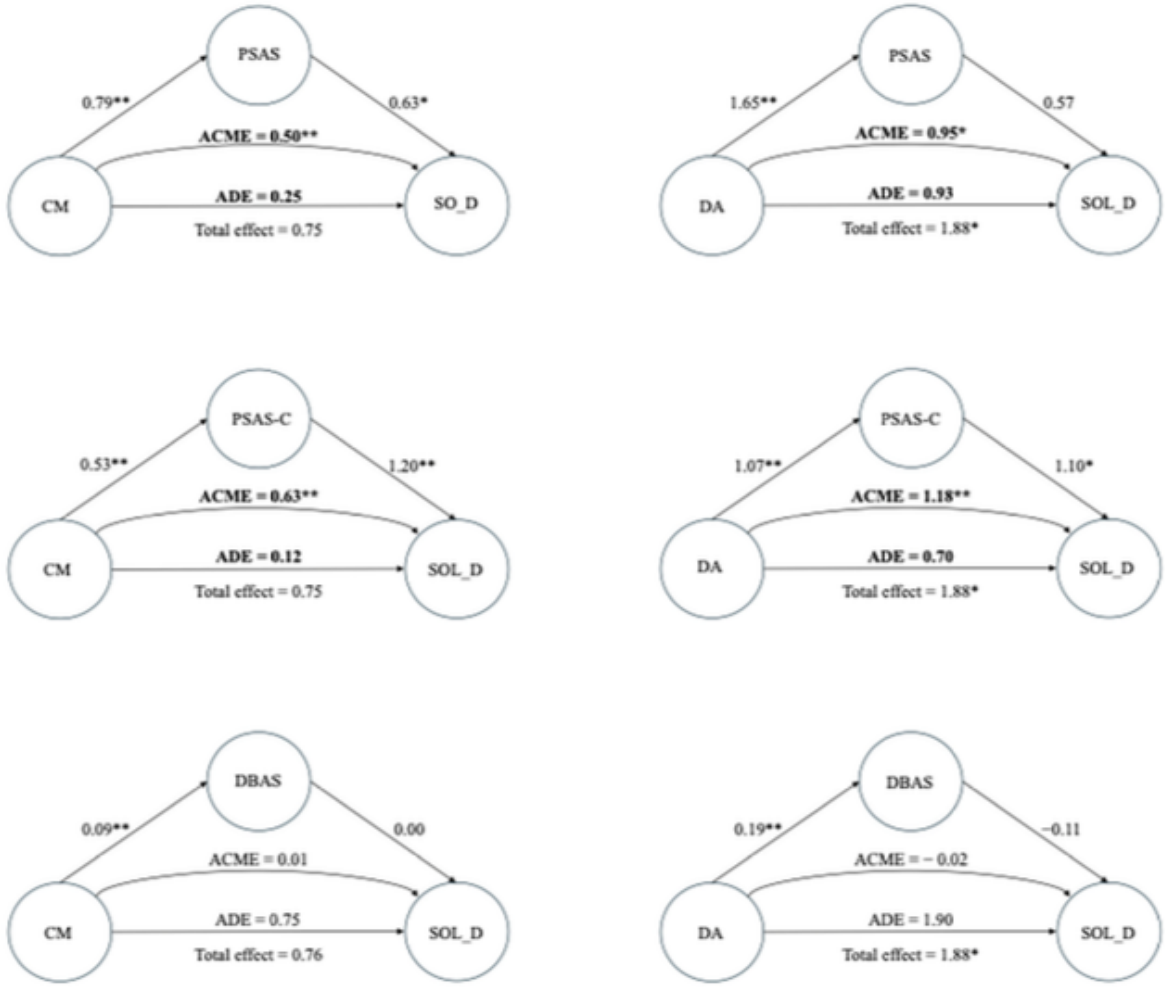


Figure 2. Results from mediation analyses using PSAS, PSAS Cognitive arousal subscale and DBAS as a mediator in the relationship between sleep onset latency discrepancy and Concern over Mistakes and Doubts about Actions subscales of perfectionism (n = 60, simulations = 10,000). Notes. ACME = average causal mediation effects; ADE = average direct effects; CM = Concerns over Mistakes; DA = Doubts about Actions; PSAS = Pre-Sleep Arousal Scale; PSAS-C = Pre-Sleep Arousal Scale Cognitive arousal subscale; DBAS = Dysfunctional Beliefs and Attitudes about Sleep Scale; SOL_D = discrepancy in sleep onset latency. * $p < 0.05$, ** $p < 0.01$.

4. Discussion

This study explored the relationships between dimensions of perfectionism and sleep-wake state discrepancy, as measured by self-reported and actigraphy-derived objective sleep measures. It was explored whether these relationships were mediated by dysfunctional sleep beliefs and attitudes and pre-sleep arousal. Results showed that individuals who reported higher levels of perfectionism also demonstrated higher levels of sleep-wake state discrepancy. Specifically, those who reported higher levels of Concern over Mistakes and Doubts about Actions also reported higher discrepancy in sleep onset latency. Furthermore, Doubts about Actions was a significant predictor of sleep onset latency discrepancy, and that relationship was mediated by pre-sleep arousal and cognitive pre-sleep arousal. Pre-sleep arousal and cognitive pre-sleep arousal also mediated the relationship between Concern

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over Mistakes and sleep onset latency discrepancy. Overall, these results suggest certain aspects of perfectionism (i.e., Concern over Mistakes and Doubts about Actions) relate to a poorer perception of sleep relative to objective sleep measures. Exploratory analyses suggest that cognitive pre-sleep arousal may mediate this relationship and is associated with sleep-wake state discrepancy during sleep onset.

Compared to actigraphy, poor sleepers in the current study perceived their sleep to be worse than that of good sleepers despite having similar or better objective sleep measures. This is consistent with the results of previous studies examining the sleep-wake state discrepancy in insomnia patients and healthy controls using actigraphy [8,12,16,74]. The current findings suggest that sleep-wake state discrepancy may play a role in the relationship between perfectionism and poor sleep. The correlations between perfectionism dimensions of Concern over Mistakes and Doubts about Actions with discrepancy in sleep onset latency, as well as the significant association between Doubts about Actions and sleep onset latency discrepancy, are consistent with past research findings that identified these facets of perfectionism to be associated with markers of poor sleep and insomnia [27,31–33,35,38,39,44,46–50]. It also suggests sleep-wake state discrepancy may account for the stronger relationship that perfectionism has with self-reported compared to objective markers of poor sleep, as found in our previous study [44]. Given that sleep-wake state discrepancy is commonly experienced by people with insomnia, this provides a new line of preliminary evidence to support the theory that perfectionism may serve as a predisposing and potential perpetuating factor for insomnia [7,27,28].

We observed self-reported overestimation of sleep onset latency and total sleep time, and underestimation of wake after sleep onset relative to actigraphy measures. This is consistent with findings from a large community sample of women in the United States by Lehrer et al. [75]. These findings may appear to contradict past research indicating that patients with insomnia tend to underestimate total sleep time relative to objective measures of sleep using actigraphy [10,76,77]. However, the difference may be accounted for by our current predominant community-based sample compared to clinical samples used in previous studies. This finding is also consistent with past demographic studies showing that sleep tends to be overestimated in the general population [18,20,78,79]. Furthermore, some studies have also reported the underestimation of self-reported WASO relative to objective WASO using actigraphy and polysomnography [11,12,16]. Given that actigraphy proxies sleep via a lack of body movement, the detection of minor body movement during sleep as wake could have also contributed to the overestimation of WASO relative to self-report [69,80,81].

Although both good and poor sleepers in our sample underestimated wake after sleep onset, the difference between self-reported and actigraphy-derived wake after sleep onset was not significant in poor sleepers, but it was significant in good sleepers. This is consistent with the finding that people with insomnia perceive their wake after sleep onset to be consistent with actigraphy-derived wake after sleep onset [8]. It also aligns with the recommendation that, unlike actigraphy measures of sleep onset latency and total sleep time, actigraphy wake after sleep onset is considered imprecise compared to polysomnography in assessing and treating adult insomnia [82]. Given the above and that self-reported total sleep time was derived using wake after sleep onset, we focused our attention on sleep onset latency discrepancy.

Pre-sleep arousal, specifically cognitive pre-sleep arousal, mediated the relationship between sleep onset latency discrepancy and Doubts about Actions, as well as Concern over Mistakes. This current finding parallels past research that identified arousability and counterfactual processing as mediators in the relationship between perfectionism and poor sleep [38,46,48]. It is also consistent with recent research supporting the role of

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hyperarousal and pre-sleep arousal in insomnia. Zhao et al. [64] identified hyperarousal as the link between insomnia and the perfectionism dimensions of Concern over Mistakes and Doubts about Actions. Similarly, Kuskens et al. [65] found that those with higher Concern over Mistakes and Doubts about Actions experienced worse sleep on days of higher pre-sleep arousal than on days of lower pre-sleep arousal. This study takes the literature further by potentially identifying sleep-wake state discrepancy as a plausible symptom of poor sleep experienced by those who have high levels of perfectionism and experience hyperarousal in the pre-sleep period.

Individuals who are highly perfectionistic are thought to experience higher arousal in the period before sleep, which may contribute to a delay in sleep onset [27,47]. One plausible explanation for the current findings may be that on nights when individuals are aroused due to being excessively concerned about mistakes or doubting their own actions that might have occurred during the day or in the past, sleep onset can become delayed due to rumination or worry. As such, the automaticity of sleep normalcy becomes disrupted, which would be consistent with the attention-intention-effort pathway model of insomnia [57]. Given that self-reported sleep is assessed the next morning in studies of sleep-wake discrepancy, those who excessively doubt their own actions may subsequently doubt their ability to initiate sleep, leading them to question how long it took for them to fall asleep and/or even question their time asleep and mistaking it as wake, leading to an overestimation of sleep onset latency. This is consistent with time overestimation and perceiving sleep as wake in explaining sleep-wake state discrepancy when experiencing higher cognitive arousal, which were suggested to be related to worry, selective attention and monitoring [10,26,83]. Furthermore, this ties in with past research that found worry, anxiety and rumination to be significantly associated with Concern over Mistakes and Doubts about Actions [84–86] The current findings, therefore, add exploratory evidence to suggest pre-sleep arousal as an indirect effect through which perfectionism may influence the cognitive and emotional interpretations of sleep experiences associated with sleep-wake state discrepancy, which can lead to perception of poor sleep.

Notably, the current study did not find evidence to support the mediating role of dysfunctional sleep cognitions in the relationship between perfectionism and sleep-wake state discrepancy. This is inconsistent with a previous finding of the mediating role of dysfunctional sleep cognitions between insomnia symptoms and Doubts about Actions using a similar but much larger general population sample by Akram et al. [33]. It is plausible that the current sample size was too small to detect the effects or that sleep-wake state discrepancy is not a symptom of insomnia that is affected by these dysfunctional sleep cognitions. However, our current study is consistent with the network analysis findings in a recent study of young adults by Zhao et al. [64]. The authors found only hyperarousal, but not dysfunctional sleep cognitions, to be a key node linking insomnia and perfectionism despite finding direct associations between insomnia severity, dysfunctional beliefs and attitudes about sleep and hyperarousal. The role, if any, that dysfunctional sleep cognitions play in the relationships between perfectionism and sleep-wake state discrepancy and insomnia remains unclear.

4.1. Theoretical and Clinical Implications

Results from the current study provide new exploratory evidence supporting prior theoretical conceptualisations and empirical literature suggesting that perfectionism is a contributing factor in poor sleep and insomnia. Specifically, pre-sleep arousal was identified as an indirect effect in which perfectionism may lead to sleep-wake state discrepancy. It is not uncommon for people with insomnia to report their sleep to be worse than objective sleep measures obtained simultaneously [7]. This study has identified sleep-wake state dis-

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crepancy to be associated with perfectionism via the mediating effect of pre-sleep arousal. Together, these provide insight into the theoretical conceptualisation of how perfectionism may serve as a plausible predisposing and perhaps perpetuating risk factor for poor sleep in line with cognitive models of insomnia [7,27,28,47].

Although this study was conducted primarily on a community-based sample, it may provide some important clinical insights for insomnia management. It is possible that the current findings could have stronger effects in a clinical sample. Nevertheless, the following discussion on clinical insights is speculative, given the exploratory nature of the current study. It may be important for clinicians to consider possible traits of perfectionism, particularly Concern over Mistakes and Doubts about Actions, in addition to initial diagnostic indications of prolonged self-reported sleep onset latency when assessing the nature of their patients' sleep perceptions. The specific subscales of the FMPS can be easily incorporated into clinical practice to screen for such traits of perfectionism. Furthermore, clinicians should exercise caution in relying on self-reported sleep measures and consider supplementing with objective measures in the assessment and monitoring of sleep in this population group, particularly where sleep-state wake discrepancy may be contributing to the complaints of poor sleep. As suggested by Fernandez-Mendoza et al. [20], different sleep phenotypes may respond better to different treatment approaches. The current results, if confirmed with a clinical sample in the future, suggest that in individuals who present with significant sleep-wake state discrepancy and high levels of perfectionism, it may be more appropriate to implement Cognitive Behavioural Therapy for Insomnia and Acceptance and Commitment Therapy for Insomnia than relying on sleep medication to reduce physiological hyperarousal and/or increase sleep duration. For example, providing psychoeducation to normalise sleep-wake state discrepancy, incorporating behavioural strategies, such as avoiding clock checking and introducing acceptance, mindfulness practice and relaxation training to reduce hyperarousal. Such strategies may also be more relevant than addressing dysfunctional beliefs and attitudes about sleep in the treatment of sleep-wake state discrepancy for this population group if the current findings hold true with a clinical sample. Lastly, treating perfectionistic concerns of making mistakes and doubts about actions, particularly if they relate to sleep, may also be helpful in therapy. Such modifications to current standard treatment therapy will need to be tested in future research.

4.2. Strengths, Limitations and Future Directions

To our best knowledge, this is the first study to explore relationships between perfectionism and sleep-wake state discrepancy relating to poor sleep. Although actigraphy provided good ecological sleep data for this study, it lacks the capacity to capture other physiological and neurobiological markers of sleep, such as electrical brain activity, increased heart rate variability, muscle responses and cortical arousals, which have been suggested to contribute to sleep-wake state discrepancy [10]. Actigraphy may have contributed to a key limitation in the current study, as self-reported lights-out time was used to partially derive objective sleep onset latency, which may be partly attributable to assessment artefact, to reduce the accuracy of the actual incongruence between self-reported and objective discrepancy [70]. While GeneActiv actigraphy is capable of estimating lights-out time based on the lack of movement and light, its accuracy is variable when relying on actigraphy alone, e.g., reading in bed under dim light while wearing long sleeve top, can be detected as sleep [87]. Although the processing of GeneActiv actigraphy was found to be comparable with and without a sleep diary, a sleep diary is generally recommended when using actigraphy [88,89]. Consequently, the current study adopted the use of a sleep diary to identify lights-out in an attempt to improve the accuracy of deriving objective

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sleep onset latency. Therefore, replicating this study using EEG-derived sleep estimates is needed to confirm the effects found here.

In a recent scoping review, Walton et al. [70] identified alternate ways of computing sleep discrepancy measures other than the arithmetic difference method used in the current study. For example, the Sleep Perception Index, as demonstrated by Lecci et al. [90] and Cini et al. [91], allows for comparisons between sleep metrics and identification of patterns in discrepancy across sleep metrics. While no comparison between sleep metrics was made in the current study and arithmetic differences are a commonly used method of calculating discrepancy measures [70] (e.g., Bensen-Boakes et al. [92], Naito et al. [93], Spina et al. [94], Bensen-Boakes et al. [95], Moulder et al. [96]), the Sleep Perception Index may be considered in future research. Until a consensus on sleep discrepancy measures and derivation is reached in the field, future studies should consider utilising other methods of sleep monitoring, such as PSG, and different ways of deriving sleep discrepancy measures to explore if these factors play a role in the relationships between perfectionism and insomnia.

While the nature of this study was exploratory, the relatively small sample size with numerous analyses may increase the risk of type 1 error, and thus the results should be interpreted with caution. This will need further investigation in larger studies with prior hypotheses. Another limitation of this study is that the resulting generalisations are based on a sample that consists of a small clinical subsample and is predominantly female. While gender was included as a covariate in the analysis, and insomnia is more prevalent in females, cautious generalisation of findings is warranted [97]. The current findings were considered to have small effects and were found using a general population sample that included both good and poor sleepers, which could have contributed to the conservative findings. Therefore, it is possible that stronger effects may be found using clinical samples. Although initial descriptive data analysis suggests differences exist between good and poor sleepers, between-group analysis was not conducted due to a lack of power. It will be ideal to recruit a larger sample, include both clinical and control samples and conduct between-group analysis in future studies. The cross-sectional data also do not allow for causality to be determined, so future longitudinal studies are recommended. Another limitation of the current study relates to the averaging of multiple nights' data, which assumes consistency across nights in patterns of sleep over/underestimation [70]. Therefore, future studies can focus on intra-individual differences across nights in these relationships to test whether daily fluctuations in levels of perfectionism impact on sleep and/or sleep-wake state discrepancy; and whether and how pre-sleep arousal plays a part in those relationships if they exist.

5. Conclusions

This is the first study to explore perfectionism as a possible factor in sleep-wake discrepancy in relation to markers of poor sleep. The current study found that perfectionism facets of high levels of Concern about Mistakes and Doubts about Actions may increase one's vulnerability to experiencing sleep-wake state discrepancy, and that relationship may be facilitated by heightened levels of pre-sleep arousal. These findings suggest perfectionism may be an important consideration in the assessment and treatment of poor sleep.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/brainsci16060600/s1, Table S1: Mean scores and standard deviations for objective and subjective sleep measures; Table S2: Results from mediation analysis using PSAS as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000); Table S3: Results from mediation analysis using PSAS subscale Somatic (PSAS-C) as a mediator in the relationship between sleep discrepancy measures and

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selected subscales of perfectionism (n = 60, simulations = 10,000); Table S4: Results from mediation analysis using PSAS subscale Cognition as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000); Table S5: Results from mediation analysis using DBAS as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000); Table S6: Results from mediation analysis using DBAS subscale sleep Expectations (DBAS-E) as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000); Table S7: Results from mediation analysis using DBAS subscale Worry about sleep (DBAS-W) as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000); Table S8: Results from mediation analysis using DBAS subscale Consequences of insomnia (DBAS-C) as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000); Table S9: Results from mediation analysis using DBAS subscale Medication (DBAS-M) as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000).

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

CM	Concern over mistakes
DA	Doubts about actions
DBAS	Dysfunctional Beliefs and Attitudes about Sleep Scale
DBAS-C	Dysfunctional Beliefs and Attitudes about Sleep Scale—consequences of insomnia
DBAS-E	Dysfunctional Beliefs and Attitudes about Sleep Scale—sleep expectations
DBAS-M	Dysfunctional Beliefs and Attitudes about Sleep Scale—sleep medication
DBAS-W	Dysfunctional Beliefs and Attitudes about Sleep Scale—worries about sleep
FMPS	Frost Multidimensional Perfectionism Scale
HFMPS	Hewitt-Flett Multidimensional Perfectionism Scale
ISI	Insomnia Severity Index
O	Organisation
OOP	Other-oriented perfectionism
PC	Parental criticism

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PE	Parental expectations
PS	Persona standards
PSAS	Pre-Sleep Arousal Scale
PSAS-C	Pre-Sleep Arousal Scale—cognitive arousal
PSAS-S	Pre-Sleep Arousal Scale—somatic arousal
PSD	The Pittsburgh Sleep Diary
PSG	polysomnography
SEMA3	Smartphone Ecological Momentary Assessment app
SOL	sleep onset latency
SOL_D	discrepancy in sleep onset latency
SOP	self-oriented perfectionism
SPP	socially prescribed perfectionism
TST	total sleep time
TST_D	discrepancy in total sleep time
WASO	wake after sleep onset
WASO_D	discrepancy in wake after sleep onset

References

1. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*, 5th, text rev. ed.; American Psychiatric Association: Washington, DC, USA, 2022. [CrossRef]
2. Appleton, S.L.; Reynolds, A.C.; Gill, T.K.; Melaku, Y.A.; Adams, R.J. Insomnia prevalence varies with symptom criteria used with implications for epidemiological studies: Role of anthropometrics, sleep habit, and comorbidities. *Nat. Sci. Sleep* **2022**, *14*, 775–790. [CrossRef]
3. Bin, Y.S.; Marshall, N.S.; Glozier, N. The burden of insomnia on individual function and healthcare consumption in Australia. *Aust. New Zealand J. Public Health* **2012**, *36*, 462–468. [CrossRef]
4. Streatfeild, J.; Smith, J.; Mansfield, D.; Pezzullo, L.; Hillman, D. The social and economic cost of sleep disorders. *Sleep* **2021**, *44*, zsab123. [CrossRef]
5. Edinger, J.D.; Bonnet, M.H.; Bootzin, R.R.; Doghramji, K.; Dorsey, C.M.; Espie, C.A.; Jamieson, A.O.; McCall, W.V.; Morin, C.M.; Stepanski, E.J. Derivation of research diagnostic criteria for insomnia: Report of an American Academy of Sleep Medicine Work Group. *Sleep* **2004**, *27*, 1567–1596. [CrossRef]
6. Martin, J.L.; Hakim, A.D. Wrist actigraphy. *Chest* **2011**, *139*, 1514–1527. [CrossRef]
7. Castelnovo, A.; Ferri, R.; Punjabi, N.M.; Castronovo, V.; Garbazza, C.; Zucconi, M.; Ferini-Strambi, L.; Manconi, M. The paradox of paradoxical insomnia: A theoretical review towards a unifying evidence-based definition. *Sleep Med. Rev.* **2019**, *44*, 70–82. [CrossRef]
8. Maltezos, A.; Perrault, A.A.; Walsh, N.A.; Phillips, E.M.; Gong, K.; Tarelli, L.; Smith, D.; Cross, N.E.; Pomares, F.B.; Gouin, J.P.; et al. Methodological approach to sleep state misperception in insomnia disorder: Comparison between multiple nights of actigraphy recordings and a single night of polysomnography recording. *Sleep Med.* **2024**, *115*, 21–29. [CrossRef] [PubMed]
9. Bensen-Boakes, D.B.; Lovato, N.; Meaklim, H.; Bei, B.; Scott, H. "Sleep-wake state discrepancy": Toward a common understanding and standardized nomenclature. *Sleep* **2022**, *45*, zcas187. [CrossRef] [PubMed]
10. Harvey, A.G.; Tang, N.K. (Mis)perception of sleep in insomnia: A puzzle and a resolution. *Psychol. Bull.* **2012**, *138*, 77–101. [CrossRef] [PubMed]
11. Bianchi, M.T.; Williams, K.L.; McKinney, S.; Ellenbogen, J.M. The subjective-objective mismatch in sleep perception among those with insomnia and sleep apnea. *J. Sleep Res.* **2013**, *22*, 557–568. [CrossRef]
12. Buysse, D.J.; Cheng, Y.; Germain, A.; Moul, D.E.; Franzen, P.L.; Fletcher, M.; Monk, T.H. Night-to-night sleep variability in older adults with and without chronic insomnia. *Sleep Med.* **2010**, *11*, 56–64. [CrossRef]
13. Carskadon, M.A.; Dement, W.C.; Mtler, M.M.; Guilleminault, C.; Zarcone, V.P.; Spiegel, R. Self-reports versus sleep laboratory findings in 122 drug-free subjects with complaints of chronic insomnia. *Am. J. Psychiatry* **1976**, *133*, 1382–1388. [CrossRef]
14. Choi, S.J.; Suh, S.; Ong, J.; Joo, E.Y. Sleep Misperception in chronic insomnia patients with obstructive sleep apnea syndrome: Implications for clinical assessment. *J. Clin. Sleep Med.* **2016**, *12*, 1517–1525. [CrossRef]
15. Edinger, J.D.; Krystal, A.D. Subtyping primary insomnia: Is sleep state misperception a distinct clinical entity? *Sleep Med. Rev.* **2003**, *7*, 203–214. [CrossRef] [PubMed]
16. Kudo, M.; Ayabe, N.; Takeshima, M.; Ogasawara, M.; Itoh, Y.; Yoshizawa, K.; Kitamura, S.; Mishima, K. Association between sleep state misperception and bedtime behavior in patients with chronic insomnia. *Sci. Rep.* **2024**, *14*, 13991. [CrossRef] [PubMed]

https://doi.org/10.3390/brainsci16060600

17. Manconi, M.; Ferri, R.; Sagrada, C.; Punjabi, N.M.; Tettamanzi, E.; Zucconi, M.; Oldani, A.; Castronovo, V.; Ferini-Strambi, L. Measuring the error in sleep estimation in normal subjects and in patients with insomnia. *J. Sleep Res.* **2010**, *19*, 478–486. [CrossRef] [PubMed]
18. Cho, S.E.; Kang, J.M.; Ko, K.P.; Lim, W.J.; Redline, S.; Winkleman, J.W.; Kang, S.G. Association between subjective-objective discrepancy of sleeping time and health-related quality of life: A community-based polysomnographic study. *Psychosom. Med.* **2022**, *84*, 505–512. [CrossRef]
19. Blanken, T.F.; Benjamins, J.S.; Borsboom, D.; Vermunt, J.K.; Paquola, C.; Ramautar, J.; Dekker, K.; Stoffers, D.; Wassing, R.; Wei, Y.; et al. Insomnia disorder subtypes derived from life history and traits of affect and personality. *Lancet Psychiatry* **2019**, *6*, 151–163. [CrossRef] [PubMed]
20. Fernandez-Mendoza, J.; Calhoun, S.L.; Bixler, E.O.; Karataraki, M.; Liao, D.; Vela-Bueno, A.; Jose Ramos-Platon, M.; Sauder, K.A.; Basta, M.; Vgontzas, A.N. Sleep misperception and chronic insomnia in the general population: Role of objective sleep duration and psychological profiles. *Psychosom. Med.* **2011**, *73*, 88–97. [CrossRef]
21. Hermans, L.W.A.; Nano, M.M.; Leufkens, T.R.; van Gilst, M.M.; Overeem, S. Sleep onset (mis)perception in relation to sleep fragmentation, time estimation and pre-sleep arousal. *Sleep Med. X* **2020**, *2*, 100014. [CrossRef]
22. Kales, A.; Caldwell, A.B.; Preston, T.A.; Healey, S.; Kales, J.D. Personality patterns in insomnia. Theoretical implications. *Arch. Gen. Psychiatry* **1976**, *33*, 1128–1134. [CrossRef]
23. Liao, J.; Zhu, S.; Li, X. Anxiety and depression in paradoxical insomnia: A case-control study. *Neuropsychiatr. Dis. Treat.* **2018**, *14*, 231–238. [CrossRef]
24. Means, M.K.; Edinger, J.D.; Glenn, D.M.; Fins, A.I. Accuracy of sleep perceptions among insomnia sufferers and normal sleepers. *Sleep Med.* **2003**, *4*, 285–296. [CrossRef] [PubMed]
25. Rezaie, L.; Vakili-Amini, Y.; Paschall, E.; Khazaie, H. Personality profiles in paradoxical insomnia: A case-control study. *Sleep Sci.* **2020**, *13*, 242–248. [CrossRef]
26. Tang, N.K.; Harvey, A.G. Time estimation ability and distorted perception of sleep in insomnia. *Behav. Sleep Med.* **2005**, *3*, 134–150. [CrossRef] [PubMed]
27. Lundh, L.G.; Broman, J.E.; Hetta, J.; Saboonchi, F. Perfectionism and insomnia. *Scand. J. Behav. Ther.* **1994**, *23*, 3–18. [CrossRef]
28. van de Laar, M.; Verbeek, I.; Peveragie, D.; Aldenkamp, A.; Overeem, S. The role of personality traits in insomnia. *Sleep Med. Rev.* **2010**, *14*, 61–68. [CrossRef]
29. Frost, R.O.; Marten, P.; Lahart, C.; Rosenblate, R. The dimensions of perfectionism. *Cogn. Ther. Res.* **1990**, *14*, 449–468. [CrossRef]
30. Hewitt, P.L.; Flett, G.L. Perfectionism in the self and social contexts: Conceptualisation, assessment, and association with psychopathology. *J. Personal. Soc. Psychol.* **1991**, *60*, 456–470. [CrossRef]
31. Akram, U.; Ellis, J.G.; Barclay, N.L. Anxiety mediates the relationship between perfectionism and insomnia symptoms: A longitudinal study. *PLoS ONE* **2015**, *10*, e0138865. [CrossRef]
32. Akram, U.; Ellis, J.G.; Myachykov, A.; Chapman, A.J.; Barclay, N.L. Anxiety mediates the relationship between multidimensional perfectionism and insomnia disorder. *Personal. Individ. Differ.* **2017**, *104*, 82–86. [CrossRef]
33. Akram, U.; Gardani, M.; Riemann, D.; Akram, A.; Allen, S.F.; Lazuras, L.; Johann, A.F. Dysfunctional sleep-related cognition and anxiety mediate the relationship between multidimensional perfectionism and insomnia symptoms. *Cogn. Process.* **2020**, *21*, 141–148. [CrossRef] [PubMed]
34. Akram, U.; Stevenson, J.C.; Gardani, M.; Allen, S.; Johann, A.F. Personality and insomnia: A systematic review and narrative synthesis. *J. Sleep Res.* **2023**, *32*, e14031. [CrossRef]
35. Andersson, G.; Airikka, M.L.; Buhrman, M.; Kaldo, V. Dimensions of perfectionism and tinnitus distress. *Psychol. Health Med.* **2005**, *10*, 78–87. [CrossRef]
36. Azevedo, M.H.; Bos, S.C.; Soares, M.J.; Marques, M.; Pereira, A.T.; Maia, B.; Gomes, A.A.; Macedo, A. Longitudinal study on perfectionism and sleep disturbance. *World J. Biol. Psychiatry* **2010**, *11*, 476–485. [CrossRef]
37. Azevedo, M.H.; Soares, M.J.; Bos, S.C.; Gomes, A.A.; Maia, B.; Marques, M.; Pereira, A.T.; Macedo, A. Perfectionism and sleep disturbance. *World J. Biol. Psychiatry* **2009**, *10*, 225–233. [CrossRef]
38. Brand, S.; Kirov, R.; Kalak, N.; Gerber, M.; Puhse, U.; Lemola, S.; Correll, C.U.; Cortese, S.; Meyer, T.; Holsboer-Trachsler, E. Perfectionism related to self-reported insomnia severity, but not when controlled for stress and emotion regulation. *Neuropsychiatr. Dis. Treat.* **2015**, *11*, 263–271. [CrossRef]
39. Jansson-Frojmark, M.; Linton, S.J. Is perfectionism related to pre-existing and future insomnia? A prospective study. *Br. J. Clin. Psychol.* **2007**, *46*, 119–124. [CrossRef]
40. Johann, A.F.; Feige, B.; Hertenstein, E.; Nissen, C.; Benz, F.; Steinmetz, L.; Baglioni, C.; Riemann, D.; Spiegelhalder, K.; Akram, U. The effects of cognitive behavioral therapy for insomnia on multidimensional perfectionism. *Behav. Ther.* **2023**, *54*, 386–399. [CrossRef]
41. Johann, A.F.; Hertenstein, E.; Kyle, S.D.; Baglioni, C.; Feige, B.; Nissen, C.; Riemann, D.; Spiegelhalder, K. Perfectionism and polysomnography-determined markers of poor sleep. *J. Clin. Sleep Med.* **2017**, *13*, 1319–1326. [CrossRef] [PubMed]

https://doi.org/10.3390/brainsci16060600

42. Maia, B.R.; Soares, M.J.; Pereira, A.T.; Marques, M.; Bos, S.C.; Gomes, A.; Valente, J.; Azevedo, M.H.; Macedo, A. Affective state dependence and trait stability of perfectionism in sleep disturbances. *Rev. Bras. Psiquiatr.* **2011**, *33*, 252–260. [CrossRef]
43. Molnar, D.S.; Thai, S.; Blackburn, M.; Zinga, D.; Flett, G.L.; Hewitt, P.L. Dynamic changes in perfectionism dimensions and psychological distress among adolescents assessed before and during the COVID-19 pandemic. *Child Dev.* **2023**, *94*, 254–271. [CrossRef]
44. Oh, S.Y.; Meaklim, H.; Nicholas, C.L.; Cunnington, D.; Schenker, M.; Patrick, C.J.; Windred, D.; Phillips, L.J. Perfect enough to sleep? Perfectionism and actigraphy-determined markers of insomnia. *Behav. Sleep Med.* **2024**, *Sep-Oct 22*(5), 709–724. [CrossRef] [PubMed]
45. Richardson, C.; Gradisar, M. Perfectionism and insomnia in adolescents: The role of vulnerability to stress and gender. *J. Adolesc.* **2020**, *85*, 70–79. [CrossRef]
46. Trudel-Fitzgerald, C.; Savard, J.; Slim, L.M.; Roy, R.C.; Flett, G.L.; Hewitt, P.L.; Ivers, H. The relationship of perfectionism with psychological symptoms in cancer patients and the contributing role of hyperarousability and coping. *Psychol. Health* **2017**, *32*, 381–401. [CrossRef]
47. Vincent, N.K.; Walker, J.R. Perfectionism and chronic insomnia. *J. Psychosom. Res.* **2000**, *49*, 349–354. [CrossRef]
48. Schmidt, R.E.; Courvoisier, D.S.; Cullati, S.; Kraehenmann, R.; der Linden, M.V. Too imperfect to fall asleep: Perfectionism, pre-sleep counterfactual processing, and insomnia. *Front. Psychol.* **2018**, *9*, 1288. [CrossRef]
49. Lombardo, C.; Mallia, L.; Battagliese, G.; Grano, C.; Violani, C. Perfectionism mediates the relationship between insomnia and depressive symptoms. *Sleep Biol. Rhythm.* **2013**, *11*, 90–98. [CrossRef]
50. Oh, S.Y.; Meaklim, H.; Nicholas, C.L.; Cunnington, D.; Patrick, C.J.; Schenker, M.; Phillips, L.J. Bidirectional associations between daily symptoms of perfectionism and poor sleep: The mediating role of stress. *Behav. Sleep Med.* **2026**, 1–14. [CrossRef]
51. Riemann, D.; Spiegelhalder, K.; Feige, B.; Voderholzer, U.; Berger, M.; Perlis, M.; Nissen, C. The hyperarousal model of insomnia: A review of the concept and its evidence. *Sleep Med. Rev.* **2010**, *14*, 19–31. [CrossRef] [PubMed]
52. Perlis, M.L.; Giles, D.E.; Mendelson, W.B.; Bootzin, R.R.; Wyatt, J.K. Psychophysiological insomnia: The behavioural model and a neurocognitive perspective. *J. Sleep Res.* **1997**, *6*, 179–188. [CrossRef] [PubMed]
53. Morin, C.M. *Insomnia: Psychological Assessment and Management*; Guilford Press: New York, NY, USA, 1993.
54. Harvey, A.G. A cognitive model of insomnia. *Behav. Res. Ther.* **2002**, *40*, 869–893. [CrossRef]
55. Lundh, L.G.; Broman, J.E. Insomnia as an interaction between sleep-interfering and sleep-interpreting. *J. Psychomatic Res.* **2000**, *49*, 299–310. [CrossRef]
56. Ong, J.C.; Ulmer, C.S.; Manber, R. Improving sleep with mindfulness and acceptance: A metacognitive model of insomnia. *Behav. Res. Ther.* **2012**, *50*, 651–660. [CrossRef]
57. Espie, C.A.; Broomfield, N.M.; MacMahon, K.M.; Macphee, L.M.; Taylor, L.M. The attention-intention-effort pathway in the development of psychophysiologic insomnia: A theoretical review. *Sleep Med. Rev.* **2006**, *10*, 215–245. [CrossRef]
58. Buysse, D.J.; Germain, A.; Hall, M.; Monk, T.H.; Nofzinger, E.A. A neurobiological model of insomnia. *Drug Discov. Today Dis. Models* **2011**, *8*, 129–137. [CrossRef]
59. Nicassio, P.M.; Mendlowitz, D.R.; Fussell, J.J.; Petras, L. The phenomenology of the pre-sleep state: The development of the pre-sleep arousal scale. *Behav. Res. Ther.* **1985**, *23*, 263–271. [CrossRef] [PubMed]
60. Palagini, L.; Mauri, M.; Dell'Osso, L.; Riemann, D.; Drake, C.L. Trait- and pre-sleep-state-dependent arousal in insomnia disorders: What role may sleep reactivity and sleep-related metacognitions play? A pilot study. *Sleep Med.* **2016**, *25*, 42–48. [CrossRef] [PubMed]
61. Morin, C.M.; Vallieres, A.; Iver, H. Dysfunctional Beliefs and Attitudes about Sleep (DBAS): Validation of a brief version (DBAS-16). *Sleep* **2007**, *30*, 1547–1554. [CrossRef]
62. Besser, A.; Flett, G.L.; Hewitt, P.L.; Guez, J. Perfectionism, and cognitions, affect, self-esteem, and physiological reactions in a performance situation. *J. Ration.-Emotive Cogn.-Behav. Ther.* **2008**, *26*, 206–228. [CrossRef]
63. Lundh, L.G.; Lundqvist, K.; Broman, J.E.; Hetta, J. Vicious cycles of sleeplessness, sleep phobia, and sleep-incompatible behaviours in patients with persistent insomnia. *Scand. J. Behav. Ther.* **1991**, *20*, 101–114. [CrossRef]
64. Zhao, W.; Van Someren, E.J.W.; Xu, Z.; Ren, Z.; Tang, L.; Li, C.; Lei, X. Identifying the insomnia-related psychological issues associated with hyperarousal: A network perspective. *Int. J. Psychophysiol.* **2024**, *195*, 112276. [CrossRef]
65. Kuskens, A.; Stricker, J.; Hertrampf, L.S.; Peitrowsky, R.; Gieselmann, A. Perfectionism, perceived stress, and pre-sleep arousal in insomnia: Effects on sleep quality in a daily life study. *J. Clin. Sleep Med.* **2023**, *20*, 433–443. [CrossRef]
66. Bastien, C.H.; Vallieres, A.; Morin, C.M. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Med.* **2001**, *2*, 297–307. [CrossRef]
67. Monk, T.H.; Reynolds, C.F., III; Kupfer, D.J.; Buysse, D.J.; Coble, P.A.; Hayes, A.J.; Machen, M.A.; Petrie, S.R.; Ritenour, A.M. The Pittsburgh Sleep Diary. *J. Sleep Res.* **1994**, *3*, 111–120. [CrossRef]
68. Koval, P.; Hinton, J.; Dozo, N.; Gellson, J.; Alvarez, M.; Harrison, A.; Vu, D.; Susanto, R.; Jayaputera, G.; Sinnott, R. *SEMA3: Smartphone Ecological Momentary Assessment, version 3*; Melbourne eResearch Group (MeG): Melbourne, Australia, 2019.

https://doi.org/10.3390/brainsci16060600

69. van Hees, V.T.; Sabia, S.; Anderson, K.N.; Denton, S.J.; Oliver, J.; Catt, M.; Abell, J.G.; Kivimaki, M.; Trenell, M.I.; Singh-Manoux, A. A novel, open access method to assess sleep duration using a wrist-worn accelerometer. *PLoS ONE* **2015**, *10*, e0142533. [CrossRef]
70. Walton, T.F.; Ree, M.J.; Fueggle, S.N.; Bucks, R.S. A scoping review of sleep discrepancy methodology: What are we measuring and what does it mean? *Sleep Med.* **2024**, *126*, 32–66. [CrossRef]
71. Morin, C.M.; Belleville, G.; Belanger, L.; Ivers, H. The Insomnia Severity Index: Psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep* **2011**, *34*, 601–608. [CrossRef]
72. Cohen, J. *Statistical Power Analysis for the Behavioural Sciences*, 2nd ed.; Routledge Academic: New York, NY, USA, 1988.
73. O'Rourke, H.P.; MacKinnon, D.P. Reasons for testing mediation in the absence of an intervention effect: A research imperative in prevention and intervention research. *J. Stud. Alcohol. Drugs* **2018**, *79*, 171–181. [CrossRef]
74. Biddle, D.J.; Robillard, R.; Hermens, D.F.; Hickie, I.B.; Glozier, N. Accuracy of self-reported sleep parameters compared with actigraphy in young people with mental ill-health. *Sleep Health* **2015**, *1*, 214–220. [CrossRef]
75. Lehrer, H.M.; Yao, Z.; Krafty, R.T.; Evans, M.A.; Buysse, D.J.; Kravitz, H.M.; Matthews, K.A.; Gold, E.B.; Harlow, S.D.; Samuelsson, L.B.; et al. Comparing polysomnography, actigraphy, and sleep diary in the home environment: The Study of Women's Health Across the Nation (SWAN) Sleep Study. *Sleep Adv.* **2022**, *3*, zpac001. [CrossRef]
76. Tang, N.K.; Harvey, A.G. Correcting distorted perception of sleep in insomnia: A novel behavioural experiment? *Behav. Res. Ther.* **2004**, *42*, 27–39. [CrossRef]
77. Tang, N.K.; Harvey, A.G. Altering misperception of sleep in insomnia: Behavioral experiment versus verbal feedback. *J. Consult. Clin. Psychol.* **2006**, *74*, 767–776. [CrossRef]
78. Van Den Berg, J.F.; Van Rooij, F.J.; Vos, H.; Tulen, J.H.; Hofman, A.; Miedema, H.M.; Neven, A.K.; Tiemeier, H. Disagreement between subjective and actigraphic measures of sleep duration in a population-based study of elderly persons. *J. Sleep Res.* **2008**, *17*, 295–302. [CrossRef]
79. Park, S.; Park, K.; Shim, J.S.; Youm, Y.; Kim, J.; Lee, E.; Kim, H.C. Psychosocial factors affecting sleep misperception in middle-aged community-dwelling adults. *PLoS ONE* **2020**, *15*, e0241237. [CrossRef]
80. Sadeh, A. The role and validity of actigraphy in sleep medicine: An update. *Sleep Med. Rev.* **2011**, *15*, 259–267. [CrossRef]
81. Lockley, S.W.; Skene, D.J.; Arendt, J. Comparison between subjective and actigraphic measurement of sleep and sleep rhythms. *J. Sleep Res.* **1999**, *8*, 175–183. [CrossRef]
82. Smith, M.M.; Sherry, S.B.; Chen, S.; Saklofske, D.H.; Mushquash, C.; Flett, G.L.; Hewitt, P.L. The perniciousness of perfectionism: A meta-analytic review of the perfectionism-suicide relationship. *J. Personal.* **2018**, *86*, 522–542. [CrossRef]
83. Mercer, J.D.; Bootzin, R.R.; Lack, L.C. Insomniacs' perception of wake instead of sleep. *Sleep* **2002**, *25*, 564–571. [CrossRef]
84. Handley, A.K.; Egan, S.J.; Kane, R.T.; Rees, C.S. The relationships between perfectionism, pathological worry and generalised anxiety disorder. *BMC Psychiatry* **2014**, *14*, 98. [CrossRef]
85. Xie, Y.; Kong, Y.; Yang, J.; Chen, F. Perfectionism, worry, rumination, and distress: A meta-analysis of the evidence for the perfectionism cognition theory. *Personal. Individ. Differ.* **2019**, *139*, 301–312. [CrossRef]
86. Flett, G.L.; Coulter, L.M.; Hewitt, P.L.; Nepon, T. Perfectionism, rumination, worry, and depressive symptoms in early adolescents. *Can. J. Sch. Psychol.* **2011**, *26*, 159–176. [CrossRef]
87. Stone, J.E.; McGlashan, E.M.; Facer-Childs, E.R.; Cain, S.W.; Phillips, A.J.K. Accuracy of the GENEActiv Device for Measuring Light Exposure in Sleep and Circadian Research. *Clocks Sleep* **2020**, *2*, 143–152. [CrossRef]
88. Sansom, K.; Reynolds, A.; McVeigh, J.; Mazzotti, D.R.; Dhaliwal, S.S.; Maddison, K.; Walsh, J.; Singh, B.; Eastwood, P.; McArdle, N. Estimating sleep duration: Performance of open-source processing of actigraphy compared to in-laboratory polysomnography in the community. *Sleep Adv.* **2023**, *4*, zpad028. [CrossRef]
89. Ancoli-Israel, S.; Martin, J.L.; Blackwell, T.; Buenaver, L.; Liu, L.; Meltzer, L.J.; Sadeh, A.; Spira, A.P.; Tyalor, D.J. The SBSM guide to actigraphy monioring: Clinical and research applications. *Behav. Sleep Med.* **2015**, *13*, S4–S38. [CrossRef]
90. Lecci, S.; Cataldi, J.; Betta, M.; Bernardi, G.; Heinzer, R.; Siclari, F. Electroencephalographic changes associated with subjective under- and overestimation of sleep duration. *Sleep* **2020**, *43*, zsaa094. [CrossRef]
91. Cini, E.; Bolengo, F.; Fasiello, E.; Berra, F.; Gorgoni, M.; Sforza, M.; Casoni, F.; Proserpio, P.; Castronovo, V.; De Gennaro, L.; et al. Sleep State Misperception in Insomnia: The Role of Sleep Instability and Emotional Dysregulation. *Brain Sci.* **2025**, *15*, 1078. [CrossRef] [PubMed]
92. Bensen-Boakes, D.B.; Loffler, K.; Lack, L.; Paterson, J.; Scott, H.; Lovato, N. Measuring sleep-wake state disrepancy in the home across multiple nights. *Sleep Adv.* **2023**, *4*, A12–A13. [CrossRef]
93. Naito, K.; Iwamoto, K.; Miyata, S.; Okada, I.; Kawai, K.; Fujimoto, A.; Kogo, Y.; Mori, D.; Matsuyama, N.; Ando, M.; et al. Effect of lemborexant on sleep-wake state discrepancy in participants with insomnia disorder. *Psychopharmacology* **2026**, *243*, 133–143. [CrossRef]
94. Spina, M.A.; Andrillon, T.; Quin, N.; Wiley, J.F.; Rajaratnam, S.M.W.; Bei, B. Does providing feedback and guidance on sleep perceptions using sleep wearables improve insomnia? Findings from "Novel Insomnia Treatment Experiment": A randomized controlled trial. *Sleep* **2023**, *46*, zsad167. [CrossRef] [PubMed]

https://doi.org/10.3390/brainsci16060600

95. Bensen-Boakes, D.B.; Osman, A.; Lack, L.; Catcheside, P.; Antic, N.; Smith, S.S.; Chai-Coetzer, C.L.; O'Grady, A.; Dunn, N.; Robinson, J.; et al. The effect of Cognitive Behavioural Therapy for Insomnia (CBT-I) on subjective-objective sleep discrepancy in individuals with co-morbid insomnia and sleep apnoea: A randomised controlled trial. *Appl. Sci.* **2022**, *12*, 1787. [CrossRef]
96. Moulder, Z.; Sweetman, A.; Lovato, N.; Micic, G.; Lack, L.; Scott, H. Sleep-wake state discrepancy does not impair the efficacy of cognitive behavioural therapy for insomnia: Findings from a large clinic sample. *J. Sleep Res.* **2024**, *33*, e14142. [CrossRef] [PubMed]
97. Benjafield, A.V.; Sert Kuniyoshi, F.H.; Malhotra, A.; Martin, J.L.; Morin, C.M.; Maurer, L.F.; Cistulli, P.A.; Pepin, J.L.; Wickwire, E.M.; medXcloud group. Estimation of the global prevalence and burden of insomnia: A systematic literature review-based analysis. *Sleep Med. Rev.* **2025**, *82*, 102121. [CrossRef] [PubMed]

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10.3.3 Study 2 Supplementary Materials

Table B1

Mean scores and standard deviations for objective and subjective sleep measures

	Subjective		Objective		Paired t-Test		Effect Size	Discrepancy	
	M	SD	M	SD	t	P	Cohen's d_z	M	SD
SOL, mins	22.97	21.74	7.36	8.23	5.24	<.001**	0.68 (moderate)	15.29	25.21
WASO, mins	18.65	22.69	49.02	34.00	-5.50	<.001**	-0.71 (moderate)	31.44	42.37
TST, mins	447.90	59.43	424.3	72.65	2.58	.012*	0.33 (small)	17.55	69.79

Notes. SOL, sleep onset latency; WASO, wake after sleep onset; TST, total sleep time. *p < .05 **p < .01

Table B2

Results from mediation analysis using PSAS as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000)

Sleep Discrepancy		SOL_D			WASO_D			TST_D	
Perfectionism	Estimate	*95% CI*	*p*	Estimate	*95% CI*	*p*	Estimate	*95% CI*	*p*
CM									
- ACME	0.50	0.11, 1.01	.008**	0.63	-0.27, 1.72	.17	-1.57	-3.19, -0.33	.009**
- ADE	0.26	-0.58, 1.08	.55	-0.41	-2.49, 1.64	.70	0.19	-2.91, 3.34	.91
- Total effect	0.76	-0.03, 1.54	.06	0.22	-1.27, 1.63	.74	-1.38	-3.88, 1.28	.29
DA									
- ACME	0.95	0.12, 2.10	.020*	1.30	-0.35, 3.39	.13	-2.90	-6.01, -0.67	.006**
- ADE	0.93	-0.68, 2.51	.26	-0.89	-4.52, 2.74	.64	-0.95	-6.25, 4.48	.73
- Total effect	1.87	0.03, 1.99	.018*	0.42	-14.83, 15.28	.75	-3.84	-8.60, 1.11	.13

Notes. CM = Concern over Mistakes; DA = Doubts about Actions; ACME = average causal mediation effects; ADE = average direct effects. *p < .05 **p <.01.

Table B3

Results from mediation analysis using PSAS subscale Somatic (PSAS-C) as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000)

Sleep Discrepancy		SOL_D			WASO_D			TST_D	
Perfectionism	Estimate	*95% CI*	*p*	Estimate	*95% CI*	*p*	Estimate	*95%CI*	*p*
CM									
- ACME	0.43	-0.62, 1.61	.42	0.25	-0.59, 1.26	.57	-0.64	-2.11, 0.36	.23
- ADE	0.61	-.028, 1.53	.19	-0.01	-2.21, 2.00	1.00	-0.73	-3.84, 2.45	.65
- Total effect	1.04	.05, 2.08	.04*	0.23	-1.13, 1.69	.75	-1.37	-3.77, 1.21	.28
DA									
- ACME	0.26	-0.55, 1.24	.51	0.57	-1.14, 2.67	.51	-1.19	-4.00, 0.81	.25
- ADE	1.62	-0.15, 3.44	.07	-0.13	-3.76. 3.55	.95	-2.68	-8.37, 3.05	.36
- Total effect	1.88	0.33, 3.42	.02*	0.43	-2.28, 2.99	.73	-3.87	-8.47, 0.89	.11

Notes. CM = Concern over Mistakes; DA = Doubts about Actions; ACME = average causal mediation effects; ADE = average direct effects. *$p < .05$.

Table B4

Results from mediation analysis using PSAS subscale Cognition as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000)

Sleep Discrepancy		SOL_D			WASO_D			TST_D	
Perfectionism	Estimate	*95% CI*	*p*	*Estimate*	*95% CI*	*p*	Estimate	*95% CI*	*p*
CM									
- ACME	0.63	0.20, 1.15	.003**	0.75	-0.09, 1.75	.08	-1.81	-3.33, -0.60	.002**
- ADE	0.12	-0.66, 0.91	.75	-0.53	-2.38, 1.29	.58	0.44	-2.26, 3.23	.76
- Total effect	.75	-0.03, 1.54	.06	0.22	-1.21, 1.61	.73	.97	-10.72, 12.81	.28
DA									
- ACME	1.18	0.28, 2.43	.006**	1.47	0.00, 3.34	.05*	-3.29	-6.33, -0.96	.003**
- ADE	0.68	-0.80, 2.16	.36	-1.05	-4.28, 2.23	.52	-0.59	-5.70, 4.38	.82
- Total effect	1.86	0.33, 3.44	.02*	0.42	-2.29, 3.13	.77	-3.88	-8.91, 1.11	.12

Notes. CM = Concern over Mistakes; DA = Doubts about Actions; ACME = average causal mediation effects; ADE = average direct effects. *$p < .05$ **$p < .01$.

Table B5

Results from mediation analysis using DBAS as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000)

Sleep Discrepancy		SOL_D			WASO_D			TST_D	
Perfectionism	Estimate	*95% CI*	*p*	Estimate	*95% CI*	*p*	Estimate	*95% CI*	*p*
CM									
- ACME	0.00	-0.71, 0.72	.99	-0.10	-0.77, 0.53	.72	0.49	-1.31, 2.53	.59
- ADE	0.75	-0.51, 2.01	.24	0.33	-1.19, 1.81	.66	-1.84	-5.21, 1.55	.29
- Total effect	0.76	-0.12, 1.61	.09	0.23	-1.19, 1.65	.75	-1.35	-3.83, 1.15	.30
DA									
- ACME	-0.02	-1.43, 1.41	.96	-0.18	-1.45, 0.98	.74	1.07	-1.98, 4.91	.48
- ADE	1.90	-0.48, 4.31	.12	0.60	-1.99, 3.19	.66	-4.96	-11.03, 1.14	.11
- Total effect	1.88	0.20, 3.55	.03*	0.42	-2.26, 3.04	.75	-3.89	-9.12, 1.15	.14

Notes. CM = Concern over Mistakes; DA = Doubts about Actions; ACME = average causal mediation effects; ADE = average direct effects. *$p < .05$.

Table B6

Results from mediation analysis using DBAS subscale sleep Expectations (DBAS-E) as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000)

Sleep Discrepancy		SOL_D			WASO_D			TST_D	
Perfectionism	Estimate	*95% CI*	*p*	Estimate	*95% CI*	*p*	Estimate	*95% CI*	*p*
CM									
- ACME	-0.04	-0.37, 0.23	.80	-0.05	-0.42, 0.26	.76	0.11	-0.67, 1.06	.75
- ADE	0.79	-0.04, 1.63	.06	0.28	-1.13, 1.70	.69	-1.47	-3.80, 0.87	.22
- Total effect	0.75	-0.08, 1.65	.08	0.24	-1.22, 1.67	.75	-1.35	-3.76, 1.04	.26
DA									
- ACME	-0.32	-1.34, 0.29	.39	-0.37	-1.52, 0.30	.35	0.96	-0.84, 3.83	.35
- ADE	2.2	0.48, 3.96	.04*	0.80	-1.82, 3.38	.55	-4.82	-9.96, 0.33	.07
- Total effect	1.88	-1.52, 3.58	.02*	0.43	-2.21, 3.07	.75	-3.87	-9.04, 1.14	.13

Notes. CM = Concern over Mistakes; DA = Doubts about Actions; ACME = average causal mediation effects; ADE = average direct effects. *$p < .05$.

Table B7

Results from mediation analysis using DBAS subscale Worry about sleep (DBAS-W) as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000)

Sleep Discrepancy		SOL_D			WASO_D			TST_D	
Perfectionism	Estimate	*95% CI*	*p*	Estimate	*95% CI*	*p*	Estimate	*95% CI*	*p*
CM									
- ACME	0.05	-0.57, 0.68	.87	0.07	-0.61, 0.76	.83	0.18	-1.45, 1.94	.83
- ADE	0.70	-0.43, 1.83	.23	0.14	-1.54, 1.82	.86	-1.56	-4.93, 1.75	.35
- Total effect	0.75	-0.09, 1.59	.08	0.21	-1.20, 1.64	.77	-1.38	-3.81, 1.04	.27
DA									
- ACME	0.11	-0.76, 1.00	.78	0.12	-0.77, 1.08	.78	0.19	-1.94, 2.41	.84
- ADE	1.75	-0.18, 3.73	.08	0.30	-2.30, 2.88	.81	-4.04	-9.37, 1.46	.14
- Total effect	1.86	0.25, 3.45	.02*	0.42	-2.17, 2.95	.74	-3.84	-8.52, 0.93	.11

Notes. CM = Concern over Mistakes; DA = Doubts about Actions; ACME = average causal mediation effects; ADE = average direct effects. *$p < .05$.

Table B8

Results from mediation analysis using DBAS subscale Consequences of insomnia (DBAS-C) as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000)

Sleep Discrepancy		SOL_D			WASO_D			TST_D	
Perfectionism	Estimate	*95% CI*	*p*	Estimate	*95% CI*	*p*	Estimate	*95% CI*	*p*
CM									
- ACME	0.06	-0.53, 0.66	.84	-0.20	-0.84, 0.32	.44	0.49	-0.89, 2.19	.47
- ADE	0.70	-0.44, 1.83	.24	0.43	-0.10, 1.87	.56	-1.85	-4.81, 1.12	.22
- Total effect	0.76	-0.11, 1.60	.09	0.23	-1.19, 1.65	.74	-1.35	-3.82, 1.04	.27
DA									
- ACME	0.29	-1.71, 1.78	.97	-0.62	-2.24, 0.79	.39	1.83	-1.83, 6.36	.32
- ADE	1.85	-0.92, 4.54	.19	1.04	-1.59, 3.67	.44	-5.71	-12.10, 0.57	.08
- Total effect	1.87	0.17, 3.50	.03*	0.42	-2.30, 2.97	.74	-3.88	-8.89, 1.21	.13

Notes. CM = Concern over Mistakes; DA = Doubts about Actions; ACME = average causal mediation effects; ADE = average direct effects. *$p < .05$.

Table B9

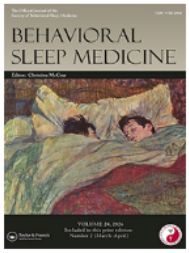
Results from mediation analysis using DBAS subscale Medication (DBAS-M) as a mediator in the relationship between sleep discrepancy measures and selected subscales of perfectionism (n = 60, simulations = 10,000)

Sleep Discrepancy		SOL_D			WASO_D			TST_D	
Perfectionism	Estimate	*95% CI*	*p*	Estimate	*95% CI*	*p*	Estimate	*95% CI*	*p*
CM									
- ACME	0.05	-0.34, 0.50	.78	0.10	-0.24, 0.54	.56	0.15	-0.77, 1.24	.73
- ADE	0.71	-0.25, 1.69	.15	0.13	-1.25, 1.52	.85	-1.52	-4.27, 1.15	.28
- Total effect	0.76	-0.04, 1.58	.07	0.23	-1.16, 1.65	.75	-1.37	-3.90, 1.10	.27
DA									
- ACME	0.09	-0.49, 0.85	.78	0.14	-0.43, 0.95	.66	0.19	-1.18, 1.86	.79
- ADE	1.79	0.03, 3.54	.05*	0.27	-2.15, 2.68	.83	-4.06	-8.99, 0.92	.11
- Total effect	1.88	0.27, 3.46	.02*	0.41	-2.17, 3.04	.76	-3.87	-8.63, 0.94	.11

Notes. CM = Concern over Mistakes; DA = Doubts about Actions; ACME = average causal mediation effects; ADE = average direct effects. *$p < .05$.

10.4 Appendix C: Study 3

10.4.1 Published Manuscript Study 3



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Bidirectional Associations between Daily Symptoms of Perfectionism and Poor Sleep: The Mediating Role of Stress

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Bidirectional Associations between Daily Symptoms of Perfectionism and Poor Sleep: The Mediating Role of Stress

Susie Y. Oh [a,b], Hailey Meaklim [a,c], Christian L. Nicholas [a], David Cunnington [d], Cameron J. Patrick [e], Maya Schenker [a], and Lisa J. Phillips [a]

[a]Melbourne School of Psychological Sciences, The University of Melbourne, Parkville, Australia; [b]Turner Institute for Brain and Mental Health, Monash University Healthy Sleep Clinic, Monash University, Clayton, Australia; [c]Institute for Breathing and Sleep, Austin Health, Victoria, Australia; [d]Sunshine Coast Respiratory and Sleep, Sunshine Coast, Australia; [e]Statistical Consulting Centre, School of Mathematics and Statistics, The University of Melbourne, Parkville, Australia

ABSTRACT

Objectives: Perfectionism is a risk factor for poor sleep. Past studies have examined the relationship between perfectionism and sleep using summary statistics that do not account for intra-individual day-to-day variability. Using ecological momentary assessment, this study investigated the bidirectional and temporal relationships between perfectionism and sleep, and the mediating effects of stress.

Methods: Sixty-three adults (85.7% female, mean age 30.13 ± 10.96 years) were sampled from the Australian general population. Measures collected over 14 days included the Pittsburgh Sleep Diary, Daily Perfectionism Measures, Daily Stress Inventory, the Concerns over Mistakes and Doubts about Actions subscales from the Frost Multidimensional Perfectionism Scale, and the Socially Prescribed Perfectionism subscale from the Hewitt-Flett Multidimensional Perfectionism Scale.

Results: Perfectionism levels were positively associated with sleep onset variability ($p \leq .04$). The relationship between perfectionism and poor sleep was significant at the between-person level in both directions ($p \leq .041$), with stress mediating the relationship of sleep predicting next-day perfectionism ($p \leq .042$). At the within-person level, stress mediated the relationship, with higher perfectionism leading to higher stress, which then related to lower sleep quality ($p \leq .009$). Poorer sleep did not predict next-day perfectionism and was not mediated by stress.

Conclusions: Perfectionism and sleep appear bidirectionally linked. Individuals with higher perfectionism scores were more likely to experience disrupted sleep and vice versa. Changes in perfectionism did not directly impact the same night's sleep, but this relationship was mediated by stress. Therefore, consider the role of perfectionism and stress management when assessing and treating poor sleep.

Introduction

Perfectionism is recognized as a transdiagnostic process contributing to psychopathology (Egan et al., 2011; Limburg et al., 2017). Perfectionism is generally defined as having excessively high standards and being overly critical of oneself, and conceptualized as a multidimensional construct with two higher-order dimensions: perfectionistic concerns and perfectionistic strivings (Frost et al., 1990; Hewitt et al., 1991; Stoeber & Otto, 2006). Perfectionistic concerns involve dimensions of having concerns about making mistakes, doubting one's actions, and being fearful of not meeting others' expectations or high standards for oneself, and are associated with psychological difficulties such as anxiety, depression, and stress. Perfectionistic strivings, which involve dimensions of having high personal standards and being organized and structured, are associated with psychological well-being (Stoeber & Otto, 2006). Therefore, as a multidimensional construct, perfectionism can be both adaptive and maladaptive.

Perfectionism has traditionally been conceptualized as a stable trait or personality disposition with enduring and substantial between-person differences. However, perfectionism has also been conceived

CONTACT Susie Y. Oh susie.oh@student.unimelb.edu.au Melbourne School of Psychological Sciences, The University of Melbourne, 12th Floor Redmond Barry Building, Parkville Campus, Melbourne, VIC 3052, Australia
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as a cognitive-affective construct that can be changed or shaped by dynamic contextual influences, situational cues, and interpersonal experiences (e.g., intrusive and high parental pressures) (Boone & Soenens, 2015; Flett & Hewitt, 2002; Rice & Aldea, 2006; Ståhlberg et al., 2020; Vecchione & Marsicano, 2023). This conceptualization is supported by evidence that perfectionism can be reduced through engagement in therapy for clinical perfectionism and induced in adults without psychopathology in a day (Boone & Soenens, 2015; Boone et al., 2012; Galloway et al., 2022; Ip, 2025; Suh et al., 2019; Wegerer, 2024). Short-term longitudinal research ranging from 7 to 21 days has also found that components of perfectionism, such as perfectionistic cognitions, perfectionistic self-presentation, and perfectionistic concerns and strivings, can fluctuate day-to-day and week to week (Boone et al., 2012; Mackinnon et al., 2014, 2017, 2019). Furthermore, such state-like dynamic variations in perfectionism predict psychopathology, including social anxiety, psychological distress, perceived stress, subjective well-being, alcohol-related problems, binge eating behaviors, and eating disorder symptoms (Boone & Soenens, 2015; Boone et al., 2012; Mackinnon et al., 2014, 2017, 2019; Merwin et al., 2022; Molnar et al., 2023). These findings indicate dynamic state-like variations can occur in perfectionism in addition to its trait-like stability.

Perfectionism as a predisposing factor of poor sleep

Perfectionism is postulated as a risk factor for poor sleep and insomnia (e.g., Espie et al., 2006; Lundh et al., 1994; Riemann et al., 2010). Poor sleep refers to experiencing insomnia symptoms, such as prolonged sleep onset latency, prolonged awakenings after sleep onset, poor sleep quality, and/or waking too early in the morning. In the model of insomnia by Lundh and Broman (2000), perfectionism was theorized to be a vulnerability factor for insomnia via dysfunctional sleep-interpreting processes. They proposed that when facing temporary sleep problems, perfectionistic individuals worry about sleeplessness leading to pre-sleep arousal and rumination that further interferes with sleep. Perfectionistic interpretations of how bad their sleep was may further contribute to the vicious cycle that causes sleep to vary beyond the typically stable sleep-wake patterns driven by biological homeostatic sleep drive and the circadian clock (Lundh & Broman, 2000). Therefore, studying whether and how perfectionism may exacerbate poor sleep may be helpful in the understanding and management of poor sleep.

Past research has found evidence of associations between perfectionism and poor sleep (e.g., Akram et al., 2023; Stuck et al., 2021). In a meta-analysis, Stricker et al. (2023) identified perfectionistic concerns, predominantly *Concerns over Mistakes* (adverse over-reaction to mistakes as failures), *Doubts about Actions* (doubting one's own actions and behaviors), and *Socially Prescribed Perfectionism* (having expectations that others expect one to have high standards), to be associated positively with insomnia. Since then, studies have added further evidence to support the associations between *Concerns over Mistakes* and *Doubts about Action*, and self-reported sleep duration, sleep efficiency, sleep onset latency, and sleep quality (Akram et al., 2023; Elbadawi et al., 2025; Johann et al., 2023; Oh et al., 2024; Zhao et al., 2024). Together, past research has consistently identified relationships between perfectionism dimensions of *Concerns over Mistakes, Doubts about Actions*, and *Socially Prescribed Perfectionism* and markers of poor sleep.

The experience of heightened stress has been identified as an indirect pathway that may explain how and why perfectionism contributes to poor sleep. According to the mediating hypothesis, the constant striving for unrealistic high standards and critical self-evaluation increases one's stress level and stress reactivity, which can adversely affect well-being, including sleep (Dunkley, 2017; Flett & Hewitt, 2002; Lundh et al., 1994). Flett and Hewitt (2002) theorized that perfectionism contributes to unhealthy outcomes via stress in various ways. These included stress generation from having unrealistic goals, stress anticipation by being preoccupied with possible stressors, stress perpetuation via maladaptive tendencies, such as rumination in maintaining and prolonging stressful periods, and stress enhancement where unhelpful cognitive appraisal or reactivity magnifies stress. Support for a mediating role of stress in the relationship between perfectionism and sleep has been found in several studies (e.g., Brand et al., 2015; Molnar et al., 2020; Oh et al., 2024; Richardson & Gradisar, 2020). However, a recent study found that daily stress did not mediate the link

between perfectionism and sleep, so the role that stress plays in that relationship remains unclear (Kuskens et al., 2023).

Intra-individual variability in sleep

In examining the relationship between sleep and perfectionism, intra-individual variability (IIV) in sleep should be a consideration. This is because people with poor sleep often describe feeling that their sleep is out of control due to inconsistency or night-to-night fluctuations in their sleep difficulties (Morin & Espie, 2007). However, sleep and insomnia research has typically relied on mean levels when quantifying sleep parameters from data collected over time. This leads to potentially missing out on more clinically nuanced insights and patterns to understanding sleep problems that could be derived by analyzing those fluctuations in daily sleep (Bei et al., 2016; Bredeli et al., 2022). Intraindividual sleep variability quantifies the extent to which an individual's sleep parameter differs from its average over time. It further captures the dynamic process of how sleep is influenced day-to-day by other factors, such as stress, mood, cognitions, biological rhythms, and social interactions (Bei et al., 2016).

In a foundational systematic review, Bei et al. (2016) identified that compared to normal sleepers, individuals with insomnia consistently demonstrated more IIV in sleep onset latency, wake after sleep onset, sleep efficiency, and sleep quality. Furthermore, poorer physical and mental health have been associated with higher sleep variability (Messman et al., 2024). Higher IIV in sleep was also associated with higher insomnia severity, more dysfunctional beliefs and attitudes about sleep, and higher fatigue level, which often exacerbated and perpetuated sleep problems (Bredeli et al., 2022). These findings suggest that studying sleep variability provides critical clinical insights into poor sleep. To date, no study has examined whether daily fluctuations in perfectionism are associated with and/or contribute to day-to-day sleep variability and how daily stress might affect those relationships.

Potential bi-directional relationship between perfectionism and poor sleep

While previous research has investigated the relationship from perfectionism to poor sleep, it is possible that poor sleep may also influence the levels of perfectionism, forming a vicious cycle to maintain and worsen one another over time. In a longitudinal study, Akram et al. (2015) found baseline insomnia symptoms to be associated with future *Doubts about Actions*, and the relationship was partially mediated by anxiety symptoms. The authors postulated that poor sleep amplifies preoccupation with daytime functioning and performance, which contributes to self-evaluation and criticism, leading to an increase in perfectionistic tendencies. In contrast, a longitudinal study of adolescents by Richardson and Gradisar (2020) found that insomnia did not predict total perfectionism; however, *Socially Prescribed Perfectionism* predicted insomnia symptoms over time. There is little research that has examined the relationship from sleep to perfectionism, so it remains unclear if poor sleep plays a part in increasing perfectionism. The possibility of daily fluctuations in sleep being associated with and/or contributing to daily levels of perfectionism and whether daily stress plays a mediating role in these reverse relationships is yet to be explored.

The current study

The current study aimed to examine the bi-directional and temporal associations between perfectionism and sleep, and the mediating effects of stress in those relationships. It utilized a short-term longitudinal design with repeated ecological momentary assessments (EMA) across 14 days to capture daily variations in self-reported sleep, stress, and perfectionism in individuals with normal sleep and varying sleep difficulties. Specific hypotheses were: (1) higher levels of perfectionism measures of *Concerns over Mistakes*, *Doubts about Actions*, and *Socially Prescribed Perfectionism* would be associated with higher sleep variability, as measured by the variance in sleep across the 14 days; (2A) between participants, those with higher perfectionism levels (i.e., higher levels of *Concerns over Mistakes* and *Doubts about Actions*) compared to the sample would experience worse sleep (i.e, longer sleep onset latency and lower sleep quality) and vice versa; and (2B) these relationships would be mediated by stress. Given the limited research and the

exploratory nature of the current study, no a priori hypotheses were formulated on the day-to-day relationships between sleep and perfectionism, as well as how stress mediates these effects daily.

Materials and methods

Participants

Recruitment of adult participants, aged 18 years and older, occurred via the University of Melbourne Research Experience Program (REP), social media, word-of-mouth, or referrals by sleep physicians at the Melbourne Sleep Disorder Center. Participants from the REP were undergraduate psychology students who responded to an online advertisement at the University of Melbourne, Australia, to participate in exchange for course credit. An online eligibility screening survey, including demographic information, via Qualtrics (https://www.qualtrics.com) was completed by all potential participants and excluded those with the following considerations: (a) current diagnosis of mental illness excluding insomnia disorder; (b) central nervous disorder; (c) prior head injury; (d) shift work, defined as paid work with rotating shifts, outside of 7 a.m. to 6 p.m. or starting before 7 a.m. or after 2 p.m.; and (e) symptoms indicative of sleep disorders other than insomnia (e.g., obstructive sleep apnea, restless leg syndrome). Participants were screened using a sleep algorithm to exclude sleep disorders other than insomnia, as presented in Wilson et al. (2010). Participants with and without insomnia disorder (no clinical insomnia diagnosis was required for participation) were included to capture a broad range of sleep quality and variability. Participants self-reported insomnia symptomology via the Insomnia Severity Index (ISI, see below, Bastien et al., 2001).

Out of the 1,132 screening responses obtained, 243 were deemed eligible after removing duplicate and incomplete responses. The final sample consisted of 63 participants, who agreed to participate in and complete the two-week sleep study. Each participant provided informed written consent online and was given an online gift voucher of $25 upon study completion. The University of Melbourne's Human Research Ethics Committee granted approval for this research study (HREC 1955374). Self-reported sleep data in summary statistics from this current sample were previously analyzed and published in a study by Oh et al. (2024).

Study protocol

All individuals who met the eligibility criteria received information about the study protocol via an in-person or online (via Zoom [https://zoom.us]) meeting with the first author (S.O). Participants who agreed to participate in the two-week sleep and EMA study then completed additional surveys (see below). During the two-week study period, participants responded to daily surveys using the Smartphone Ecological Momentary Assessment app (SEMA; Koval et al., 2019), with reminders scheduled once in the morning (sleep-related measures) and once at night (daytime perfectionism measures). At the end of the 14-day sleep study period, participants attended a debriefing session when they completed the post-study survey (see below) and received remuneration.

Sleep measures

Pittsburgh sleep diary (PSD)

The Pittsburgh Sleep Diary records bedtime, lights-out time, minutes to sleep, total number of times awake, total number of minutes awake during the night, wake time, and sleep quality (Monk et al., 1994). Questions include "went to bed last night at," "lights out at," "minutes until fell asleep," "finally woke at," etc. These data were used to derive total time in bed (time between bedtime and wake up time), sleep onset latency, wake after sleep onset, total sleep time (time between sleep time, which is derived as lights out time plus sleep onset latency, and wake time minus wake after sleep onset), number of awakenings and sleep efficiency (calculated as total sleep time/total time in bed *100%). The PSD captures sleep quality using a Likert scale ranging from 0 for *very bad* to 10 for *very good*. To measure IIV of these measures across the 14-day study period, the square root of each variable's variance was used as per previous research (e.g., Bei et al., 2016; Bredeli et al., 2022).

Insomnia Severity Index (ISI)

At the end of the 14-day sleep study period, participants completed the Insomnia Severity Index (Bastien et al., 2001). The 7-item self-report ISI measures the nature, severity, and impact of insomnia rated on a 5-point Likert scale over the past 14 days. These items assess difficulties falling and staying asleep, problems with early morning awakenings, sleep satisfaction, distress by sleep problems, difficulties with daytime functioning, and how noticeable impairment from sleep problems was to others. Answers range from 0 (*no problem*) to 4 (*very severe problem*) and are summed to yield a total score ranging from 0 to 28. A cutoff score of 10 was used to detect insomnia in a community sample with 86.1% sensitivity and 87.7% specificity (Morin et al., 2011).

Perfectionism

Perfectionism scales

Three subscales were used to assess the perfectionism dimensions of trait perfectionism at baseline. They are *Concerns over Mistakes* and *Doubts about Actions* from the Frost Multidimensional Perfectionism Scale (FMPS; Frost et al., 1990), and *Socially Prescribed Perfectionism* from the Hewitt-Flett Multidimensional Perfectionism Scale (HFMPS; Hewitt & Flett, 1991). The FMPS subscales are made up of items rated on a Likert scale from 1 (*disagree strongly*) to 5 (*agree strongly*). The *Concern over Mistakes* subscale consists of nine items, while the *Doubts about Actions* subscale consists of four items, giving a maximum score of 45 and 20, respectively (Frost et al., 1990). The *Socially Prescribed Perfectionism* subscale consists of 15 items, which are rated on a 7-point Likert scale from 1 (*disagree*) to 7 (*agree*), for a total score range from 15 to 105 (Hewitt et al., 1991). Higher scores in each subscale indicated higher levels of trait perfectionism.

Daily perfectionism measures (DPM)

Currently, there is no validated instrument available to measure state perfectionism. Therefore, three broad questions were created for this study: "I was concerned about mistake(s) I made today," "I had doubts about how well I did things today," and "Others had high expectations of me today". They were administered to participants at the end of each day via the SEMA3 app to capture daily fluctuations in *Concerns over Mistakes*, *Doubts about Actions*, and *Socially Prescribed Perfectionism*, respectively. Responses were rated from 1 (*never*) to 5 (*always*). We refer to this as the Daily Perfectionism Measures. Higher DPM scores indicated higher levels of state perfectionism.

Daily stress inventory (DSI)

To assess participants' daily stress level, the Daily Stress Inventory was administered at the end of each day via the SEMA3 app (Brantley et al., 1987). It consists of 58 relatively minor stressful events or stressors, e.g., "Performed poorly at task," "Was embarrassed," "Argued with another person," etc. Participants indicated if they experienced those stressors in the past 24 hours, and where applicable, they rated the impact on their stress level using a 7-point Likert scale, ranging from 1 (*not stressful*) to 7 (*caused panic*). Three scores were then obtained: 1) a frequency score (FREQ) consisting of the total number of events endorsed for the day; 2) an impact score (SUM), which is the sum of all impact ratings for the day; and 3) an average impact rating of the stressful events for the day (SUM/FREQ). Higher scores indicated higher levels of stress experienced for the day, and AIR was used in mediating analyses.

Statistical analysis

All analyses were conducted using the statistical software package R (version 4.4.2; http://www.R-project.org/). The sample was analyzed as a whole, and no between-group analysis was conducted. To assess the hypothesis that higher levels of perfectionism will be associated with higher sleep variability, the associations between measures of perfectionism (*Concern over Mistakes*, *Doubts about Actions*, and *Socially Prescribed Perfectionism*) and IIV sleep measures (sleep onset latency, total sleep time, wake after sleep onset, sleep efficiency, number of awakenings, and sleep quality) were analyzed using Pearson correlations. Correlations of .10, .30, and .50 were considered small, medium, and large effects, respectively (Cohen, 1988).

Before linear mixed-effects modeling (LMM) was used to test the between and within-subject hypotheses, sample size and data missingness were assessed. The study sample size was well above the recommended minimum (Maas & Hox, 2005). On average, missing data at 17.31% was within the expected missingness range of 18% to 23% for research using EMA (Ottenstein & Werner, 2022; Williams et al., 2021). Multilevel logistic regression models were conducted to predict the missingness of each variable from observed same-day and lagged predictors. This is consistent with recommendations in EMA research and LMM as an evaluation of the plausibility of the missing at random assumption by testing whether missingness depends on observed data, including prior measurements (Enders, 2022; West et al., 2014). Results indicated missingness was independent of observed variables, which is consistent with the plausible missing at random assumption. The only exception was missingness in sleep quality, which was modestly predicted by prior-day *Concerns over Mistakes*. Overall, these results broadly supported the plausible missing at random assumption and thus, the use of maximum likelihood estimates in LMM for subsequent analyses. However, results should be interpreted with caution since the missing at random assumption cannot be definitely tested.

Following Barr et al. (2013), models were initially fitted with the maximal random effect structure, including random slopes, using restricted maximum likelihood estimation. However, the random slope models failed to converge, so all multilevel models were estimated with random intercepts and fixed slopes. For each combination of EMA sleep and perfectionism variable, a separate multilevel model was run, accounting for within-person variability (mean-centered) and between-person variability (grand mean-centered) in line with Brown (2021). Age and gender were included as covariates using bootstrapping with 10,000 simulations in sensitivity analyses. Results remained unchanged; therefore, models without covariates are presented here.

Next, multilevel mediation analyses were performed for each model by incorporating the average impact rating of stressful events for the day as a mediator. Age and gender were also included as covariates in sensitivity analyses. All multilevel analyses were conducted using the R package lavaan (Rosseel, 2012). As lavaan is unable to provide bootstrapping for clustered data, the R package brms was used to rerun each model using Bayesian multilevel mediation with 4,000 simulations to confirm lavaan results (Bürkner, 2017). As per O'Rourke and MacKinnon (2018), mediation analyses were conducted despite a non-significant total effect. Sleep onset latency was the only outcome variable that was skewed and, therefore, log transformed. Model assumptions and effects were visually inspected and met. Alpha level was set at $p < .05$ for two-tailed analyses.

Results

Descriptive data

A total of 63 participants, aged 18–66 years ($M = 30.13$, $SD = 10.96$) and of whom 85.7% identified as female, were included in the final sample. Participants reported ISI scores that ranged from 0 to 25 ($M = 7.63$, $SD = 5.92$). Using an ISI score exceeding 9, 39.7% of the sample were classified as "poor sleepers" (Morin et al., 2011). Means and standard deviations of sleep measures are presented in Table 1. Means and standard deviations of perfectionism measures collected once at baseline (FMPS and HFMPS subscales) and daily

Table 1. Mean scores and standard deviations of sleep measures.

			Range	
	M	*SD*	Minimum	Maximum
Sleep onset latency (minutes)	21.80	28.71	0	270
Wake after sleep onset (minutes)	19.06	33.47	0	270
Total sleep time (hours)	7.30	1.49	1.33	12.50
Number of awakenings	1.46	1.52	0	9
Sleep efficiency (%)	91.65	9.63	34	100
Sleep quality [rate 0 (very bad) to 10 (very good)]	6.49	2.18	0	10

Notes. SOL, sleep onset latency; WASO, wake after sleep onset; TST, total sleep time; NOA, number of awakenings; SE, sleep efficiency; SQ, sleep quality.

Table 2. Mean scores and standard deviations of perfectionism measures, and intraclass correlations of daily perfectionism and stress measures.

	M	*SD*	Sample Range (Score Range)	Intraclass Correlation
Subscales from FMPS and HFMPS				
FMPS: Concern over Mistakes	26.70	8.16	11–45 (9–45)	
FMPS: Doubts about Actions	11.84	3.80	5–20 (4–20)	
HFMPS: Socially Prescribed Perfectionism	52.10	13.01	28–105 (15–105)	
Daily Perfectionism Measures				
Daily Concern over Mistakes	2.01	1.13	1–5 (1–5)	.52
Daily Doubts about Actions	2.23	1.22	1–5 (1–5)	.54
Daily Socially Prescribed Perfectionism	1.87	1.11	1–5 (1–5)	.48
Daily Stress Inventory (AIR)	2.27	1.24	0–6 (N.A.)	.63

Notes. FMPS, Frost Multidimensional Perfectionism Scale; HFMPS, Hewitt-Flett Multidimensional Perfectionism Scale; AIR, average impact rating of stressful events for the day.

Table 3. Correlations between sleep variability and perfectionism measures.

n = 63	1	2	3	4	5	6	7	8	9	10
1. CM										
2. DA	.61**									
3. SPP	.65**	.51**								
4. SOL variability	.26*	.32*	.10							
5. WASO variability	−.06	.01	.07	.06						
6. TST variability	.11	.19	.08	.07	.15					
7. NOA variability	−.02	−.04	−.06	−.17	.01	.09				
8. SE variability	.02	.14	.04	.48**	.82**	.26*	−.11			
9. SQ variability	−.04	.09	−.01	.07	.31*	.19	.05	.35		
10. DSI variability	.11	.05	.30*	.22	.24	.14	.01	.10	.09	
11. ISI	.42**	.43**	.50**	.24*	.40**	.10	.04	.44**	.26*	.18

Notes. CM, Concern over Mistakes; DA, Doubts about Actions; SPP, Socially Prescribed Perfectionism; variability is calculated as standard deviation of sleep and stress measures: SOL, sleep onset latency; WASO, wake after sleep onset; TST, total sleep time; NOA, number of awakenings; SE, sleep efficiency; SQ, sleep quality, DSI, Daily Stress Inventory; ISI, Insomnia Severity Index. *$p < .05$. **$p < .01$.

perfectionism EMA measures are presented in Table 2. Intraclass correlations greater than .05 in daily perfectionism indicated substantial day-to-day state-like variation and thus were suitable for multilevel analysis (Preacher et al., 2010).

Correlation analyses between sleep variability and perfectionism measures

Table 3 shows the number and strength of correlations between the sleep IIV and perfectionism dimensions. Specifically, IIV in sleep onset latency correlated significantly with *Concern over Mistakes* ($p = .04$) and *Doubts about Actions* ($p = .01$). These correlations were considered to have small to medium effects (Cohen, 1988).

Perfectionism predicting sleep with mediating effects of stress

LMM summaries of between- and within-person changes in daily perfectionism predicting sleep during the same night with daily stress as a mediator are presented in Table 4. Model summaries of multilevel analysis before mediation are presented in Appendix Table 1A. Results were consistent across analyses. Between-person effects showed that individuals with higher *Concern over Mistakes* had longer sleep onset latency and lower sleep quality. Furthermore, those with higher levels of *Doubts about Action* had lower sleep quality. Stress did not mediate any relationships from perfectionism to sleep. No within-person effects were found for changes in perfectionism to predict sleep during the same night. However, daily stress mediated the relationships from *Concerns over Mistakes* and *Doubts about Actions* to sleep quality (see Figures 1 and 2). Sensitivity analyses, including covariates and Bayesian models, are presented in Appendix Tables 3A and 5A, respectively.

Table 4. Multilevel analysis of daily perfectionism predicting daily sleep using daily stress as a mediator ($n = 63$).

	Sleep Onset Latency		Sleep Quality	
	Direct Pathway	Mediated Pathway	Direct Pathway	Mediated Pathway
Daily Concerns over Mistake				
Within	−0.061 [−0.093 - 0.061]	0.0138 [−0.004 - 0.03]	0.153 [−0.035 - 0.340]	**-0.058*** [-0.096 - −0.020] $p = .003$
Between	**0.298*** [0.012 - 0.584] $p = .041$	−0.061 [−0.359 - 0.236]	**−0.889**** [−1.329 - −0.449] $p < .001$	−0.437 [−0.957 - 0.084]
Daily Doubts about Actions				
Within	0.001 [−0.066 - 0.068]	0.011 [−0.006 - 0.027]	0.075 [−0.089 - 0.240]	**−0.050*** [−0.088 - −0.013] $p = .009$
Between	0.217 [0.055 - 0.489]	0.006 [−0.301 - 0.313]	**−0.813**** [−1.263 - 0.364] $p < .001$	−0.347 [−0.892 - 0.199]

Notes. Results are unstandardized regression coefficients [95% confidence interval]. *$p < .05$, **$p < .001$.

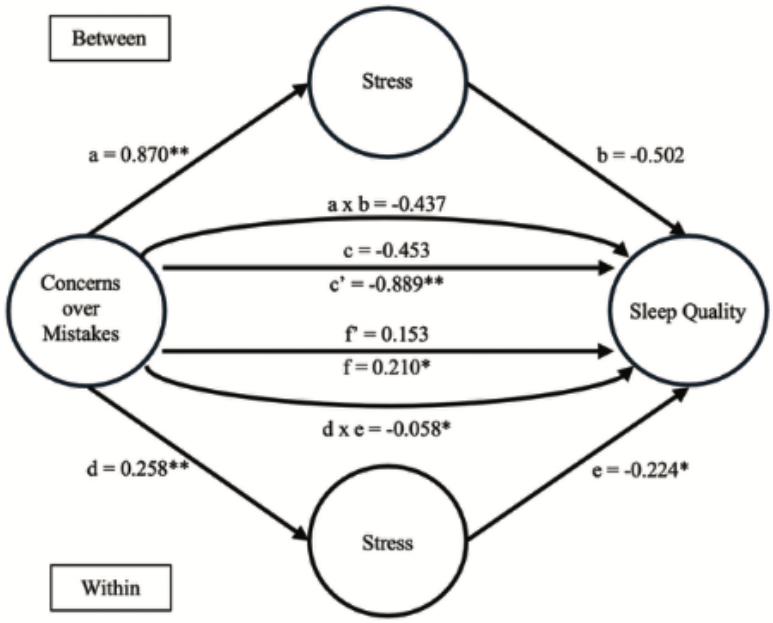


Figure 1. Multilevel path analysis of daily Concerns over Mistakes predicting sleep quality using daily stress as a mediator. *Notes*. a × b and d × e, indirect mediated pathway, c and f, total effect without mediator, c′ and f,′ direct effect controlling for mediator, results presented are unstandardised regression coefficients. *$p < .05$, **$p < .001$.

Sleep predicting next-day perfectionism with mediating effects of stress

LMM summaries of daily sleep predicting daily perfectionism with daily stress as a mediator are presented in Table 5, showing between-person and within-person effects. Initial analysis before mediation is presented in Appendix Table 2A. Between-person effects showed that individuals with longer sleep onset latency and lower sleep quality reported higher levels of *Concerns over Mistakes* and *Daily Doubts about Actions*, and those relationships were mediated by stress. No within-person effect was found for sleep onset latency and sleep quality in predicting next-day *Concerns over Mistakes* and *Doubts about Actions*. Stress did not affect these relationships. Sensitivity analyses, including covariates and Bayesian models, are presented in Appendix Tables 4A and 6A, respectively.

Discussion

The current study is the first to examine the relationship between perfectionism and sleep variability. It investigated the direct temporal effects of changes in perfectionism and sleep and vice versa on a day-to-day

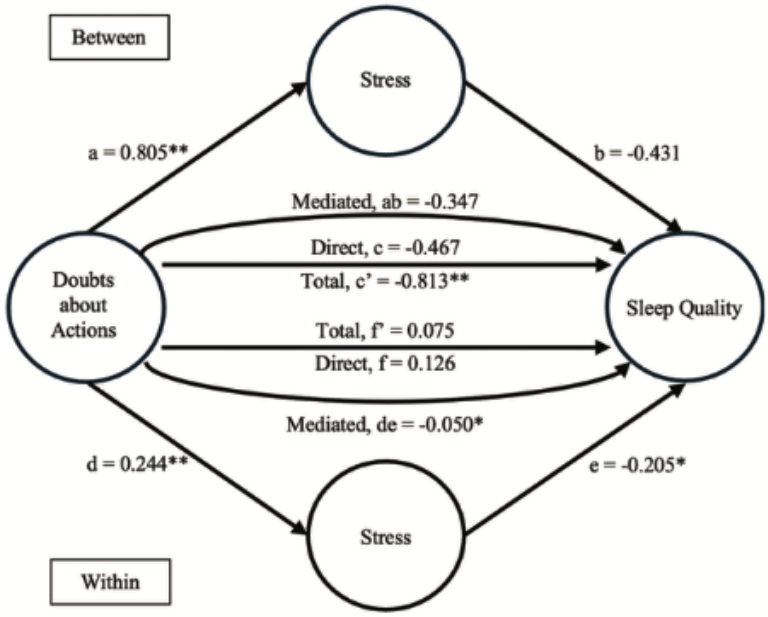


Figure 2. Multilevel path analysis of daily Doubts about Action predicting sleep quality using daily stress as a mediator. *Notes*. a × b and d × e, indirect mediated pathway, c and f, total effect without mediator, c' and f,' direct effect controlling for mediator, results presented are unstandardized regression coefficients. *$p < .05$, **$p < .001$.

Table 5. Multilevel analysis of daily sleep predicting daily perfectionism using daily stress as a mediator ($n = 63$).

	Daily Concerns over Mistakes		Daily Doubts about Actions	
	Direct Pathway	Mediated Pathway	Direct Pathway	Mediated Pathway
Sleep onset latency				
Within	0.002 [−0.002 - 0.005]	0.001 [−0.000 - 0.005]	0.002 [−0.001 - 0.005]	0.001 [−0.000 - 0.002]
Between	**0.017*** [0.007 - 0.028] $p = .001$	**0.008*** [0.000 -0.016] $p = .042$	**0.017*** [0.006 - 0.028] $p = .003$	**0.010*** [0.001 - 0.019] $p = .029$
Sleep quality				
Within	−0.002 [−0.053 - 0.048]	−0.008 [−0.021 - 0.006]	−0.034 [−0.092 - 0.023]	−0.008 [−0.022 - 0.006]
Between	**−0.266**** [−0.409 - −0.122] $p < .001$	**-0.164*** [*-0.270 - −0.058*] $p = .002$	**−0.301**** [−0.434 - −0.168] $p < .001$	**−0.196**** [−0.304 - − 0.088] $p < .001$

Notes. Results are unstandardised regression coefficients [95% confidence interval]. *$p < .05$, **$p < .001$.

basis, with daily stress as a mediator across a 14-day longitudinal design with repeated EMA. Correlations showed that higher levels of perfectionism were associated with higher variability in sleep onset latency. Multilevel analysis results suggest that at the between-person level, a relationship between perfectionism and poor sleep exists and is bidirectional. Individuals with higher perfectionistic tendencies were more likely to experience disrupted sleep (i.e., prolonged sleep onset latency and poorer sleep quality), and conversely, those with more disrupted sleep also reported elevated perfectionism. However, changes in daily perfectionism did not directly influence sleep or vice versa. Nonetheless, stress provided an indirect pathway from daytime perfectionism to the same night of sleep, showing that stress mediated that relationship, but only in this direction. Compared to one's own average level of perfectionism, greater perfectionism tendencies during the day led to higher stress, which in turn predicted lower sleep quality that night. Stress did not mediate the effect of sleep on next-day perfectionism. These results highlight the role stress plays in the relationships between sleep and perfectionism.

Overall, results suggest that higher perfectionism is associated with poorer sleep. Specifically, all between-person results were significant in both directions of the relationships between perfectionism and sleep, except for *Doubts about Actions* not predicting sleep onset latency. These results provide support for the bidirectionality in those relationships, suggesting that those with higher levels of perfectionism tend to

report worse sleep, and those with worse sleep also tend to report higher levels of perfectionistic concerns. The finding is consistent with previous research indicating that perfectionism is associated positively with sleep onset latency and negatively with sleep quality and that insomnia symptoms are associated with and predict future perfectionism levels (e.g., Akram et al., 2015, 2023; Elbadawi et al., 2025; Oh et al., 2024; Richardson & Gradisar, 2020).

The lack of within-person effects in both directions of the relationship between perfectionism and sleep suggests that day-to-day fluctuations in perfectionism do not affect day-to-day fluctuations in sleep and vice versa. This implies that there are trait-like fluctuations in perfectionism, which are not linked to, and fluctuate independently from, sleep. However, it is important to consider that instrument insensitivity might explain the lack of intra-individual relationships. As there was no existing validated measure of daily perfectionism, the items that formed the DPM were adapted from FMPS and HFMPS. The restricted response options on the 5-point Likert scale may not have been sufficiently nuanced to capture changes over time, thereby reducing its sensitivity. Furthermore, reliance on a single item derived from an instrument established at the between-person level may not have reflected the full dimensionality of the daily construct and should be reconsidered in future research (Brose et al., 2020). Nonetheless, the intraclass correlations, which measure the proportion of between-person variation to total variation, were acceptable for multilevel analysis (Preacher et al., 2010).

Another consideration relates to sample characteristics, which might have also contributed to the lack of within-person effects. Participants in this study were drawn from the general population and included individuals who reported a range of normal sleep and insomnia symptoms, which may have reduced the likelihood of finding within-person effects compared to a clinical sample. It is also possible that the current study did not have enough power to detect any within-person effects, given the short study duration of 14 days, particularly if those effects were small.

This study found the experience of heightened stress as an indirect pathway in the effect of daytime perfectionism on sleep quality at the within-person level and in the relationship between sleep and perfectionism at the between-person level. At the within-person level, when a person reported higher than their average daily perfectionism level, they also reported higher levels of stress for that day, which led to worse sleep quality that night. This suggests that individuals who experience higher than their average levels of state-like perfectionism are at greater risk of experiencing stress, which then adversely affects sleep. This contrasts with the finding by Kuskens et al. (2023) that stress was not a pathway in the link between perfectionism and sleep. The difference in outcomes is likely due to differences in methodology. Kuskens et al. (2023) studied how trait perfectionism at baseline related to daily sleep and stress measures, whereas here, daily fluctuations in perfectionism, stress, and sleep were studied. The current finding is, however, consistent with previous research findings that trait perfectionism was associated with poor sleep via stress and provides further evidence to support the mediating hypothesis of stress in the relationship between perfectionism and sleep (Brand et al., 2015; Lundh et al., 1994; Molnar et al., 2020). Furthermore, the mediating effects found at the between-person level in this study offer initial evidence that individuals who experience poorer sleep tend to report higher levels of stress, which increase their level of perfectionism.

Clinical implications

Overall, the current study indicates that perfectionism is a risk factor for poor sleep and that stress plays an indirect role in the bi-directional relationships between sleep and perfectionism. When assessing and delivering treatment for poor sleep, it may be helpful for clinicians to consider whether perfectionism is playing a role in the patient's poor sleep and treatment response. More importantly, stress management may be an important consideration when delivering therapy for sleep difficulties to people who also report high levels of perfectionism. Specifically, when sleep difficulties are experienced, stress management may be a viable initial target for intervention for people with high perfectionism. Stress management strategies, such as progressive muscle relaxation, deep breathing, and guided imagery, which can be delivered face-to-face or easily accessed via recorded audio, are effective in promoting states of relaxation and reducing symptoms of anxiety and distress (Hamdani et al., 2022; Toussaint et al., 2021). Such interventions may be helpful in

preventing the worsening of sleep difficulties, particularly while waiting for access to limited behavioral sleep medicine providers and specialist sleep therapy resources, such as cognitive behavioral therapy for insomnia (Koffel et al., 2018).

Strengths, limitations, and future directions

The current study extended the perfectionism-sleep literature beyond cross-sectional evidence. To our knowledge, this is the first study to examine the relationship between perfectionism and sleep at an intra-individual level, and it provided new evidence that poor sleep predicted perfectionistic thinking, as opposed to the reverse of perfectionism predicting sleep, which is well supported by previous research (e.g., Azevedo et al., 2009; Molnar et al., 2020; Oh et al., 2024; Vincent & Walker, 2000). As already noted, due to the lack of a validated measure of daily perfectionism, key dimensions from the FMPS and HFPMS were used in a novel approach. We therefore developed the Daily Perfectionism Measures. However, it is possible that the Daily Perfectionism Measures were not sensitive enough to capture the nuanced day-to-day fluctuations in these perfectionism dimensions. This highlights the need for future research to develop a validated measure for capturing daily fluctuations in levels of perfectionism to facilitate further intra-individual variability studies in the future. The current study has limited the analysis of relationships between daily perfectionism and markers of poor sleep using only dimensions of *Concerns over Mistakes* and *Doubts about Actions*. It is possible that day-to-day fluctuations in other perfectionism subscales may be related to poor sleep and, therefore, should be explored in future research. Finally, this study may have lacked sufficient power to detect potential effects. Future work should increase sample size, extend study duration, and include clinical samples.

Conclusions

This is the first study to explore the bi-directional relationships between perfectionism and sleep using ecological momentary assessment data, and it found that perfectionism and poor sleep influence each other bidirectionally at the between-person level. Individuals who reported higher levels of perfectionism tend to report longer sleep onset latency and lower sleep quality, and those who report longer sleep onset latency and lower sleep quality also tend to report higher levels of perfectionism. Furthermore, stress appears to be an indirect pathway linking sleep and perfectionism. The only within-person effect found indicates that when individuals experience higher than their average level of perfectionism, they are also more likely to experience stress, which leads to lower sleep quality. These findings suggest that when assessing and treating sleep problems, perfectionism may be an important factor to consider. Additionally, when individuals with poor sleep report high levels of perfectionism, stress management may be an important therapy target.

Author contributions

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ORCID

Susie Y. Oh http://orcid.org/0009-0008-8145-9038
Hailey Meaklim http://orcid.org/0000-0003-0448-3567
Christian L. Nicholas http://orcid.org/0000-0002-3837-3609
David Cunnington http://orcid.org/0000-0002-8403-0420
Cameron J. Patrick http://orcid.org/0000-0002-4677-535X
Maya Schenker http://orcid.org/0000-0003-3811-2940
Lisa J. Phillips http://orcid.org/0000-0003-1060-6068

References

Akram, U., Ellis, J. G., & Barclay, N. L. (2015). Anxiety mediates the relationship between perfectionism and insomnia symptoms: A longitudinal study. *PLOS ONE*, *10*(10), e0138865. https://doi.org/10.1371/journal.pone.0138865

Akram, U., Stevenson, J. C., Gardani, M., Allen, S., & Johann, A. F. (2023). Personality and insomnia: A systematic review and narrative synthesis. *Journal of Sleep Research*, *32*(6), e14031. https://doi.org/10.1111/jsr.14031

Azevedo, M. H., Soares, M. J., Bos, S. C., Gomes, A. A., Maia, B., Marques, M., Pereira, A. T., & Macedo, A. (2009). Perfectionism and sleep disturbance. *The World Journal of Biological Psychiatry*, *10*(3), 225–233. https://doi.org/10.1080/15622970701367930

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, *68*(3), 255–278. https://doi.org/10.1016/j.jml.2012.11.001

Bastien, C. H., Vallieres, A., & Morin, C. M. (2001). Validation of the insomnia severity Index as an outcome measure for insomnia research. *Sleep Medicine*, *2*(4), 297–307. https://doi.org/10.1016/s1389-9457(00)00065-4

Bei, B., Wiley, J. F., Trinder, J., & Manber, R. (2016). Beyond the mean: A systematic review on the correlates of daily intraindividual variability of sleep/wake patterns. *Sleep Medicine Review*, *28*, 108–124. https://doi.org/10.1016/j.smrv.2015.06.003

Boone, L., & Soenens, B. (2015). In double trouble for eating pathology? An experimental study on the combined role of perfectionism and body dissatisfaction. *Journal of Behavior Therapy and Experimental Psychiatry*, *47*, 77–83. https://doi.org/10.1016/j.jbtep.2014.11.005

Boone, L., Soenens, B., Mouratidis, A., Vansteenkiste, M., Verstuyf, J., & Braet, C. (2012). Daily fluctuations in perfectionism dimensions and their relation to eating disorder symptoms. *Journal of Research in Personality*, *46*(6), 678–687. https://doi.org/10.1016/j.jrp.2012.08.001

Brand, S., Kirov, R., Kalak, N., Gerber, M., Puhse, U., Lemola, S., Correll, C. U., Cortese, S., Meyer, T., & Holsboer-Trachsler, E. (2015). Perfectionism related to self-reported insomnia severity, but not when controlled for stress and emotion regulation. *Neuropsychiatric Disease and Treatment*, *11*, 263–271. https://doi.org/10.2147/NDT.S74905

Brantley, P. J., Waggoner, C. D., Jones, G. N., & Rappaport, N. B. (1987). A daily stress inventory: Development, reliability, and validity. *Journal of Behavioral Medicine*, *10*(1), 61–74. https://doi.org/10.1007/BF00845128

Bredeli, E., Vestergaard, C. L., Sivertsen, B., Kallestad, H., Overland, S., Ritterband, L. M., Glozier, N., Pallesen, S., Scott, J., Langsrud, K., & Vedaa, O. (2022). Intraindividual variability in sleep among people with insomnia and its relationship with sleep, health and lifestyle factors: An exploratory study. *Sleep Medicine*, *89*, 132–140. https://doi.org/10.1016/j.sleep.2021.12.006

Brose, A., Schmiedek, F., Gerstorf, D., & Voelkle, M. C. (2020). The measurement of within-person affect variation. *Emotion*, *20*(4), 677–699. https://doi.org/10.1037/emo0000583

Brown, V. A. (2021). An introduction to linear mixed-effects modeling in r. *Advances in Methods and Practices in Psychological Science*, *4*(1), 4(1). https://doi.org/10.1177/2515245920960351

Bürkner, P. (2017). Brms: An R package for Bayesian multilevel models using Stan. *Journal of Statistical Software*, *80*(1), 1–28. https://doi.org/10.18637/jss.v080.i01

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge Academic.

Dunkley, D. M. (2017). Perfectionism and daily stress, coping, and affect. Advancing multilevel explanatory conceptualisations. In J. Stoeber (Ed.), *The psychology of perfectionism: Theory, research, applications* (pp. 222–242). Routledge/Taylor & Francis Group. https://doi.org/10.1037/a0034673

Egan, S. J., Wade, T. D., & Shafran, R. (2011). Perfectionism as a transdiagnostic process: A clinical review. *Clinical Psychology Review*, *31*(2), 203–212. https://doi.org/10.1016/j.cpr.2010.04.009

Elbadawi, M. H., Mubasher, A. A., Abdulgalil, A. A., Alsaid, A., Elameen, N., Magdi, R., Mohamed, W. A., & Fadul, M. H. (2025). The relationship between perfectionism and quality of sleep: A cross-sectional study among Sudanese medical students. *Health Science Reports*, *8*(7), e71075. https://doi.org/10.1002/hsr2.71075

Enders, C. K. (2022). *Applied missing data analysis* (2nd ed.). The Guildord Press.

Espie, C. A., Broomfield, N. M., MacMahon, K. M., Macphee, L. M., & Taylor, L. M. (2006). The attention-intention-effort pathway in the development of psychophysiologic insomnia: A theoretical review. *Sleep Medicine Review*, *10*(4), 215–245. https://doi.org/10.1016/j.smrv.2006.03.002

Flett, G. L., & Hewitt, P. L. (Eds.). (2002). *Perfectionism: Theory, research, and treatment*. American Psychological Association. https://doi.org/10.1037/10458-000

Frost, R. O., Marten, P., Lahart, C., & Rosenblate, R. (1990). The dimensions of perfectionism. *Cognitive Therapy and Research*, *14*(5), 449–468. https://doi.org/10.1007/BF01172967

Galloway, R., Watson, H., Greene, D., Shafran, R., & Egan, S. J. (2022). The efficacy of randomised controlled trials of cognitive behaviour therapy for perfectionism: A systematic review and meta-analysis. *Cognitive Behavior Therapy*, *51*(2), 170–184. https://doi.org/10.1080/16506073.2021.1952302

Hamdani, S. U., Zill, E. H., Zafar, S. W., Suleman, N., Um Ul, B., Waqas, A., & Rahman, A. (2022). Effectiveness of relaxation techniques 'as an active ingredient of psychological interventions' to reduce distress, anxiety and depression in adolescents: A systematic review and meta-analysis. *International Journal of Mental Health Systems*, *16*(1), 31. https://doi.org/10.1186/s13033-022-00541-y

Hewitt, P. L., & Flett, G. L. (1991). Perfectionism in the self and social contexts: Conceptualisation, assessment, and association with psychopathology. *Journal of Personality & Social Psychology*, *60*(3), 456–470. https://doi.org/10.1037/0022-3514.60.3.456

Hewitt, P. L., Flett, G. L., Turnbull-Donovan, W., & Mikail, S. F. (1991). The multidimensional perfectionism scale: Reliability, validity, and psychometric properties in psychiatric samples. *Psychological Assessment: A Journal of Consulting Clinical Psychology*, *3*(3), 464–468. https://doi.org/10.1037/1040-3590.3.3.464

Ip, V. (2025). Cognitive behavioural therapy outcomes for clinical perfectionism: A scoping review. *Technology in Medicine*, *102*(1), 7–17. https://doi.org/10.33137/utmj.v102i1.42426

Johann, A. F., Feige, B., Hertenstein, E., Nissen, C., Benz, F., Steinmetz, L., Baglioni, C., Riemann, D., Spiegelhalder, K., & Akram, U. (2023). The effects of cognitive behavioral therapy for insomnia on multidimensional perfectionism. *Behavior Therapy*, *54*(2), 386–399. https://doi.org/10.1016/j.beth.2022.10.001

Koffel, E., Bramoweth, A. D., & Ulmer, C. S. (2018). Increasing access to and utilization of cognitive behavioral therapy for insomnia (CBT-I): A narrative review. *Journal of General Internal Medicine*, *33*(6), 955–962. https://doi.org/10.1007/s11606-018-4390-1

Koval, P., Hinton, J., Dozo, N., Gellson, J., Alvarez, M., Harrison, A., Vu, D., Susanto, R., Jayaputera, G., & Sinnott, R. (2019). *Sema3: Smartphone ecological momentary assessment, version 3*. http://www.sema3.com

Kuskens, A., Stricker, J., Hertrampf, L. S., Peitrowsky, R., & Gieselmann, A. (2023). Perfectionism, perceived stress, and pre-sleep arousal in insomnia: Effects on sleep quality in a daily life study. *Journal of Clinical Sleep Medicine*, *20*(3), 433–443. https://doi.org/10.5664/jcsm.10910

Limburg, K., Watson, H. J., Hagger, M. S., & Egan, S. J. (2017). The relationship between perfectionism and psychopathology: A meta-analysis. *Journal of Clinical Psychology*, *73*(10), 1301–1326. https://doi.org/10.1002/jclp.22435

Lundh, L. G., & Broman, J. E. (2000). Insomnia as an interaction between sleep interfering and sleep-interpreting processes. *Journal of Psychosomatic Research*, *49*(5), 299–310. https://doi.org/10.1016/S0022-3999(00)00150-1

Lundh, L. G., Broman, J. E., Hetta, J., & Saboonchi, F. (1994). Perfectionism and insomnia. *Scandinavian Journal of Behaviour Therapy*, *23*(1), 3–18. https://doi.org/10.1080/16506079409455949

Maas, C. J. M., & Hox, J. J. (2005). Sufficient sample sizes for multilevel modeling. *Methodology*, *1*(3), 86–92. https://doi.org/10.1027/1614-2241.1.3.86

Mackinnon, S. P., Battista, S. R., Sherry, S. B., & Stewart, S. H. (2014). Perfectionistic self-presentation predicts social anxiety using daily diary methods. *Personality & Individual Differences*, *56*, 143–148. https://doi.org/10.1016/j.paid.2013.08.038

Mackinnon, S. P., Kehayes, I. L., Leonard, K. E., Fraser, R., & Stewart, S. H. (2017). Perfectionistic concerns, social negativity, and subjective well-being: A test of the social disconnection model. *Journal of Personality*, *85*(3), 326–340. https://doi.org/10.1111/jopy.12243

Mackinnon, S. P., Ray, C. M., Firth, S. M., & O'Connor, R. M. (2019). Perfectionism, negative motives for drinking, and alcohol-related problems: A 21-day diary study. *Journal of Research in Personality*, *78*, 177–188. https://doi.org/10.1016/j.jrp.2018.12.003

Merwin, K. E., Mackinnon, S. P., O'Connor, R. M., & Flett, G. L. (2022). Socially prescribed perfectionism predicts next-day binge eating behaviors over 20-days. *Journal of Counseling Psychology*, *69*(4), 554–564. https://doi.org/10.1037/cou0000600

Messman, B. A., Wiley, J. F., Feldman, E., Dietch, J. R., Taylor, D. J., & Slavish, D. C. (2024). Irregular sleep is linked to poorer mental health: A pooled analysis of eight studies. *Sleep Health*, *10*(4), 493–499. https://doi.org/10.1016/j.sleh.2024.03.004

Molnar, D. S., Janssen, W. F., & Sirois, F. M. (2020). Sleeping perfectly? Trait perfectionism, perceived stress, and sleep quality. *Personality & Individual Differences*, *167*, 110244. https://doi.org/10.1016/j.paid.2020.110244

Molnar, D. S., Thai, S., Blackburn, M., Zinga, D., Flett, G. L., & Hewitt, P. L. (2023). Dynamic changes in perfectionism dimensions and psychological distress among adolescents assessed before and during the COVID-19 pandemic. *Child Development*, *94*(1), 254–271. https://doi.org/10.1111/cdev.13855

Monk, T. H., Reynolds, C. F., III, Kupfer, D. J., Buysse, D. J., Coble, P. A., Hayes, A. J., Machen, M. A., Petrie, S. R., & Ritenour, A. M. (1994). The Pittsburgh sleep diary. *Journal of Sleep Research*, *3*(2), 111–120. https://doi.org/10.1111/j.1365-2869.1994.tb00114.x

Morin, C. M., Belleville, G., Belanger, L., & Ivers, H. (2011). The insomnia severity index: Psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep*, *34*(5), 601–608. https://doi.org/10.1093/sleep/34.5.601

Morin, C. M., & Espie, C. A. (2007). *Insomnia: A clinical guide to assessment and treatment*. Springer Science & Business Media.

Oh, S. Y., Meaklim, H., Nicholas, C. L., Cunnington, D., Schenker, M., Patrick, C. J., Windred, D., & Phillips, L. J. (2024). Perfect enough to sleep? Perfectionism and actigraphy-determined markers of insomnia. *Behavioral Sleep Medicine*, *22*(5), 1–16. https://doi.org/10.1080/15402002.2024.2355476

O'Rourke, H. P., & MacKinnon, D. P. (2018). Reasons for testing mediation in the absence of an intervention effect: A research imperative in prevention and intervention research. *Journal of Studies on Alcohol and Drugs*, *79*(2), 171–181. https://doi.org/10.15288/jsad.2018.79.171

Ottenstein, C., & Werner, L. (2022). Compliance in ambulatory assessment studies: Investigating study and sample characteristics as predictors. *Assessment*, *29*(8), 1765–1776. https://doi.org/10.1177/10731911211032718

Preacher, K. J., Zyphur, M. J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods*, *15*(3), 209–233. https://doi.org/10.1037/a0020141

Rice, K. G., & Aldea, M. A. (2006). State dependence and trait stability of perfectionism: A short-term longitudinal study. *Journal of Counseling Psychology*, *53*(2), 205–213. https://doi.org/10.1037/0022-0167.53.2.205

Richardson, C., & Gradisar, M. (2020). Perfectionism and insomnia in adolescents: The role of vulnerability to stress and gender. *Journal of Adolescence*, *85*(1), 70–79. https://doi.org/10.1016/j.adolescence.2020.10.003

Riemann, D., Spiegelhalder, K., Feige, B., Voderholzer, U., Berger, M., Perlis, M., & Nissen, C. (2010). The hyperarousal model of insomnia: A review of the concept and its evidence. *Sleep Medicine Review*, *14*(1), 19–31. https://doi.org/10.1016/j.smrv.2009.04.002

Rosseel, Y. (2012). Lavaan: An R package for structural equation modeling. *Journal of Statistical Software*, *48*(2), 1–36. https://doi.org/10.18637/jss.v048.i02

Ståhlberg, J., Tuominen, H., Pulkka, A. T., & Niemivirta, M. (2020). Students' perfectionistic profiles: Stability, change, and associations with achievement goal orientations. *Psychology in the Schools*, *58*(1), 162–184. https://doi.org/10.1002/pits.22444

Stoeber, J., & Otto, K. (2006). Positive conceptions of perfectionism: Approaches, evidence, challenges. *Personality and Social Psychology Review*, *10*(4), 295–319. https://doi.org/10.1207/s15327957pspr1004_2

Stricker, J., Kroger, L., Johann, A. F., Kuskens, A., Gieselmann, A., & Pietrowsky, R. (2023). Multidimensional perfectionism and poor sleep: A meta-analysis of bivariate associations. *Sleep Health*, *9*(2), 228–235. https://doi.org/10.1016/j.sleh.2022.09.015

Stuck, B. A., Maurer, J. T., Schlarb, A. A., Schredl, M., & WeeB, H.-G. (2021). *Practice of sleep medicine: Sleep disorders in children and adults*. Springer.

Suh, H., Sohn, H., Kim, T., & Lee, D. G. (2019). A review and meta-analysis of perfectionism interventions: Comparing face-to-face with online modalities. *Journal of Counseling Psychology*, *66*(4), 473–486. https://doi.org/10.1037/cou0000355

Toussaint, L., Nguyen, Q. A., Roettger, C., Dixon, K., Offenbacher, M., Kohls, N., Hirsch, J., & Sirois, F. (2021). Effectiveness of progressive muscle relaxation, deep breathing, and guided imagery in promoting psychological and physiological states of relaxation. *Evidence-Based Complementary and Alternative Medicine*, *2021*, 5924040. https://doi.org/10.1155/2021/5924040

Vecchione, M., & Marsicano, G. (2023). Mean-level change of perfectionism in late childhood: A 2-year longitudinal investigation. *Current Psychology*, *43*(14), 12321–12334. https://doi.org/10.1007/s12144-023-05317-2

Vincent, N. K., & Walker, J. R. (2000). Perfectionism and chronic insomnia. *Journal of Psychosomatic Research*, *49*(5), 349–354. https://doi.org/10.1016/S0022-3999(00)00175-6

Wegerer, M. (2024). Cognitive-behavioral treatment of rerfectionism: An overview of the state of research and practical therapeutical procedures. *Verhaltenstherapie*, *34*(1), 1–10. https://doi.org/10.1159/000532044

West, B. T., Welch, K. B., & Galecki, A. T. (2014). *Linear mixed models: A practical guide to using statistical software* (2nd ed.). CRC Press

Williams, M. T., Lewthwaite, H., Fraysse, F., Gajewska, A., Ignatavicius, J., & Ferrar, K. (2021). Compliance with mobile ecological momentary assessment of self-reported health-related behaviors and psychological constructs in adults: Systematic review and meta-analysis. *Journal of Medical Internet Research*, *23*(3), e17023. https://doi.org/10.2196/17023

Wilson, S. J., Nutt, D. J., Alford, C., Argyropoulos, S. V., Baldwin, D. S., Bateson, A. N., Britton, T. C., Crowe, C., Dijk, D. J., Espie, C. A., Gringras, P., Hajak, G., Idzikowski, C., Krystal, A. D., Nash, J. R., Selsick, H., Sharpley, A. L., & Wade, A. G. (2010). British Association for Psychopharmacology consensus statement on evidence-based treatment of insomnia, parasomnias and circadian rhythm disorders. *Journal of Psychopharmacology*, *24*(11), 1577–1601. https://doi.org/10.1177/0269881110379307

Zhao, W., Van Someren, E. J. W., Xu, Z., Ren, Z., Tang, L., Li, C., & Lei, X. (2024). Identifying the insomnia-related psychological issues associated with hyperarousal: A network perspective. *International Journal of Psychophysiology*, *195*, 112276. https://doi.org/10.1016/j.ijpsycho.2023.112276

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10.4.3 Study 3 Supplementary Materials

Table C1

Multilevel analysis of daily perfectionism predicting daily sleep with age and gender as covariates and bootstrapping (n = 63, simulations = 10,000)

		Log Sleep Onset Latency			Sleep Quality		
		Estimate	*CI*	*p*	*Estimate*	*CI*	*p*
Daily Concerns over Mistakes							
	Within	-0.03	-0.1 – 0.05	.480	0.14	-0.04 – 0.33	.130
	Between	0.29	0.02 – 0.57	.037*	-0.87	-1.34 - -0.40	.001*
Daily Doubts about Actions							
	Within	0.00	-0.06 – 0.07	.891	0.1	-0.06 – 0.26	.220
	Between	0.19	-0.05 – 0.43	.122	-0.77	-1.18 - -0.36	.001*

Notes. *$p < .05$.

Table C2

Multilevel analysis of daily sleep predicting daily perfectionism with age and gender as covariates and bootstrapping (n = 63, simulations = 10,000)

		Daily Concerns over Mistakes			Daily Doubts about Actions		
		Estimate	*CI*	*p*	*Estimate*	*CI*	*p*
Sleep onset latency							
	Within	0.002	-0.001 - 4.57	.218	0.002	-0.001 - 0.004	.214
	Between	0.01	0.005 - 2.55	.001*	0.015	0.004 - 0.027	.012*
Sleep quality							
	Within	-0.006	-0.046 - 0.034	.756	-0.038	-0.079 - 0.005	.080
	Between	-0.25	-0.368 - -0.134	.000**	-0.282	-0.415 - -0.150	.000**

Notes. *$p < .05$, **$p < .001$.

Table C3

Multilevel analysis of daily perfectionism predicting daily sleep using daily stress as a mediator and age and gender as covariates (n = 63)

	Sleep Onset Latency		Sleep Quality	
	Direct Pathway (total)	Mediated Pathway	Direct Pathway	Mediated Pathway
Daily Concerns over Mistake				
Within (de)	-0.016 [-0.093 - 0.062]	0.013 [-0.004 - 0.030]	0.152 [-0.035 - 0.340]	**-0.058* [**-0.096 - -0.020] *p* = .003
Between (ab)	**0.282+** [-0.015 - 0.580] *p* = .063	-0.081 [-0.363 - 0.202]	**-0.849**** [-1.303 - -0.396] *p* < .001	**-0.442+** [-0.957 - 0.072] *p* = .092
Daily Doubts about Actions				
Within	0.001 [-0.066 - 0.068]	0.011 [-0.006 - 0.027]	0.076 [-0.089 - 0.240]	**-0.050*** [-0.088 - -0.013] *p* = .009
Between	0.177 [-0.092 - 0.446]	0.015 [-0.271 - 0.300]	**-0.776*** [-1.234 - -0.319] *p = .001*	-0.352 [-0.883 - 0.180]

Notes. Results are unstandardised regression coefficients [95% confidence interval]. +$p < .10$, *$p < .05$, **$p < .001$.

Table C4

Multilevel analysis of daily sleep predicting daily perfectionism using daily stress as a mediator and age and gender as covariates (n = 63)

	Daily Concerns over Mistakes		Daily Doubts about Actions	
	Direct Pathway	Mediated Pathway	Direct Pathway	Mediated Pathway
Sleep onset latency				
Within	0.002 [-0.002 - 0.005]	**0.001**+ [-0.000 - 0.002] *p* = .074	0.002 [-0.001 - 0.005]	**0.001**+ [-0.000 - 0.002] *p* = .088
Between	**0.016*** [0.006 - 0.026] *p* =.002	**0.008*** [0.000 -0.015] *p* = .042	**0.016*** [0.004 - 0.027] *p* = .007	**0.010*** [0.001 - 0.018] *p* = .029
Sleep quality				
Within	-0.002 [-0.053 - 0.048]	-0.008 [-0.021 - 0.006]	-0.034 [-0.092 - 0.023]	-0.008 [-0.022 - 0.006]
Between	**-0.244*** [-0.389 - -0.099] *p* = .001	**-0.163*** ***[****-0.269 - -0.057]* *p = .003*	**-0.284**** [-0.418 - -0.149] *p* < .001	**-0.195**** [-0.303 - - 0.088] *p* < .001

Notes. Results are unstandardised regression coefficients [95% confidence interval]. +*p* < .01, **p* < .05, ***p* < .001.

Table C5

Bayesian multilevel analysis of daily perfectionism predicting daily sleep using daily stress as a mediator (n = 63, simulations = 4000)

	Sleep Onset Latency		Sleep Quality	
	Direct Pathway	Mediated Pathway	Direct Pathway	Mediated Pathway
Daily Concerns over Mistake				
Within	0.023 [-0.098 - 0.148]	0.054 [-0.041 - 0.158]	**0.313*** [0.074 - 0.547] *Pr(direction)* = .995	**0.108+ [**-0.057 - 0.283] *Pr(direction)* = .906
Between	**0.300*** [0.020 - 0.568] *Pr(direction)* = .983	-0.081 [-0.363 - 0.202]	**-0.879**** [-1.350 - -0.405] *Pr(direction)* = 1.000	**-0.510*** [-1.030 - -0.033] *Pr(direction)* = .981
Daily Doubts about Actions				
Within	0.030[-0.088 - 0.155]	0.041 [-0.056 - 0.143]	**0.222*** [0.003 - 0.442] *Pr(direction)* = .976	**0.102+** [-0.057 - 0.269] *Pr(direction)* = .902
Between	0.223 [-0.027 - 0.474]	-0.086 [-0.390 - 0.205]	**-0.809**** [-1.220 - -0.388] *Pr(direction)* = 1.000	**-0.469*** [-0.957 - 0.004] *Pr(direction)* = .974

Notes. Results are posterior mean estimates [95% confidence interval]. +*Pr(direction)* ≥ .90;**Pr(direction)* ≥ .95; ***Pr(direction)* ≥ .99

Table C6

Multilevel analysis of daily sleep predicting daily perfectionism using daily stress as a mediator and age and gender as covariates (n = 63)

	Daily Concerns over Mistakes		Daily Doubts about Actions	
	Direct Pathway	Mediated Pathway	Direct Pathway	Mediated Pathway
Sleep onset latency				
Within	-0.002 [-0.003 - 0.003]	**-0.001**· [-0.002 - -0.001] *Pr(direction)* = .988	-0.000 [-0.004 - 0.003]	**-0.001**· [-0.003 - -0.000] *Pr(direction)* = .989
Between	**0.018*** [0.007 - 0.028] *Pr(direction)* = .999	**0.008*** [0.001 -0.015] *Pr(direction)* = .986	**0.017*** [0.006 - 0.029] *Pr(direction)* = .998	**0.009*** [0.001 - 0.018] *Pr(direction)* = .986
Sleep quality				
Within	0.012 [-0.027 - 0.0554]	0.007 [-0.0021 - 0.002]	-0.017 [-0.061 - 0.027]	0.009 [-0.003 - 0.026]
Between	**-0.266**** [-0.384 - -0.145] *Pr(direction)* = 1.000	**-0.165**** *[-0.263 - -0.083]* *Pr(direction)* = 1.000	**-0.303**** [-0.431 - -0.171] *Pr(direction)* = .1.000	**-0.196**** [-0.307 - - 0.1] *Pr(direction)* = .1.000

Notes. Results are posterior mean estimates [95% confidence interval]. **Pr(direction)* ≥ .95; ***Pr(direction)* ≥ .99

10.5 Subjective Sleep and Sleep-Related Measures

10.5.1 Insomnia Severity Index (ISI; Bastien et al., 2001)

Insomnia Severity Index

The Insomnia Severity Index has seven questions. The seven answers are added up to get a total score. When you have your total score, look at the 'Guidelines for Scoring/Interpretation' below to see where your sleep difficulty fits.

For each question, please CIRCLE the number that best describes your answer.

Please rate the CURRENT (i.e. LAST 2 WEEKS) SEVERITY of your insomnia problem(s).

Insomnia Problem	None	Mild	Moderate	Severe	Very Severe
1. Difficulty falling asleep	0	1	2	3	4
2. Difficulty staying asleep	0	1	2	3	4
3. Problems waking up too early	0	1	2	3	4

4. How SATISFIED/DISSATISFIED are you with your CURRENT sleep pattern?

Very Satisfied	Satisfied	Moderately Satisfied	Dissatisfied	Very Dissatisfied
0	1	2	3	4

5. How NOTICEABLE to others do you think your sleep problem is in terms of impairing the quality of your life?

Not at all Noticeable	A Little	Somewhat	Much	Very Much Noticeable
0	1	2	3	4

6. How WORRIED/DISTRESSED are you about your current sleep problem?

Not at all Worried	A Little	Somewhat	Much	Very Much Worried
0	1	2	3	4

7. To what extent do you consider your sleep problem to INTERFERE with your daily functioning (e.g. daytime fatigue, mood, ability to function at work/daily chores, concentration, memory, mood, etc.) CURRENTLY?

Not at all Interfering	A Little	Somewhat	Much	Very Much Interfering
0	1	2	3	4

Guidelines for Scoring/Interpretation:

Add the scores for all seven items (questions 1 + 2 + 3 + 4 + 5 +6 + 7) = _____ your total score

Total score categories:
0–7 = No clinically significant insomnia
8–14 = Subthreshold insomnia
15–21 = Clinical insomnia (moderate severity)
22–28 = Clinical insomnia (severe)

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10.5.2 Pittsburgh Sleep Diary (PSD; Monk et al., 1994)

SLEEP DIARY **BEDTIME** KEEP BY BED study ID#.....

Please fill out this part of the diary last thing at night.

day..... date..... initials.....

Today, when did you have: breakfast.....
(if none, write "none")

lunch.....

dinner.....

How many of the following did you have in each time period?
(if none, leave blank)

	before or with breakfast	after breakfast before/with lunch	after lunch before/with dinner	after dinner
caffeinated drinks	.....	.....	.....	.....
alcoholic drinks	.....	.....	.....	.....
cigarettes	.....	.....	.....	.....
cigars/pipes/plugs (of chewing tobacco)	.....	.....	.....	.....

Which drugs and medications did you take today?
(prescribed & over the counter)

name	time	dose
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

What exercise did you take today? (if none, check here.....)

start..... end..... type.....

start..... end..... type.....

How many daytime naps did you take today? (if none, write 0).....
give times for each:

start..... end..... start..... end.....

SLEEP DIARY WAKETIME KEEP BY BED study ID#.....

Please fill out this part of the diary first thing in the morning.

day..... date..... initials.....

went to bed last night at.....

lights out at.....,.

minutes until fell asleep.....

finally woke at.....

awakened by: (check one) alarm clock/radio.....
someone whom I asked to wake me.....
noises.....
just woke.....

after falling asleep, woke up this many times during the night (circle)
0 1 2 3 4 5 or more

total number of minutes awake.....

-woke to use bathroom (circle # times)
0 1 2 3 4 5 or more

-awakened by noises/child/bedpartner (circle # times)
0 1 2 3 4 5 or more

-awakened due to discomfort or physical complaint (circle # times)
0 1 2 3 4 5 or more

-just woke (circle # times)
0 1 2 3 4 5 or more

RATINGS (place a mark somewhere along the line)

SLEEP QUALITY:
very bad _____ very good

MOOD ON FINAL WAKENING:
very tense _____ very calm

ALERTNESS ON FINAL WAKENING:
very sleepy _____ very alert

10.5.3 Pre-Sleep Arousal Scale (PSAS; Nicassio et al., 1985)

Pre-Sleep Arousal Scale

Please describe how intensely you generally experience each of these symptoms as you attempt to fall asleep in your own bedroom.

1 not at all 2 slightly 3 moderately 4 a lot 5 extremely

Somatic	Cognitive
_____ 1. Heart racing, pounding, or beating irregularly.	_____ 9. Worry about falling asleep.
_____ 2. A jittery, nervous feeling in your body.	_____ 10. Review or ponder events of the day.
_____ 3. Shortness of breath or labored breathing.	_____ 11. Depressing or anxious thoughts.
_____ 4. A tight, tense feeling in your muscles.	_____ 12. Worry about problems other than sleep.
_____ 5. Cold feeling in your hands, feet or your body	_____ 13. Being mentally alert, active.
_____ 6. Have stomach upset (knot or nervous feeling, heartburn, nausea, etc.	_____ 14. Can't shut off your thoughts.
_____ 7. Perspiration in the palms of your hands or other parts of your body.	_____ 15. Thoughts keep racing through your head.
_____ 8. Dry feeling in your mouth or throat.	_____ 16. Being distracted by sounds, noise in the environment, (e.g., ticking of the clock, house noises, traffic).

10.5.4 Dysfunctional Beliefs and Attitudes about Sleep (DBAS; Morin et al., 2007)

DYSFUNCTIONAL BELIEFS AND ATTITUDES ABOUT SLEEP (DBAS)

Name _____ Date ☐☐/☐☐/☐☐

Several statements reflecting people's beliefs and attitudes about sleep are listed below. Please indicate to what extent you personally agree or disagree with each statement. There is no right or wrong answer. For each statement, circle the number that corresponds to your own personal belief. Please respond to all items even though some may not apply directly to your own situation.

		Strongly disagree									Strongly agree
1	I need 8 hours of sleep to feel refreshed and function well during the day.	1	2	3	4	5	6	7	8	9	10
2	When I don't get proper amount of sleep on a given night, I need to catch up on the next day by napping or on the next night by sleeping longer.	1	2	3	4	5	6	7	8	9	10
3	I am concerned that chronic insomnia may have serious consequences on my physical health.	1	2	3	4	5	6	7	8	9	10
4	I am worried that I may lose control over my abilities to sleep.	1	2	3	4	5	6	7	8	9	10
5	After a poor night's sleep, I know that it will interfere with my daily activities on the next day.	1	2	3	4	5	6	7	8	9	10
6	In order to be alert and function well during the day, I believe I would be better off taking a sleeping pill rather than having a poor night's sleep.	1	2	3	4	5	6	7	8	9	10
7	When I feel irritable, depressed, or anxious during the day, it is mostly because I did not sleep well the night before.	1	2	3	4	5	6	7	8	9	10
8	When I sleep poorly on one night, I know it will disturb my sleep schedule for the whole week.	1	2	3	4	5	6	7	8	9	10
9	Without an adequate night's sleep, I can hardly function the next day.	1	2	3	4	5	6	7	8	9	10
10	I can't ever predict whether I'll have a good or poor night's sleep.	1	2	3	4	5	6	7	8	9	10
11	I have little ability to manage the negative consequences of disturbed sleep.	1	2	3	4	5	6	7	8	9	10
12	When I feel tired, have no energy, or just seem not to function well during the day, it is generally because I did not sleep well the night before.	1	2	3	4	5	6	7	8	9	10
13	I believe insomnia is essentially the result of a chemical imbalance.	1	2	3	4	5	6	7	8	9	10
14	I feel insomnia is ruining my ability to enjoy life and prevents me from doing what I want.	1	2	3	4	5	6	7	8	9	10
15	Medication is probably the only solution to sleeplessness.	1	2	3	4	5	6	7	8	9	10
16	I avoid or cancel obligations (social, family) after a poor night's sleep.	1	2	3	4	5	6	7	8	9	10

10.6 Perfectionism Questionnaires

10.6.1 Frost Multidimensional Perfectionism Scale (FMPS; Frost et al., 1990)

Frost Multidimensional Perfectionism Scale (FMPS)

Instructions:

Please answer the following questions in relation to how much they apply to you. Do not spend too much time on any one question.

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	My parents set very high standards for me.	1	2	3	4	5
2	Organization is very important to me.	1	2	3	4	5
3	As a child, I was punished for doing things less than perfectly.	1	2	3	4	5
4	If I do not set the highest standards for myself, I am likely to end up a second-rate person.	1	2	3	4	5
5	My parents never tried to understand my mistakes.	1	2	3	4	5
6	It is important to me that I be thoroughly competent in what I do.	1	2	3	4	5
7	I am a neat person.	1	2	3	4	5
8	I try to be an organized person.	1	2	3	4	5
9	If I fail at work/school, I am a failure as a person.	1	2	3	4	5
10	I should be upset if I make a mistake.	1	2	3	4	5
11	My parents wanted me to be the best at everything.	1	2	3	4	5
12	I set higher goals than most people.	1	2	3	4	5
13	If someone does a task at work/school better than I do, then I feel as if I failed the whole task.	1	2	3	4	5
14	If I fail partly, it is as bad as being a complete failure.	1	2	3	4	5
15	Only outstanding performance is good enough in my family.	1	2	3	4	5
16	I am very good at focusing my efforts on attaining a goal.	1	2	3	4	5

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
17	Even when I do something very carefully, I often feel that it is not quite right.	1	2	3	4	5
18	I hate being less than the best at things.	1	2	3	4	5
19	I have extremely high goals.	1	2	3	4	5
20	My parents expect excellence from me.	1	2	3	4	5
21	People will probably think less of me if I make a mistake.	1	2	3	4	5
22	I never feel that I can meet my parents' expectations.	1	2	3	4	5
23	If I do not do as well as other people, it means I am an inferior being.	1	2	3	4	5
24	Other people seem to accept lower standards from themselves than I do.	1	2	3	4	5
25	If I do not do well all the time, people will not respect me.	1	2	3	4	5
26	My parents have always had higher expectations for my future than I have.	1	2	3	4	5
27	I try to be a neat person.	1	2	3	4	5
28	I usually have doubts about the simple everyday things that I do.	1	2	3	4	5
29	Neatness is very important to me.	1	2	3	4	5
30	I expect higher performance in my daily tasks than most people.	1	2	3	4	5
31	I am an organized person.	1	2	3	4	5
32	I tend to get behind in my work because I repeat things over and over.	1	2	3	4	5
33	It takes me a long time to do something "right".	1	2	3	4	5
34	The fewer mistakes I make, the more people will like me.	1	2	3	4	5
35	I never feel that I can meet my parents' standards.	1	2	3	4	5

10.6.2 Hewitt Flett Multidimensional Perfectionism Scale (HFMPS; Hewitt & Flett, 1991)

Hewitt-Flett Multidimensional Perfectionism Scale

INSTRUCTIONS: Listed below are a number of statements concerning personal characteristics and traits. Read each item and decide whether you agree or disagree & to what extent.

		Disagree						Aagree
1.	When I am working on something, I cannot relax until it is perfect	1	2	3	4	5	6	7
2.	I am not likely to criticize someone for giving up too easily	1	2	3	4	5	6	7
3.	It is not important that people I am close to are successful	1	2	3	4	5	6	7
4.	I seldom criticize my friends for accepting second best	1	2	3	4	5	6	7
5.	I find it difficult to meet others' expectations of me	1	2	3	4	5	6	7
6.	One of my goals is to be perfect in everything I do	1	2	3	4	5	6	7
7.	Everything that others do must be of top-notch quality	1	2	3	4	5	6	7
8.	I never aim for perfection on my work	1	2	3	4	5	6	7
9.	Those around me readily accept that I can make mistakes too	1	2	3	4	5	6	7
10.	It doesn't matter when someone close to me does not do their absolute best	1	2	3	4	5	6	7
11.	The better I do, the better I am expected to do	1	2	3	4	5	6	7
12.	I seldom feel the need to be perfect	1	2	3	4	5	6	7
13.	Anything that I do that is less than excellent will be seen as poor work by those around me	1	2	3	4	5	6	7
14.	I strive to be as perfect as I can be	1	2	3	4	5	6	7
15.	It is very important that I am perfect in everything I attempt	1	2	3	4	5	6	7
16.	I have high expectations for the people who are important to me	1	2	3	4	5	6	7
17.	I strive to be the best at everything I do	1	2	3	4	5	6	7
18.	The people around me expect me to succeed at everything I do	1	2	3	4	5	6	7
19.	I do not have very high standards for those around me	1	2	3	4	5	6	7
20.	I demand nothing less than perfection of myself	1	2	3	4	5	6	7
21.	Others will like me even if I don't excel at everything	1	2	3	4	5	6	7
22.	I can't be bothered with people who won't strive to better themselves	1	2	3	4	5	6	7
23.	It makes me uneasy to see an error in my work	1	2	3	4	5	6	7
24.	I do not expect a lot from my friends	1	2	3	4	5	6	7
25.	Success means that I must work even harder to please others	1	2	3	4	5	6	7
26.	If I ask someone to do something, I expect it to be done flawlessly	1	2	3	4	5	6	7
27.	I cannot stand to see people close to me make mistakes	1	2	3	4	5	6	7

28.	I am perfectionistic in setting my goals	1	2	3	4	5	6	7
29.	The people who matter to me should never let me down	1	2	3	4	5	6	7
30.	Others think I am okay, even when I do not succeed	1	2	3	4	5	6	7
31.	I feel that people are too demanding of me	1	2	3	4	5	6	7
32.	I must work to my full potential at all times	1	2	3	4	5	6	7
33.	Although they may not say it, other people get very upset with me when I slip up	1	2	3	4	5	6	7
34.	I do not have to be the best at whatever I am doing	1	2	3	4	5	6	7
35.	My family expects me to be perfect	1	2	3	4	5	6	7
36.	I do not have very high goals for myself	1	2	3	4	5	6	7
37.	My parent rarely expected me to excel in all aspects of my life	1	2	3	4	5	6	7
38.	I respect people who are average	1	2	3	4	5	6	7
39.	People expect nothing less than perfection from me	1	2	3	4	5	6	7
40.	I set very high standards for myself	1	2	3	4	5	6	7
41.	People expect more from me than I am capable of giving	1	2	3	4	5	6	7
42.	I must always be successful at school or work	1	2	3	4	5	6	7
43.	It does not matter to me when a close friend does not try their hardest	1	2	3	4	5	6	7
44.	People around me think I am still competent even if I make a mistake	1	2	3	4	5	6	7
45.	I seldom expect others to excel at whatever they do.	1	2	3	4	5	6	7

10.6.3 Daily Perfectionism Measures

Daily Perfectionism Measures

INSTRUCTIONS: Below are some statements concerning your day today. Read each item and decide the extent it applies to you.

		Never	Rarely	Sometimes	Often	Always
1.	I was concerned about mistake(s) I made today.	1	2	3	4	5
2.	I had doubts about how well I did things today.	1	2	3	4	5
3.	Others had high expectations of me today.	1	2	3	4	5

10.7 Other Measures

10.7.1 Depression, Anxiety Stress Scale 21 items (DASS-21; Lovibond & Lovibond, 1995)

DASS 21 NAME _____ DATE _____

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Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 Did not apply to me at all - NEVER

1 Applied to me to some degree, or some of the time - SOMETIMES

2 Applied to me to a considerable degree, or a good part of time - OFTEN

3 Applied to me very much, or most of the time - ALMOST ALWAYS

		N	S	O	AA	FOR OFFICE USE D	A	S
1	I found it hard to wind down	0	1	2	3			
2	I was aware of dryness of my mouth	0	1	2	3			
3	I couldn't seem to experience any positive feeling at all	0	1	2	3			
4	I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3			
5	I found it difficult to work up the initiative to do things	0	1	2	3			
6	I tended to over-react to situations	0	1	2	3			
7	I experienced trembling (eg, in the hands)	0	1	2	3			
8	I felt that I was using a lot of nervous energy	0	1	2	3			
9	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3			
10	I felt that I had nothing to look forward to	0	1	2	3			
11	I found myself getting agitated	0	1	2	3			
12	I found it difficult to relax	0	1	2	3			
13	I felt down-hearted and blue	0	1	2	3			
14	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3			
15	I felt I was close to panic	0	1	2	3			
16	I was unable to become enthusiastic about anything	0	1	2	3			
17	I felt I wasn't worth much as a person	0	1	2	3			
18	I felt that I was rather touchy	0	1	2	3			
19	I was aware of the action of my heart in the absence of physicalexertion (eg, sense of heart rate increase, heart missing a beat)	0	1	2	3			
20	I felt scared without any good reason	0	1	2	3			
21	I felt that life was meaningless	0	1	2	3			
					TOTALS			

10.7.2 Daily Stress Inventory (DSI; Brantley et al., 1987)

Daily Stress Inventory

Subject:
Date:

Below are listed a variety of events that may be viewed as stressful or unpleasant. Read each item carefully and decide whether or not that event occurred within the past 24 hours. If the event did not occur, place an "X" in the space next to that item. If the event did occur, indicate the amount of stress that it caused you by placing a number from 1 to 7 in the space next to that item (see numbers below). Please answer as honestly as you can so that we may obtain accurate information.

X = did not occur (past 24 hrs.)
1 = occurred but was not stressful
2 = caused very little stress
3 = caused a little stress
4 = caused some stress
5 = caused much stress
6 = caused very much stress 7 = caused me to panic

I. Performed poorly at task
2. Performed poorly due to others
3. Thought about unfinished work
4. Hurried to meet deadline
5. Interrupted during task/activity
6. Someone spoiled your completed task
7. Did something you are unskilled at
8. Unable to complete a task
9. Was unorganized
10. Criticized or verbally attacked
11. Ignored by others
12. Spoke or performed in public
13. Dealt with rude waiter/waitress/salesperson
14. Interrupted while talking
15. Was forced to socialize
16. Someone broke a promise/appointment
17. Competed with someone
18. Was stared at
19. Did not hear from someone you expected to hear from
20. Experienced unwanted physical contact (crowded, pushed)
21. Was misunderstood
22. Was embarrassed
23. Had your sleep disturbed
24. Forgot something
25. Feared illness/pregnancy
26. Experienced illness/physical discomfort
27. Someone borrowed something without your permission
28. Your property was damaged
29. Had minor accident (broke something, tore clothing)
30. Thought about the future
31. Ran out of food/personal article
32. Argued with spouse/boyfriend/girlfriend
33. Argued with another person
34. Waited longer than you wanted
35. Interrupted while thinking/relaxing
36. Someone "cut"ahead of you in a line
37. Performed poorly at sport/game
38. Did something that you did not want to do
39. Unable to complete all plans for today
40. Had car trouble
41. Had difficulty in traffic
42. Money problems
43. Store lacked a desired item
44. Misplaced something

45. Bad weather
46. Unexpected expenses (fines, traffic ticket, etc.)
47. Had confrontation with an authority figure
48. Heard some bad news
49. Concerned over personal appearance
50. Exposed to feared situation or object
51. Exposed to upsetting TV show, movie, book
52. "Pet peeve" violated (someone fails to knock, etc.)
53. Failed to understand something
54. Worried about another's problems
55. Experienced narrow escape from danger.
56. Stopped unwanted personal habit (overeating, smoking, nail-biting)
57. Had problem with kid(s)
58. Was late for work/appointment

Any stressors that we missed? (list below)
59. _____
60._____