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Impact of a behavioral intervention, delivered by pediatricians or psychologists, on sleep problems in children with ADHD: a cluster-randomized, translational trial

Running head: RCT of a sleep intervention in children with ADHD

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Background: We have demonstrated the efficacy of a brief behavioral intervention for sleep in children with ADHD in a previous randomized controlled trial (RCT) and now aim to examine whether this intervention is effective and cost-effective when delivered by pediatricians or psychologists in community settings. **Methods:** Translational, cluster-randomized trial of a behavioral intervention versus usual care from 19th January, 2015 to 30th June, 2017. Participants (n=361) were children aged 5-13 years with ADHD and parent report of a moderate/severe sleep problem who met criteria for American Academy of Sleep Medicine criteria for chronic insomnia disorder, delayed sleep–wake phase disorder, or were experiencing sleep-related anxiety. Participants were randomized at the level of the pediatrician (n=61) to intervention (n=183) or usual care (n=178). Families in the intervention group received 2 consultations with a pediatrician or a psychologist covering sleep hygiene and tailored behavioral strategies. **Results:** In an intention-to-treat analysis, at 3 and 6 months respectively, the proportion of children with moderate to severe sleep problems was lower in the intervention (28.0%, 35.8%) compared with usual care group (55.4%, 60.1%) (3 month: risk ratio (RR): 0.51, 95% CI 0.37, 0.70, p<0.001; 6 month: RR: 0.58; 95% CI 0.45, 0.76, p<0.001). Intervention children had improvements across multiple Children's Sleep Habits Questionnaire subscales at 3 and 6 months. No benefits of the intervention were observed in other domains. Cost-effectiveness of the intervention was AUD 13 per percentage point reduction in child sleep problem at 3 months. **Conclusions:** A low-cost brief behavioral sleep intervention is effective in improving sleep problems when delivered by community clinicians. Greater sample comorbidity, lower intervention dose or insufficient clinician supervisions may have contributed to the lack benefits seen in our previous trial. **Keywords:** Sleep; attention-deficit/hyperactivity disorder; randomized controlled trial; effectiveness

Introduction

ADHD affects around 5% of school-aged children worldwide (Polanczyk, Willcutt, Salum, Kieling, & Rohde, 2014). Compared to healthy peers, children with ADHD have higher rates of externalizing behavior disorders (Barkley, Fischer, Smallish, & Fletcher, 2006; Lee & Hinshaw, 2006), and are at an increased risk of substance abuse and internalizing (mood, anxiety) disorders (Mannuzza, Klein, Bessler, Malloy, & LaPadula, 1998). Furthermore, children with ADHD are at increased risk of

poorer educational outcomes (Barbarese, Katusic, Colligan, Weaver, & Jacobsen, 2007) including grade repetition, school suspension and academic underachievement.

The mainstay of treatment for ADHD is stimulant medication (Jensen, 1999), prescribed for around 77% of Australian children with ADHD (Efron, Davies, & Sciberras, 2013), and 87% of children with ADHD in the US (Garfield et al., 2012). There are concerns about the potential adverse effects of stimulant medication including poor growth (Poulton et al., 2013) and cardiac effects (Benner-Davis & Heaton, 2007). Thus strategies which reduce the need for medication are desirable. Identifying and managing sleep problems may be one such strategy.

Up to 70% of children with ADHD experience sleep problems (Sung, Hiscock, Sciberras, & Efron, 2008; Yoon, Jain, & Shapiro, 2012), compared with 20-30% of children in the general population (Quach, Hiscock, & Wake, 2012). Sleep problems experienced by children with ADHD are largely behavioral and can be categorized as difficulties initiating and/or maintaining sleep (Ball, Tiernan, Janusz, & Furr, 1997; Owens, Maxim, Nobile, McGuinn, & Msall, 2000). In an Australian community sample of 239 children with ADHD (Sung et al., 2008), children whose caregivers reported that their child had behavioral sleep problems also reported worse child ADHD symptoms (effect size (ES): 0.6), quality of life (ES: 0.9), and daily functioning (ES: 1.2). Caregivers of children with ADHD and moderate/severe sleep problems were also more likely to have mental health difficulties (OR 3.2; 95% CI 1.7 to 6.0; $p < 0.001$). All associations held after adjusting for key confounders (medication use, comorbidities, child age and gender, socioeconomic status).

Effectively treating sleep problems in children with ADHD may therefore be a simple way of improving child and family functioning. Three RCTs have demonstrated the efficacy of improving sleep problems in children with ADHD. Keshavarzi et al. (2014) reported children with ADHD ($n=40$) who received a 12-week sleep training program had improved sleep and psychosocial functioning compared to children with ADHD who did not receive the program ($n=20$) and healthy controls ($n=20$). Further, Corkum et al. (2016) reported improvements in sleep and psychosocial functioning associated with their distance sleep intervention in a mixed group of children with and without ADHD ($n=61$).

In 2010-12 we conducted an efficacy RCT to evaluate the impact of a behavioral sleep program in children with ADHD (*Sleeping Sound with ADHD*) and sleep problems (Hiscock et al., 2015). We recruited 244 5-12 year old children from 50 pediatric practices across the state of Victoria, Australia. HHi (pediatrician) and ES (clinical psychologist) trained 6 clinicians with varying backgrounds (psychologists, trainee pediatricians) over two x 3-hour sessions in the intervention content. Intervention parents attended two x 50 minute individual sessions (held two weeks apart) with a trained clinician at their home or the pediatrician's office. The first session

focused on an assessment of the child's sleep problem, providing information about normal sleep and sleep cycles, advice about sleep hygiene (e.g. set bedtimes, bedtime routine), and a plan specifically tailored to the child's sleep problem, drawing on a menu of flexible yet standardized techniques (Mindell & Owens, 2015). The second session provided an opportunity for the child's parents to ask further questions, reinforce strategies, trouble shoot, and monitor progress. A follow-up phone call occurred two weeks later to monitor progress and reinforce strategies.

At 3 and 6 months post randomization, the intervention was effective in reducing child ADHD symptoms. Fewer intervention children had a moderate/severe sleep problem at 3 and 6 months. Caregivers in the intervention group were less likely to miss or be late for work at 3 months, while children in the intervention group were less likely to be late for school at 6 months (Hiscock et al., 2015). Benefits of the intervention were sustained at 12 months post-randomization, whereby children in the intervention arm had fewer sleep problems, reduced ADHD symptom severity, and improved quality of life, daily functioning, and behavior compared to children in the usual care arm (Sciberras et al., 2019).

Taking the next step in the translation pathway from efficacy to effectiveness, we aimed to determine, in this pragmatic trial, whether the same intervention, when delivered by pediatricians and psychologists practicing in the community, could improve child sleep (primary outcome) and ADHD symptom severity, psychosocial quality of life, behavior, and daily functioning in children aged 5 to 12 years with ADHD. We also aimed to determine the impact of the intervention on primary caregiver mental health and intervention cost effectiveness.

Methods

Design and setting

Our protocol has been published (Sciberras et al., 2017). Briefly, the Sleeping Sound with ADHD translational trial is a cluster-randomized trial of a behavioral sleep intervention delivered by pediatricians or psychologists in the community, compared with usual clinical care for children with ADHD and sleep problems. The trial was prospectively registered on 17th November 2014, <http://www.isrctn.com/ISRCTN50834814>.

Eligibility and recruitment

Clinicians. We approached pediatricians (n=84) in Victoria and Queensland, Australia through the Australian Paediatric Research Network and clinical networks to participate. Pediatricians who agreed to participate then provided the research team with contact details of local psychologists (n = 56) to whom they refer patients. All participating psychologists received the intervention training. All clinicians signed a memorandum of understanding agreeing not to share the intervention materials with non-intervention families or pediatricians.

Families. Participating pediatricians identified families of children aged 5-12 years with a diagnosis of ADHD, seen within the prior 12 months and sent them an invitation letter about the study. An 'opt out' approach was used where parents were asked to contact their pediatrician if they did not want to be contacted by the research team about the study. One pediatric practice (n = 3 pediatricians) elected to utilize an 'opt in' approach. Children were recruited before randomization and were eligible if at the time of the screening interview (completed over the phone) they 1) met full DSM-5 diagnostic criteria for ADHD – that is at least six of nine symptoms of inattention and/or hyperactivity were rated as 'often' or 'very often' present on the ADHD Rating Scale IV, and the symptoms had been present for at least six months, and were associated with cross-situational impairment (e.g., at home and school); 2) had a moderate to severe parent-rated sleep problem; and 3) met the International Classification of Sleep Disorders – 3rd edition criteria for chronic insomnia disorder or delayed sleep-wake phase disorder, or had sleep-related anxiety. Children were excluded if they had suspected obstructive sleep apnea, had a serious medical condition (e.g., cerebral palsy), or an intellectual disability (pediatrician record of IQ < 70), if their parents had insufficient English language proficiency to complete surveys, and if they participated in the efficacy trial. We posted/emailed eligible families an information sheet, consent form, and baseline survey.

Once consent was returned, we telephoned families to complete a diagnostic interview (Anxiety Disorders Interview Schedule for Children, IV), assessing internalizing and externalizing comorbidities. At this time we also emailed the child's teacher a baseline survey to complete.

Randomization

There were two steps of randomization. In the first step, randomization occurred at the level of the pediatrician whereby pediatricians were randomly allocated on a 1:1 ratio by an independent statistician to either receive the intervention training or not. Randomization was conducted at the level of the pediatrician to reduce the potential of treatment contamination and occurred once

families for a pediatrician were enrolled. Randomization was based on a pre-generated group allocation sequence from the Murdoch Children's Research Institute's Clinical Epidemiology and Biostatistics Unit and was stratified by location of the pediatrician (regional or metropolitan area) and by the predicted number of enrolled patients (<10 and 10 or more). Pediatricians, families and researchers were blind to group allocation at the time of recruitment. In the second step, for pediatricians allocated to the intervention group with more than four patients enrolled, families were randomly allocated on a 1:1 ratio to receive the intervention from the pediatrician or from a psychologist. Families in the control group could access care as usual from their pediatrician, which does not typically include assessment and management of child sleep problems.

Intervention

Clinician training consisted of a 3.5 hour training session in the program described for our efficacy trial above. Training occurred conjointly for pediatricians and psychologists with investigators HHi, HHe and ES. Training included information on normal sleep, sleep cycles, sleep cues, sleep hygiene, and standard management strategies for behavioral sleep problems (Hiscock et al., 2015; Sciberras et al., 2017).

The intervention comprised two face-to-face sessions with the parent and child approximately two weeks apart. Families were offered a follow up phone call a further two weeks later. As described in detail previously (Sciberras et al., 2017), the first consultation involved an assessment of the child's sleep problem and establishment of treatment goals with parent and child. In this session the clinician provided information about normal sleep, sleep cycles, and sleep hygiene strategies, and formulated a behavioral sleep management plan tailored to the child's sleep problem. For example, limit setting problems were managed by ignoring child protests and rewarding compliance with bedtime routines. Anxiety related insomnia was managed by visual imagery and relaxation techniques. Parents were asked to complete a sleep diary between the first and second consultation. The second consultation and follow-up telephone call were used to review the sleep diary, reinforce suggested strategies, and troubleshoot any problems.

Families were provided with information sheets designed for the study, which addressed dealing with normal sleep, common sleep problems, and strategies for managing specific problems. The clinicians completed a standardized consultation form, recording the duration of the consultation and key components of the program (history, diagnoses, and management) to maximize program fidelity. HHi, HHe and ES were available for clinicians to consult on clinical issues.

Measures

The primary outcome measure was whether children were experiencing moderate/severe sleep problems at the three month follow up ascertained using the following question: “Has your child’s sleep been a problem for you over the past four weeks?” If ‘yes’, parents were asked to rate the severity (mild, moderate, or severe). This measure has good agreement with the Children’s Sleep Habits Questionnaire in children with ADHD (Lycett, Mensah, & Hiscock, 2015). Table 1 summarizes the baseline and secondary outcome measures. We administered parent and teacher surveys at baseline and at three and six months. At six months, trained research staff, blinded to child group allocation, administered a face-to-face assessment of child memory and academic functioning. Resources used in intervention training and delivery were prospectively recorded and valued in 2017 Australian dollars (AUD 1 = USD 0.72, December 2018). Parents reported time, travel and out-of-pocket costs associated with intervention visits as well as health service use related to their child’s sleep problem and associated costs over the 6-month follow-up period.

Sample size

Sample size calculation was based on the primary outcome, the proportion of children for whom parents report moderate/severe sleep problems at 3 months. In our efficacy study, 56% of control group parents reported that their child's sleep was a problem at 3 months as did 30% of the intervention group i.e. a difference of 26%. We assumed a smaller difference of 20% to be observed in this trial. A sample size of 107 per treatment arm has 80% power to detect this difference with two-sided type one error level of 0.05. As this is a cluster randomized trial, at the level of the pediatrician, we inflated our sample size by a design effect of 1.2 where the design effect was $1 + (n - 1) \times r$ with $n=3$ (the number of children seen by each pediatrician) and $r=0.1$ (the intra-cluster correlation). Allowing for 20% drop out and accounting for clustering, we required 160 children in each arm (total sample size $n=320$) at the 3 month follow-up.

Statistical analysis

All analyses were conducted using Stata Version 14. For the primary analysis, the proportion of children who have sleep problems was compared between the two treatment arms at 3 months. Model-based effect estimates (risk ratios or risk differences) are reported along with 95% confidence intervals. Analyses are at the level of the individual child and adjust for clustering at the level of the pediatrician using a generalized linear mixed effects model. The stratification variables at

randomization were adjusted for; location of study site (regional or metropolitan area) and predicted number of enrolled patients (<10 or 10 and more). Risk differences were calculated using an additive binomial model, which was a binomial generalized linear model with an identity link function, while the risk ratios used a log link function. For continuous outcomes, the same basic generalized linear mixed effects model was used, but a normal distribution was assumed and an identity link function was used. To reduce potential bias due to patient drop out over time, multiple imputation methodology was used to accommodate missing outcome data. Variables included in the imputation models were prespecified as variables that are likely to be associated with the outcome variables. The following baseline variables were included in the imputation model for 3 month continuous variables: treatment arm, clinician (psychologist or pediatrician), stratification variables (location of pediatrician and expected number of enrolments), pediatrician, child's age, Children's Sleep Habits Questionnaire (total score and the following subscales: daytime sleepiness, bedtime resistance, sleep duration, anxiety, night wakings, parasomnias, sleep disordered breathing (SDB)), ADHD symptoms total score, ADHD subtype and inattention total score. The binary variables at 3 months were imputed using the same variables plus Children's Sleep Habits Questionnaire (total score and the following subscales: daytime sleepiness, bedtime resistance, sleep duration, anxiety, night wakings, parasomnias, SDB) at 3 months. These included all variables included in the analysis model.

For the 6-month imputation of continuous variables, the same baseline variables were included as well as the following 3-month variables: Children's Sleep Habits Questionnaire (total score and the following subscales: daytime sleepiness, bedtime resistance, sleep duration, anxiety, night wakings, parasomnias, SDB), ADHD total score (parent and teacher). Binary variables at 6 months were imputed using the same baseline variables as for the continuous variables, primary outcome variable at 3 months, Children's Sleep Habits Questionnaire (total score and the following subscales: daytime sleepiness, bedtime resistance, night wakings, parasomnias) at 6 months. Multiple imputation was done by filling in missing values in multiple variables iteratively by using chained equations, a sequence of univariate imputation methods with fully conditional specification of prediction equations. Fifty imputations were done.

An additional analysis was done comparing the type of health care professional who delivered the intervention (pediatrician or psychologist) in the intervention arm only using the same statistical methodology as for the primary analysis. All reported results adjust for clustering at the level of the pediatrician, and for the stratification variables (metropolitan versus rural location, and predicted number of enrolled patients).

Results

Sample characteristics

Between January 2015 and October 2016, 61 pediatricians identified 4,298 potentially eligible families, of whom 710 were confirmed as eligible and 361 consented to participate (see Figure 1). Families who participated were comparable to non-participating families for the child's sex, age, and ADHD symptom severity, though participating families were likely to live in more advantaged neighborhoods (see Table S1 in the Supporting Information). The sample characteristics are summarized in Table 2. Most of the children were boys, were taking stimulant medication, and had either an internalizing or externalizing comorbidity. Forty psychologists (77% of those invited) agreed to take part, and 27 were allocated participants.

Primary outcome: prevalence of sleep problem at three months

Primary outcome data were provided by 132 families in the intervention arm and 139 families in the control arm at three months. This information was also provided at six months by 137 families in the intervention arm and 138 families in the control arm. Families who provided data at three and six months were comparable to families who did not on child sex, age, ADHD symptom severity, SEIFA, and parent education (see Table S2). The results reported are based on the multiple imputation analysis (Table 3). Compared with children in the control arm, children in the intervention arm had fewer moderate/severe sleep problems at three (55% versus 31%, Risk Ratio (RR) 0.57, $p < .001$) and six months (60% versus 38%, RR 0.60, $p = .001$). The estimated number needed to treat is 3.8 (95% CI: 2.6 to 7.2) at three months and 4.3 (95% CI: 2.8 to 8.5) at six months. At three months, 25% children treated by psychologists had moderate/severe sleep problems compared to 37% children treated by pediatricians. There was no statistically significant difference in reducing sleep problems comparing pediatricians to psychologists.

Secondary outcomes

Compared with children in the control arm, children in the intervention arm had improved sleep as measured by the parent-reported Children's Sleep Habits Questionnaire at three and six months. There were no evident differences in teacher or child report of sleep in the multiple imputation analysis. Children in the intervention arm had improved sleep hygiene at six months compared to

controls. There was no evidence that the intervention impacted ADHD symptoms, behavior, quality of life, ASD symptoms, or parenting (Table 4). At three months, children in the intervention arm had missed fewer days of school than children in the control arm (AMD -1.71, 95% CI -2.91 to -0.52, $p=.005$) although this effect attenuated by six months (AMD -1.08, 95% CI -2.39 to 0.22, $p=.11$). The number of days parents were late or missed work did not differ between the groups at three or six months. Performance on direct assessment measures of memory and academic functioning did not differ between arms. Compared with children in the control arm, children in the intervention arm had significant improvements in multiple domains on the Children's Sleep Habits Questionnaire at three and six months (see Table S3), including greater improvements in bedtime resistance and sleep onset delay. No adjustment was made for multiple comparisons so secondary outcome results should be interpreted with caution.

Program fidelity

Of the 183 children randomized to the intervention, 151 attended at least one consultation and clinicians completed consultation forms for 140 of these children. Overall, 151 families (83%) received the first consultation (pediatrician: mean duration 36 minutes, range 22-60 minutes; psychologist: 54 minutes, 25-80 minutes), 106 (58%) received the second consultation (pediatrician: 19 minutes, 4-48 minutes; psychologist: 31 minutes, 5-70 minutes), and 72 (39%) received the telephone call (pediatrician and psychologist: 3.5 minutes, 0-30 minutes). In all forms, the sections for diagnosis and management were completed, with an average of 2.6 diagnoses and 3.1 management strategies for each child.

Costs and cost-effectiveness

Average intervention cost from a healthcare perspective was AUD 395 per study participant ($n=183$), with families contributing an additional AUD 124 (see Table S4). There were no significant differences in reported sleep-related use of other health services between groups over the 6-month follow-up period. Total cost from a healthcare perspective, combining intervention costs and service use to 6 months, was AUD 347 higher for intervention compared to control group families (95% CI 247.48, 447.51, $p<0.001$). Costs from a societal perspective (including costs for families) was AUD 501 (95% CI 395.40, 606.75). Cost-effectiveness of the intervention from a healthcare perspective against the primary outcome was AUD 13 per percentage point reduction in child sleep problem at 3 months.

Discussion

In this translational trial, a brief sleep intervention, previously shown to be efficacious when delivered by a small group of clinicians, improved child sleep problems and patterns but not child or parent functioning. The cost of the intervention per child was AUD 347.

There may be several reasons for a lack of flow on benefits to child and parent functioning. It is well known that improvements seen in tightly controlled efficacy trials often fail to translate in effectiveness trials, where interventions are implemented in “real world” settings (Singal, Higgins, & Waljee, 2014). An efficacious intervention must be readily available, providers must identify the target population and recommend the intervention, and patients (and providers) must accept and adhere to the intervention. Whilst our intervention was readily available, there were differences in our target population, intervention dose, and clinician supervision between the two trials. Compared to our efficacy trial, children in this trial were more likely to have co-morbid ASD which may have reduced the impact of the intervention on the child’s functioning and parent mental health, given that the nature of sleep problems in children with ASD can differ from those in children with ADHD (eg prolonged night time waking is more common). In our first trial, 87% (106/122) children received two face-to-face consultations whilst in this trial, only 66% (120/183) did. The lack of a second consultation may have prevented families from learning about alternative sleep strategies if the initial strategy they chose for their child was not working. Finally, in our efficacy trial, HH and ES provided fortnightly supervision to the small clinical team delivering the intervention. In this effectiveness trial with 32 pediatricians and 27 psychologists, this was impractical. Whilst we offered support via email and telephone calls, few clinicians took up this offer. Thus, the opportunity to trouble shoot strategies with experienced clinicians was comparatively less and may have compromised the flow on effects of the intervention.

There is a dearth of RCTs that have evaluated the effects of behavioral sleep interventions in children with ADHD. In addition to our efficacy trial, two other RCTs (Corkum et al., 2016; Keshavarzi et al., 2014) have demonstrated that behavioral sleep interventions have beneficial effects on sleep and have flow on benefits to child behavior. However, both trials had small sample sizes (n=40 and n=61) and only a third of the sample in Corkum et al.’s trial had ADHD, so results should be interpreted with caution with respect to flow on benefits to child behavior.

Previous trials have not assessed costs or cost-effectiveness, reflecting a general lack of economic evidence in the area of sleep medicine outside of treatments for OSA and insomnia (Mohit

& Cohen, 2019). The increased costs of the intervention assessed here (AUD347) are dominated by training costs, which under the trial conditions are spread over an artificially small number of patients (see Table S4). Over time, as trained providers treat more patients, we would expect intervention costs to fall substantially, from AUD347 per family to under AUD200. We see this as a relatively low-cost intervention, which is cost-effective in terms of reducing child sleep problems. While there are no available benchmarks for the value of a percentage point change in child sleep problems, Tilford et al. (2015) provide estimates of the association of child sleep problems measured by CSHQ with significant impacts on child and family wellbeing. Applying these estimates to the change in CSHQ seen here estimates the value of our intervention at AUD750 using the common Australian benchmark of AUD50,000 per quality adjusted life year.

This trial has several strengths. We recruited families and clinicians from a broad sociodemographic and geographic range and included children with co-morbid mental and developmental health problems, making our findings generalizable to Australian children with ADHD attending pediatricians. We had good retention at follow up, used multiple imputation to account for missing data and trialed the intervention as it would be implemented in the Australian system, including out of pocket costs. We included blinded assessment of child memory and academic functioning. Limitations include a lack of objective measurement of child sleep (e.g., actigraphy), but the experience in our efficacy study, echoed by that in two previous trials of children with ADHD and neurodevelopmental disorders (Corkum et al., 2016; Gringras et al., 2012), shows that adherence to actigraphy is low in children with ADHD. We therefore deemed the costs and pragmatic effort to obtain adequate actigraphy data too great. Furthermore, less objective sleep problems such as anxiety-related insomnia, cannot be captured by actigraphy. We excluded children whose parents had insufficient English to complete questionnaires, so results may not generalize to them.

In summary, a brief behavioral intervention for sleep problems in children with ADHD, when delivered by practicing clinicians in a community setting, improves child sleep but not child or parent functioning. Future research should determine whether outcomes could be improved if interventions are tailored to the needs of children with autism and ADHD, or if clinician support is improved, e.g., by online chat forums with experienced sleep clinicians. We also need to understand how best to enhance family uptake of the full intervention. In the meantime, clinicians can be trained in and can deliver a brief, low cost intervention for common sleep problems in children with ADHD, with established benefits to the child's sleep.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of this article:

Table S1. Sample characteristics of eligible children who did and did not enrol in the trial.

Table S2. Baseline sample characteristics of children with and without follow up data at three and six months.

Table S3. Comparison of Children's Sleep Habits Questionnaire subscales between children in the intervention and control arms.

Table S4. Cost comparison between intervention and control group

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Key points

- Sleep problems are common in children with ADHD and associated with increased ADHD symptom severity and poorer functioning.
- We have previously demonstrated that a brief behavioral intervention reduces sleep problems and improves child and family well-being.
- In this translational RCT the intervention was found to be low-cost and effective in improving a broad range of behavioral sleep problems but there were no flow on benefits to broader functioning.

Ref

- Ball, J., Tiernan, M., Janusz, J., & Furr, A. (1997). Sleep patterns among children with attention-deficit hyperactivity disorder: a reexamination of parent perceptions. *Journal of Pediatric Psychology*, 22(3), 389-398.
- Barbarese, W. J., Katusic, S. K., Colligan, R. C., Weaver, A. L., & Jacobsen, S. J. (2007). Long-term school outcomes for children with attention-deficit/hyperactivity disorder: a population-based perspective. *Journal of Developmental and Behavioral Pediatrics*, 28(4), 265-273.
- Barkley, R. A., Fischer, M., Smallish, L., & Fletcher, K. (2006). Young adult outcome of hyperactive children: adaptive functioning in major life activities. *Journal of the American Academy of Child and Adolescent Psychiatry*, 45(2), 192-202.
- Benner-Davis, S., & Heaton, P. C. (2007). Attention deficit and hyperactivity disorder: controversies of diagnosis and safety of pharmacological and nonpharmacological treatment. *Current Drug Safety*, 2(1), 33-42.
- Colonna, A., Smith, A. B., Pal, D. K., & Gringras, P. (2015). Novel mechanisms, treatments, and outcome measures in childhood sleep. *Frontiers in Psychology*, 6, 602.
- Colonna, A., Smith, A. B., Smith, S., VanDenEshof, K., Orgill, J., Gringras, P., & Pal, D. K. J. F. i. p. (2018). The Effects of Sleep on Emotional Target Detection Performance: A Novel iPad-Based Pediatric Game. 9, 241.
- Corkum, P., Lingley-Pottie, P., Davidson, F., McGrath, P., Chambers, C. T., Mullane, J., . . . Weiss, S. K. (2016). Better Nights/Better Days—Distance Intervention for Insomnia in School-Aged Children With/Without ADHD: A Randomized Controlled Trial. *Journal of Pediatric Psychology*, jsw031.
- DuPaul, G., Power, T., Anastopoulos, A., & Reid, R. (1998). ADHD rating scale—IV. Checklists, norms and interpretation. *New York, NY: Guilford*.

- Efron, D., Davies, S., & Sciberras, E. (2013). Current Australian pediatric practice in the assessment and treatment of ADHD. *Academic Pediatrics*, 13(4), 328-333.
- Furukawa, T. A., Kessler, R. C., Slade, T., & Andrews, G. (2003). The performance of the K6 and K10 screening scales for psychological distress in the Australian National Survey of Mental Health and Well-Being. *Psychological Medicine*, 33(02), 357-362.
- Garfield, C. F., Dorsey, E. R., Zhu, S., Huskamp, H. A., Conti, R., Dusetzina, S. B., . . . Alexander, G. C. J. A. p. (2012). Trends in attention deficit hyperactivity disorder ambulatory diagnosis and medical treatment in the United States, 2000–2010. *12*(2), 110-116.
- Goodman, R. (2001). Psychometric properties of the strengths and difficulties questionnaire. *Journal of the American Academy of Child and Adolescent Psychiatry*, 40(11), 1337-1345.
- Gringras, P., Gamble, C., Jones, A., Wiggs, L., Williamson, P., Sutcliffe, A., . . . Allport, T. (2012). Melatonin for sleep problems in children with neurodevelopmental disorders: randomised double masked placebo controlled trial. *bmj*, 345, e6664.
- Hiscock, H., Sciberras, E., Mensah, F., Gerner, B., Efron, D., Khano, S., & Oberklaid, F. (2015). Impact of a behavioural sleep intervention on symptoms and sleep in children with attention deficit hyperactivity disorder, and parental mental health: randomised controlled trial. *BMJ*, 350, h68.
- Jensen, P. S. (1999). A 14-month randomized clinical trial of treatment strategies for attention-deficit/hyperactivity disorder. *Archives of General Psychiatry*, 56(12), 1073-1086.
- Keshavarzi, Z., Bajoghli, H., Mohamadi, M. R., Salmanian, M., Kirov, R., Gerber, M., . . . Brand, S. (2014). In a randomized case-control trial with 10-years olds suffering from attention deficit/hyperactivity disorder (ADHD) sleep and psychological functioning improved during a 12-week sleep-training program. *The World Journal of Biological Psychiatry*, 15(8), 609-619.
- Lee, S. S., & Hinshaw, S. P. (2006). Predictors of adolescent functioning in girls with attention deficit hyperactivity disorder (ADHD): the role of childhood ADHD, conduct problems, and peer status. *Journal of Clinical Child and Adolescent Psychology*, 35(3), 356-368.
- Lycett, K., Mensah, F., & Hiscock, H. J. S. M. (2015). The validity of a global measure of sleep problem severity in children with ADHD: a cross-sectional comparison with a validated multi-dimensional measure and sleep log. *16*, 1377-1380.
- Mannuzza, S., Klein, R. G., Bessler, A., Malloy, P., & LaPadula, M. (1998). Adult psychiatric status of hyperactive boys grown up. *American Journal of Psychiatry*, 155(4), 493-498.
- Mindell, J. A., & Owens, J. A. (2015). *A clinical guide to pediatric sleep: diagnosis and management of sleep problems*: Lippincott Williams & Wilkins.

- Mohit, B., & Cohen, J. (2019). Trends of cost-effectiveness studies in sleep medicine. *Sleep Medicine*, 53, 176-180.
- Moul, C., Cauchi, A., Hawes, D. J., Brennan, J., & Dadds, M. R. (2015). Differentiating autism spectrum disorder and overlapping psychopathology with a brief version of the Social Responsiveness Scale. *Child Psychiatry and Human Development*, 46(1), 108-117.
- Owens, J. A., Maxim, R., Nobile, C., McGuinn, M., & Msall, M. (2000). Parental and self-report of sleep in children with attention-deficit/hyperactivity disorder. *Archives of Pediatrics & Adolescent Medicine*, 154(6), 549-555.
- Owens, J. A., Spirito, A., & McGuinn, M. (2000). The Children's Sleep Habits Questionnaire (CSHQ): psychometric properties of a survey instrument for school-aged children. *SLEEP-NEW YORK*, 23(8), 1043-1052.
- Owens, J. A., Spirito, A., McGuinn, M., & Nobile, C. (2000). Sleep habits and sleep disturbance in elementary school-aged children. *Journal of Developmental and Behavioral Pediatrics*, 21(1), 27-36.
- Pickering, S., & Gathercole, S. E. (2001). *Working memory test battery for children (WMTB-C)*: Psychological Corporation.
- Polanczyk, G. V., Willcutt, E. G., Salum, G. A., Kieling, C., & Rohde, L. A. J. I. j. o. e. (2014). ADHD prevalence estimates across three decades: an updated systematic review and meta-regression analysis. 43(2), 434-442.
- Poulton, A. S., Melzer, E., Tait, P. R., Garnett, S. P., Cowell, C. T., Baur, L. A., & Clarke, S. (2013). Growth and pubertal development of adolescent boys on stimulant medication for attention deficit hyperactivity disorder. *Medical Journal of Australia*, 198(1), 29-32.
- Quach, J., Gold, L., Arnup, S., Sia, K.-L., Wake, M., & Hiscock, H. (2013). Sleep well—be well study: improving school transition by improving child sleep: a translational randomised trial. *BMJ open*, 3(10), e004009.
- Quach, J., Hiscock, H., & Wake, M. (2012). Sleep problems and mental health in primary school new entrants: Cross-sectional community-based study. *Journal of Paediatrics and Child Health*, 48(12), 1076-1081.
- Ratcliffe, J., Stevens, K., Flynn, T., Brazier, J., & Sawyer, M. (2012). An assessment of the construct validity of the CHU9D in the Australian adolescent general population. *Quality of Life Research*, 21(4), 717-725.
- Sciberras, E., Mulraney, M., Heussler, H., Rinehart, N., Schuster, T., Gold, L., . . . Hiscock, H. (2017). Does a brief, behavioural intervention, delivered by paediatricians or psychologists

- improve sleep problems for children with ADHD? Protocol for a cluster-randomised, translational trial. *BMJ Open*, 7, e014158. doi:10.1136/bmjopen-2016-014158
- Sciberras, E., Mulraney, M., Mensah, F., Efron, D., Oberklaid, F., & Hiscock, H. (2019). Sustained impact of a sleep intervention and moderators of treatment outcome for children with ADHD: A randomized controlled trial. *Psychological Medicine*, 1-10. doi:10.1017/S0033291718004063
- Singal, A. G., Higgins, P. D., & Waljee, A. K. (2014). A primer on effectiveness and efficacy trials. *Clinical and translational gastroenterology*, 5(1), e45.
- Stevens, K. (2012). Valuation of the child health utility 9D index. *Pharmacoeconomics*, 30(8), 729-747.
- Stringaris, A., Goodman, R., Ferdinando, S., Razdan, V., Muhrer, E., Leibenluft, E., & Brotman, M. A. (2012). The Affective Reactivity Index: a concise irritability scale for clinical and research settings. *Journal of Child Psychology and Psychiatry*, 53(11), 1109-1117.
- Sung, V., Hiscock, H., Sciberras, E., & Efron, D. (2008). Sleep problems in children with attention-deficit/hyperactivity disorder: prevalence and the effect on the child and family. *Archives of Pediatrics and Adolescent Medicine*, 162(4), 336-342.
- Tilford, J. M., Payakachat, N., Kuhlthau, K. A., Pyne, J. M., Kovacs, E., Bellando, J., . . . Frye, R. E. (2015). Treatment for sleep problems in children with autism and caregiver spillover effects. *Journal of Autism and Developmental Disorders*, 45(11), 3613-3623.
- Varni, J. W., Burwinkle, T. M., & Seid, M. (2005). The PedsQL™ as a pediatric patient-reported outcome: Reliability and validity of the PedsQL™ Measurement Model in 25,000 children. *Expert Review of Pharmacoeconomics & Outcomes Research*, 5(6), 705-719.
- Wilkinson, G. S., & Robertson, G. J. (2006). Wide range achievement test 4 (WRAT4). *Lutz, FL: Psychological Assessment Resources*.
- Yoon, S. Y. R., Jain, U., & Shapiro, C. (2012). Sleep in attention-deficit/hyperactivity disorder in children and adults: past, present, and future. *Sleep Medicine Reviews*, 16(4), 371-388.
- Zubrick, S. R., Lucas, N., Westrupp, E. M., & Nicholson, J. M. (2014). Parenting measures in the Longitudinal Study of Australian Children: Construct validity and measurement quality, Waves 1 to 4. *LSAC Technical Paper*, 12, 1-110.

Table 1. Outcomes, measured at baseline and 3 and 6 months

Primary Outcome: Child
Sleep problem prevalence – Primary caregiver report of child sleep problems; no problem, small, moderate or large problem, dichotomised as none/mild and moderate/severe (Sung et al., 2008). This measure also defined trial eligibility and has good agreement with the Children’s Sleep Habits Questionnaire (Lycett et al., 2015).
Secondary Outcomes: Child
<p>Sleep difficulties</p> <p>Children’s Sleep Habits Questionnaire - 33-item validated parent reported measure of difficulties of initiating and maintaining sleep over the past week ($\alpha=0.78$) (Owens, Spirito, & McGuinn, 2000). Items on a three-point scale from “rarely” to “usually,” with possible scores ranging from 33 to 99. Child Sleep Self Report (Owens, Maxim, et al., 2000) collected at 6 months only. We report the total scores for the parent and child reported surveys.</p> <p>Teacher Daytime Sleepiness Questionnaire - 10-item validated teacher reported scale of daytime sleepiness at school ($\alpha=0.82$) (Owens, Spirito, McGuinn, & Nobile, 2000). Items are rated on a three point scale from “rarely” to “usually,”. We report on the total score with possible scores ranging from 10 to 30.</p> <p>Sleep Hygiene* - 7-item measure assessing sleep hygiene ($\alpha=0.88$) (Quach et al., 2013). The measures are summed to provide a total score.</p>
<p>ADHD Symptoms</p> <p>ADHD Rating Scale IV - 18-item validated scale measuring the core symptoms of ADHD completed by parents ($\alpha=0.85$) and teachers ($\alpha=0.95$) (DuPaul, Power, Anastopoulos, & Reid, 1998). Items rated on a four point scale from “never” to “very often”, with possible scores ranging from 0 to 54. We report the total score for parents and teachers.</p>
<p>Behaviour</p> <p>Strengths and Difficulties Questionnaire, parent ($\alpha=.79$) and teacher ($\alpha=.88$) versions: 25 items assessing the following subscales:</p>

<p>hyperactivity/inattention, conduct problems, emotional symptoms, peer relationship problems, and prosocial behavior (Goodman, 2001). Items are scored on a three point scale from “not true” to “certainly true”. 20 items contribute to the Total Problems score reported here (possible range 0 - 40, with higher scores representing worse behavior). The SDQ is a widely used reliable and valid measure of child behavior (Goodman, 2001).</p>
<p>Irritability</p> <p>Affective reactivity index (ARI) - 6-item validated parent reported measure assessing child irritability ($\alpha=0.91$) (Stringaris et al., 2012). Items are scored on a three point scale from “not true” to “certainly true”, to form a total score with possible scores ranging from 0 to 12.</p>
<p>School attendance</p> <p>Parent report of whether or not their child had missed or been late for school over the preceding three months, and the number of days missed or late for school during that period (Sung et al., 2008).</p>
<p>Quality of Life*</p> <p>Child Health Utility-9D (CHU-9D) – 9-item parent proxy report of child quality of life used to calculate quality adjusted life years ($\alpha=0.79$). Child report is collected at the 6 month follow up only (Stevens, 2012). 9 dimensions each with 5 levels; generates preference-based single scores. The measure has been validated for use in children aged 6-17 years (Ratcliffe, Stevens, Flynn, Brazier, & Sawyer, 2012; Stevens, 2012).</p> <p>Pediatrics Quality of Life Inventory 4.0 – 23-item parent reported measure of child health related QoL (Varni, Burwinkle, & Seid, 2005). Items rated on a five point scale from “never” to “almost always” based on the child’s problems over the past month. 15 items contribute to a psychosocial health summary score ($\alpha=0.82$), with scores ranging from 0 to 100 (higher scores indicate better quality of life).</p>
<p>Memory[^]</p> <p>Sleep Suite App – An animated iPad application that includes a continuous performance test to measure sustained attention (Bubbles</p>

<p>task), and 2 tests of memory consolidation (Maze test) and learning (Animals test) (Colonna, Smith, Pal, & Gringras, 2015). Sleep Suite has been demonstrated to be sensitive to sleep restriction (Colonna et al., 2018).</p> <p>Working Memory Test Battery for Children – The Backward digit span recall subtest was administered as a measure of child working memory (Pickering & Gathercole, 2001).</p>
<p>Academic functioning[^]</p> <p>Wide Range Achievement Test 4 (WRAT) – word reading and math computation subtests (Wilkinson & Robertson, 2006).</p>
<p>Autism symptoms[^]</p> <p>Social Responsiveness Scale (SRS) Brief – 16-item parent reported measure of autism spectrum disorder symptoms ($\alpha=0.92$) (Moul, Cauchi, Hawes, Brennan, & Dadds, 2015). Items rated on a four point scale from “never true” to “almost always true”, to generate a total score with possible scores ranging from 0 to 48. The SRS Brief has good reliability and sensitivity when classifying children as having autism or not (Moul et al., 2015).</p>
<p>Parent Outcomes</p>
<p>Mental health</p> <p>Kessler 6 (K6) - 6-item validated measure of adult psychological stress ($\alpha=0.87$) (Furukawa, Kessler, Slade, & Andrews, 2003). Items rated on a five point scale from “none of the time” to “all of the time” based on distress in the past 30 days. A total score is generated with possible scores from 0 to 24.</p>
<p>Work attendance</p> <p>Parent report of whether or not they had missed or been late for work over the preceding three months, and the number of days missed or late for work during that period (Sung et al., 2008).</p>
<p>Parenting behavior[*]</p> <p>Parenting consistency (6-items; $\alpha=0.76$) and parental warmth (5-items; $\alpha=0.87$): validated scales developed for the Longitudinal Study of Australian Children (Zubrick, Lucas, Westrupp, & Nicholson, 2014). Items rated on a five point scale from “never” to “all the time”, with possible scores ranging from 6 to 30 (consistency) and 5 to 25 (warmth).</p>

*Not collected at 3 months; ^Only collected at 6 months.

Table 2 Baseline sample characteristics

Characteristics	Intervention group (n=183)	Control group (n=178)
Child		
Male	137 (74.9)	134 (75.3)
Mean (SD) age	9.6 (1.7)	9.4 (1.8)
Sleep disorder		
Chronic insomnia	182 (99.5)	174 (97.8)
Delayed sleep-wake phase	24 (13.1)	34 (19.1)
Anxiety	92 (50.3)	91 (51.1)
Any medication use	164 (89.6)	161 (90.5)
Stimulant^	146 (79.8)	144 (80.9)
Atomoxetine	8 (4.6)	12 (6.9)
Melatonin	59 (32.8)	65 (36.9)
Other^^	37 (20.2)	27 (15.2)
Comorbidities		
Internalizing	116 (63.7)	101 (56.2)
Externalizing	83 (45.4)	100 (56.2)
Autism spectrum disorder	74 (40.4)	66 (37.1)
Primary Caregiver		
Mother	167 (92.3)	164 (92.7)
Completed high school	134 (73.6)	118 (66.3)
Trade apprenticeship/technical diploma	61 (33.5)	90 (51.1)
Tertiary/postgraduate degree	88 (48.4)	55 (31.3)
Employed	98 (69.5)	89 (62.7)

Mean (SD) index of relative socioeconomic disadvantage^{^^} 1023 (60.5) 1000 (61.8)

[^]Ritalin, Ritalin LA, Concerta, Dexamphetamine, Vyvanse

^{^^}Antidepressants, antipsychotics, clonidine

^{^^^}National mean 1000 (SD100); higher score denotes more advantaged area

Table 3 Number, percentage and adjusted differences and risk ratios of children with moderate and severe sleep problems, by (i) intervention vs control groups, (ii) pediatrician vs psychologists (Intervention group only) and (iii) attendance (Intervention group only)

	Intervention group (N=183) N (%)	Usual care (N=178) N (%)	Difference (intervention–control) Risk difference, 95% CI, p-value	Risk ratio (intervention/control) Risk ratio, 95% CI, p-value
3 months				
Complete case	37/132 (28.0)	77/139 (55.4)	-27.6 (-38.4; -16.9) <0.001	0.51 (0.37; 0.70) <0.001
Multiple imputation	31.1% (95% CI: 24.7-39.6)	55.0% (95% CI: 47.0-63.6)	-23.7 (-35.9; -11.4) <0.001	0.57 (0.40; 0.80) 0.001
6 months				
Complete case	49/137 (35.8)	83/138 (60.1)	-24.7 (-36.1; -13.3) <0.001	0.58 (0.45; 0.76) <0.001
Multiple imputation	37.9% (95% CI: 29.6-46.3)	60.1% (95% CI: 52.2-68.0)	-22.0 (-34.4; -9.7) <0.001	0.60 (0.47; 0.83) 0.001

Intervention group	Pediatricians (N= 71)	Psychologists (N=66)		
3 months				
Complete case	25/71 (35.2)	12/61 (19.7)	-15.3 (-33.0; 2.4) 0.09	0.57 (0.27; 1.21) 0.14
Multiple imputation	37.3% (95% CI: 25.7-48.8)	25.2% (95% CI: 13.9-36.5)	-12.2 (-31.9; 7.5) 0.22	0.69 (0.38; 1.28) 0.24
6 months				
Complete case	26/71 (36.6)	23/66 (34.8)	-1.9 (-15.6; 11.8) 0.79	0.98 (0.67; 1.42) 0.90
Multiple imputation	36.7% (95% CI: 25.8-49.6)	38.3% (95% CI: 26.9-49.5)	-0.6 (-14.8; 13.6) 0.94	1.00 (0.69; 1.47) 0.98
Intervention group	Attended at least one session (N= 151)*	Attended no session (N= 28)*		
3 months				
Complete case	35/122 (28.7)	2/10 (20.0)	6.2 (-15.4; 27.8) 0.58	1.51 (0.48; 4.80) 0.49
6 months				
Complete case	42/122 (34.4)	6/14 (42.9)	-9.1 (-40.4; 22.3) 0.57	0.79 (0.37; 1.71) 0.55

* 4 participants had no information on whether sessions were attended

Table 4 Comparison of secondary outcomes between children in the intervention and control arms

Outcomes	Intervention	Control	Adjusted difference (intervention – control)	Adjusted difference with multiple imputation (intervention – control)

	N	Mean (SD)	N	Mean (SD)	Mean	95% CI	p	Mean	95% CI	p
Children's Sleep Habits Questionnaire										
Baseline	183	58.3 (8.2)	178	58.5 (8.4)	-	-	-	-	-	-
3 months	130	50.8 (8.2)	132	55.3 (9.2)	-4.20	-6.54, -1.86	<0.001	-3.49	-6.34, -0.64	0.016
6 months	139	52.0 (8.1)	138	56.1 (8.7)	-3.70	-5.94, -1.46	<0.001	-3.61	-6.02, -1.19	0.003
Teacher Daytime Sleepiness Questionnaire										
Baseline	129	15.4 (4.2)	141	14.9 (3.6)	-	-	-	-	-	-
3 months	126	14.5 (3.9)	122	14.4 (3.6)	0.00	-0.97, 0.97	0.998	0.40	-1.04, 1.85	0.584
6 months	114	13.5 (3.0)	117	14.2 (3.2)	-0.74	-1.44, -0.04	0.037	-0.28	-1.77, 1.20	0.708
Child sleep self-report										
6 months	126	51.5 (6.4)	135	51.0 (6.6)	0.39	-1.34, 2.13	0.657	0.28	-2.11, 2.68	0.817
Sleep Hygiene										
Baseline	176	2.6 (1.8)	170	2.9 (1.7)	-	-	-	-	-	-
6 months	133	2.0 (1.6)	137	2.7 (1.7)	-0.68	-1.12, -0.23	0.003	-0.64	-1.19, -0.09	0.022
ADHD Rating Scale – parent report										
Baseline	183	39.5 (8.4)	178	39.0 (8.1)	-	-	-	-	-	-
3 months	127	31.0 (10.5)	133	32.2 (10.8)	-1.60	-4.02, 0.81	0.194	-1.39	-4.97, 2.20	0.448
6 months	137	31.4 (10.5)	138	31.1 (10.2)	0.38	-2.16, 2.92	0.768	0.10	-3.15, 3.35	0.950
ADHD Rating Scale – teacher report										
Baseline	128	25.2 (14.1)	141	24.0 (13.6)	-	-	-	-	-	-
3 months	127	22.1 (13.7)	122	22.2 (14.0)	-0.75	-4.21, 2.71	0.672	0.95	-4.27, 6.17	0.721
6 months	115	19.2 (12.7)	117	19.9 (13.3)	-0.84	-3.73, 2.06	0.570	2.14	-3.67, 7.95	0.471
SDQ – parent report										
Baseline	183	21.6 (5.7)	175	22.1 (5.3)	-	-	-	-	-	-
3 months	127	19.4 (5.9)	133	21.0 (5.9)	-1.63	-3.30, 0.05	0.057	-1.29	-3.45, 0.87	0.241

6 months	136	20.3 (5.71)	138	18.9 (6.25)	-1.38	-2.88, 0.12	0.070	-1.12	-3.00, 0.76	0.242
SDQ – teacher report										
Baseline	128	15.1 (7.3)	141	15.6 (7.0)	-	-	-	-	-	-
3 months	127	14.7 (7.6)	122	15.6 (7.3)	-0.95	-3.05, 1.15	0.373	-0.45	-3.40, 2.51	0.766
6 months	115	19.2 (12.7)	117	19.9 (13.3)	-0.51	-2.14, 1.12	0.537	0.90	-2.78, 4.58	0.632
Affective Reactivity Index										
Baseline	183	6.3 (3.8)	175	6.7 (3.3)	-	-	-	-	-	-
3 months	127	4.9 (3.5)	131	5.8 (3.5)	-0.90	-1.78, -0.01	0.048	-0.55	-1.68, 0.59	0.345
6 months	136	5.3 (3.6)	138	5.9 (3.5)	-0.61	-1.36, 0.14	0.111	-0.34	-1.41, 0.73	0.531
PedsQL										
Baseline	183	48.3 (14.4)	175	46.9 (13.6)	-	-	-	-	-	-
6 months	137	57.6 (15.3)	138	54.3 (13.4)	2.93	-0.43, 6.29	0.087	2.41	-2.32, 7.14	0.317
CHU-9D										
Baseline	171	0.7 (0.1)	159	0.7 (0.1)	-	-	-	-	-	-
6 months	130	0.8 (0.1)	130	0.8 (0.1)	0.01	-0.02, 0.04	0.568	0.00	-0.04, 0.05	0.840
School Attendance										
3 months	125	2.1 (2.8)	132	3.6 (4.2)	-1.52	-2.34, -0.70	<0.001	-1.71	-2.91, -0.52	0.005
6 months	136	2.0 (3.5)	138	3.2 (4.2)	-0.90	-1.93, 0.13	0.086	-1.08	-2.39, 0.22	0.105
SRS brief										
6 months	136	17.7 (10.1)	137	19.2 (10.4)	-1.1	-3.32, 1.12	0.333	-0.67	-3.51, 2.16	0.641
Sleep Suite Maze task										
6 months	125	33.0 (20.7)	131	35.3 (23.4)	-3.16	-8.14, 1.82	0.214	-4.89	-12.01, 2.23	0.178
Sleep Suite Bubbles task – errors of commission										
6 months	125	36.1 (39.5)	134	42.0 (39.5)	-7.34	-17.41, 2.73	0.153	-6.33	-21.34, 8.68	0.408
Sleep Suite Bubbles task – errors of omission										

6 months	125	41.2 (9.65)	134	40.9 (9.5)	0.74	-1.65, 3.12	0.545	1.74	-1.92, 5.39	0.352
Sleep Suite Animal task										
6 months	107	6.0 (2.5)	103	5.4 (2.4)	0.59	0.01, 1.17	0.045	0.34	-0.79, 1.48	0.556
Backward digit recall										
6 months	125	94.3 (16.8)	135	90.3 (16.7)	3.29	-0.33, 6.92	0.075	2.11	-3.74, 7.97	0.479
WRAT reading										
6 months	126	99.0 (17.7)	134	97.9 (15.8)	0.40	-4.01, 4.82	0.857	-0.81	-7.39, 5.77	0.809
WRAT math										
6 months	126	92.0 (14.2)	134	89.1 (13.1)	2.35	-0.78, 5.48	0.141	2.13	-2.91, 7.16	0.407
K6										
Baseline	183	5.9 (4.7)	175	6.5 (5.4)	-	-	-	-	-	-
3 months	123	5.9 (4.3)	132	7.1 (5.3)	-1.17	-2.21, -0.13	0.027	-1.05	-2.58, 0.48	0.178
6 months	136	6.0 (4.8)	138	6.8 (5.6)	0.01	-0.32, 0.35	0.936	0.06	-0.41, 0.53	0.810
Parenting warmth										
Baseline	183	24.2 (4.0)	175	24.0 (3.9)	-	-	-	-	-	-
6 months	64	4.0 (0.7)	86	3.9 (0.7)	0.04	-0.15, 0.24	0.657	0.00	-0.78, 0.77	0.993
Parenting consistency										
Baseline	183	21.6 (4.0)	175	21.1 (4.4)	-	-	-	-	-	-
6 months	127	23.7 (4.1)	136	23.9 (4.4)	0.38	-0.62, 1.38	0.460	-0.04	-1.53, 1.45	0.956

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