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Review Article

Associations between diet quality and anxiety and depressive disorders: A systematic review

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ABSTRACT

Background: Emerging evidence suggests that a healthier diet is associated with a reduced risk for depressive symptoms. However, the relationships between diet quality and *clinical* depression and anxiety have not been established. This systematic review is the first to examine whole-of-diet associations in cohorts with diagnosed depression and/or anxiety disorders.

Methods: Literature searches captured 44 studies reporting on diet quality (22 cross-sectional, 12 prospective, seven combining cross-sectional/longitudinal data) OR using a dietary intervention in adults with depression and/or anxiety diagnoses (3 RCTs). A best-evidence synthesis of 25 observational studies of higher methodological quality was conducted.

Results: There was strong evidence that adherence to a Mediterranean diet was associated with lower depression incidence in prospective studies. Level of adherence to national dietary guidelines was not consistently associated with anxiety and depression. Studies which examined other dietary quality measures reported conflicting or limited evidence in relation to both anxiety and depression, with considerably fewer studies reported in anxiety. Some dietary interventions showed promising findings in relation to improvements in depression/anxiety outcomes, however, a range of methodological limitations warrant further consideration.

Limitations: Heterogeneity across studies was high which limited the ability to compare findings and precluded meta-analysis.

Conclusions: High-quality prospective studies generally support evidence that increased adherence to a Mediterranean diet may be a cost-effective and safe adjunct to existing therapies for clinical depression, which is supported by the findings of several dietary interventions.

Common mental health disorders, such as anxiety and depression, are leading contributors to worldwide fatal and non-fatal burden of disease (World Health Organization, 2017). The most recent Global Burden of Disease Study estimated that more than 264 million and 284 million individuals suffer from depressive and anxiety disorders, respectively (James et al., 2018). These conditions constitute an enduring public health crisis as they account for significant societal and economic costs, and are expected to increase in coming years (Doran and Kinchin, 2017). This burden is further exacerbated by high disorder co-occurrence, with around 80% of individuals with diagnosed anxiety meeting criteria for a lifetime depressive disorder, and approximately 75% of individuals with diagnosed depression also meeting criteria for a lifetime anxiety disorder (Lamers et al., 2011). The comorbidity between depression and anxiety disorders may convey potentially important information about shared risk factors, pathological processes, and illness trajectories (Kotov et al., 2017). Despite an increase in

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psychotherapeutic and psychotropic interventions over the past few decades (Olfson et al., 2015; Stephenson et al., 2012), anxiety and depression continue to be highly prevalent and burdensome disorders (Ciobanu et al., 2018; Jorm et al., 2017). Identifying modifiable risk factors that could inform treatment strategies is therefore increasingly important.

Emerging research suggests that dietary quality differs considerably between individuals with depression and/or anxiety disorders and controls. The nutritional quality of diets consumed by individuals diagnosed with either condition is substantially lower compared to those without any mental health conditions, especially among individuals with comorbid anxiety and depression (Gibson-Smith et al., 2018, 2020). In contrast, a higher intake of vegetables and non-refined grains has been associated with lower anxiety and depression severity in a cross-sectional study of adults, although the authors concluded that the combined effect of the entire diet is an important consideration for investigating mental health (Gibson-Smith et al., 2020). Suggested biological mechanisms of action for understanding associations between mental health and diet include pathways related to inflammation, oxidative stress, mitochondrial dysfunction, and the gut microbiota (Jacka, 2017; Marx et al., 2020). Furthermore, the associations between diet and depression are often multifactorial and potentially bidirectional, whereby an alteration in dietary intake may be exacerbated by the presence of depressive symptoms (Jacka et al., 2015). For instance, changes in appetite, energy levels, motivation, or the capacity to enjoy healthy meals may increase the appeal of readily available convenience foods. Anxiety disorders, too, can affect dietary intake via heightened restlessness, exhaustion, and commonly associated physical symptoms (e.g., indigestion, stomach aches), which can curb appetite or motivation to prepare healthy meals (Gibson-Smith et al., 2018). However, due to the limited number of studies that have assessed nutritional intake in anxiety disorders (e.g., Gibson-Smith et al., 2020), further research is clearly warranted.

Given the bidirectional links between diet and depression, existing reviews and meta-analyses have also investigated longitudinal associations, demonstrating a direct dose-response relationship between healthy dietary patterns and reduced depression risk, as well as increased depression risk in relation to pro-inflammatory diets (Gianfredi et al., 2022; Lassale et al., 2018; Li et al., 2017; Molendijk et al., 2018). The Mediterranean diet (rich in fresh vegetables, fruits, whole grains, fish, and extra virgin olive oil) has received particular attention for its protective effects on overall and mental health (Altun et al., 2019; Psaltopoulou et al., 2013; Sánchez-Sánchez et al., 2020). However, a recent meta-review of lifestyle factors in the prevention and treatment of depression could not establish any prospective links between diagnosed depression and diet quality (Firth et al., 2020). This finding may reflect the absence of a strong focus on clinical diagnostic outcomes to date. Most population studies are based on symptom scales (Gianfredi et al., 2022), with arbitrary cut-off points for what is considered clinically relevant (Sanchez-Villegas et al., 2008). Furthermore, symptoms of depression are often temporary and potentially reversible, whereas clinical diagnoses tend to identify people with more severe, chronic, and impairing conditions (Lassale et al., 2018). As more severe forms of depression are associated with higher health costs (Cuijpers and Smit, 2008), determining the link between clinical depression and diet quality is critical. Previous studies of the role of diet in depression are also limited because most have overlooked comorbidity with anxiety (i.e., Firth et al., 2020), despite evidence for alterations in dietary quality due to anxiety disorders (Gibson-Smith et al., 2018, 2020).

Lastly, there is limited evidence for dietary interventions as a novel target for reducing depressive symptoms. A meta-analysis of sixteen randomized controlled trials (RCTs) showed that such interventions significantly reduced symptoms of depression, and this effect was particularly strong for studies with female participants (Firth et al., 2019). Interestingly, no effect of dietary interventions on anxiety was observed. Only one study examined clinically diagnosed rather than self-reported depression, comparing a dietary improvement program with social support (Jacka et al., 2017). In this intervention study, the dietary support group showed significantly reduced anxiety and depression symptomatology after 12 weeks, with depression remission achieved for 32.3% patients versus 8% in the control group. Nonetheless, authors cited the relatively small sample size and potential for expectation bias as limitations that warrant replication in larger studies.

The lack of evidence regarding the relationship between diagnosed clinical depression and diet, and the limited consideration of anxiety, are important limitations that previous research syntheses have not addressed. The present systematic review will focus on studies stratified by clinical diagnosis of anxiety and/or depression disorders to examine how these are related individually, and in combination, to whole-of-diet intake. We first aimed to investigate differences in dietary quality between healthy individuals and those with current anxiety and/or depressive disorders (including symptom severity). While cross-sectional studies cannot determine the bidirectionality of the relationship between diet and anxiety/depression, they can still provide valuable insights into the prevalence and emerging trends of this relationship (i.e., whether particular dietary patterns are associated with better or worse psychopathology) which up until now has not been summarized by previous reviews. We also aimed to investigate the prospective associations between diet quality and the risk for anxiety and/or depressive disorders (including symptom severity). Finally, we provide an overview of existing RCTs investigating dietary interventions in clinically diagnosed cohorts, given that the causal effects of such interventions in anxiety/depressive disorders is unclear (Firth et al., 2019).

1. Method

The present systematic review was conducted in line with the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement (Page et al., 2021). A protocol was registered in the PROSPERO International Prospective Register of Systematic Reviews (https://www.crd.york.ac.uk/prospero/; #CRD42020200496).

1.1. Search strategy

The PROSPERO platform and preprint servers OSFPreprints (https://osf.io/preprints/) and bioRxiv (https://biorxiv.org) revealed no similar existing reviews had been published to date, nor were there any in the process of being published. Comprehensive literature searches were then conducted for relevant articles published since inception up to September 6th 2022 in the following electronic databases: Medline and PsycINFO via Ovid (http://www.ovid.com/); Cumulative Index to Nursing and Allied Health Literature (CINAHL) via EBSCO (http://www.ebscohost.com/cinahl/); and Evidence Based Medicine Reviews (EBMR) and center for Agriculture and Bioscience International (CABI).

Databases were searched using keywords and index words selected and cross-checked with those used in related reviews: "diet" OR "nutrition" OR "food habit" (and equivalent) AND "quality" OR "score" OR "pattern" OR "index" AND "depression disorder" OR "major depression" OR "anxiety disorder" (and equivalent; see Supplementary Table S1). All searches were limited to peer-reviewed full-text articles published in languages spoken by authors performing filtering and extraction (DE, CS; English, German, French, and Spanish). Filters were not used during the searches to ensure relevant articles would not be missed.

1.2. Study selection

Titles and abstracts of articles captured by the above search terms were reviewed by one author (DE) using the Covidence screening and data extraction tool (www.covidence.org). Full-text screening was then conducted by two independent reviewers (DE and CS), with any

discrepancies discussed and resolved via consensus or consultation with independent authors (JS, AL, OS). Relevant articles of any design were included in the present review if they: i) investigated whole diet according to predefined diet quality indices/scores or empirically-derived dietary patterns from measurements of complete dietary intake (unless an RCT); ii) included individuals with clinically diagnosed depression and/or anxiety as determined directly by diagnostic interview, physician-reported diagnosis or referral for treatment, diagnosis through a national database, or indirectly via self-reported psychotropic medication use; and iii) assessed community-dwelling adults or in-/out-patients 18 years or older.

Articles were excluded if they: i) focused on the effects of individual nutrients or food items/groups, or did not examine all dietary components; ii) examined diet quality and anxiety/depression outcomes solely in relation to another psychiatric or medical condition; or iii) involved pregnant or lactating women, athletes, or children and adolescents, due to physiological changes and dietary adjustments which may confound the diet-depression relationship. Non-human animal studies, reviews, and qualitative research articles were also excluded. Studies which defined depression cases based on self-reported symptoms *and/or* anti-depressant medication use/diagnosed depression (e.g., Parletta et al., 2019; Recchia et al., 2020) were excluded from the present review as it was not possible to tease apart the influence of self-reported depressive symptoms in relation to diet quality. Lastly, in addition to the electronic database search, the reference lists of eligible studies and existing relevant reviews were screened as a final step (e.g., Lassale et al., 2018; Molendjik et al., 2018).

1.3. Data extraction and synthesis

Following study selection, data were extracted and tabulated by one author (DE) and confirmed by a second author (CS) for the following information: authors and year of publication, geographical location, study design and follow-up (if applicable), sample characteristics (sample size, sex, age), dietary assessment tool, diet quality measure (index/score or dietary pattern) or intervention details, method of anxiety and/or depression assessment, and the primary results (including symptom level outcomes where available). Results that were beyond the scope of the present review related to sensitivity or subgroup analyses, specific disorder types or subtypes, remitted anxiety/depression disorders, analyses directly comparing multiple diet measures, or those assessing the shape of dose-response relationships. For studies that provided several estimates of results, only those from the most complex or saturated models were extracted for review (i.e., controlling for confounders, or controlling for the largest number of confounders). Furthermore, for studies reporting multiple but related exposure or outcome measures, results were collapsed when findings were in the consistent direction, or else the differences in findings were clearly indicated in the visual presentation of results (Figs. 2 to 4). Details on covariate adjustments and exclusion criteria were also extracted and are reported in Supplementary Materials (Table S3).

1.4. Quality and risk of bias assessment

Individual study quality was appraised using the National Heart, Lung, and Blood Institute (NIH) Study Quality Assessment Tools (https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools). Studies were rated by two independent authors (DE and CS) and any discrepancies were discussed and resolved via consensus. The 14 criteria used for the quality assessment consider the risk for potential selection bias, information bias, measurement bias, and confounding by factors deemed important by the study authors (i.e., age, sex, body mass index (BMI), socioeconomic status (or else education or occupation), and physical activity). Individual criteria were given 1 point for any 'Yes' responses (i.e., sufficiently meets quality criteria) and 0 points for any responses assessed as 'No', 'Not Reported' (NR), or 'Cannot Determine' (CD). Each study received a total score as a percentage of each criterion met. Criteria assessed as 'Not Applicable' (NA) were not included in the total score.

1.5. Best-Evidence synthesis

Due to considerable methodological differences and the heterogeneity in exposure and outcome measures used across studies (see Table 2), a formal meta-analysis was not conducted. Instead, a best-evidence synthesis of those studies deemed to be of high quality was carried out, in line with previous reviews in the field (e.g., O'Neil et al., 2014; Quirk et al., 2013). Study findings were ranked according to five levels of evidence, ranging from strong to no evidence, taking into account the type of study design used (see Table 1).

2. Results

2.1. Search results

Fig. 1 depicts the PRISMA flow diagram for study selection, which yielded 4928 articles after deduplication. Forty-four articles met inclusion criteria, including 22 cross-sectional studies (two of these studies were prospective but only included relevant cross-sectional results), 12 prospective, seven studies combining both cross-sectional and prospective data, and three RCTs. Four of these 44 studies (Chen et al., 2021; Khosravi et al., 2015; Saeidlou et al., 2021; Sotoudeh et al., 2020) were described as case-control designs but were categorized as cross-sectional for the purposes of this review due to the nature of the exposure assessment. Lastly, five studies (Gibson-Smith et al., 2020; Khosravi et al., 2020; Rahe et al., 2016; Sánchez-Villegas et al., 2009; Sotoudeh et al., 2020) that met inclusion criteria were not incorporated in the final synthesis of results as they contained duplicate analyses of studies that are already represented. The characteristics of all included studies are summarized in Table 2.

2.2. Description of studies (see Table 2 for details)

The sample sizes of studies ranged between 102 to 121,008 participants in the observational studies and between 67 to 247 participants in the RCTs, with an age range of 18 to 83 years old. While most studies examined both men and women, four studies performed sex-stratified analyses and provided separate results for men and women (Beydoun and Wang, 2010; Schweren et al., 2021; Seo and Je, 2018; Wilson et al., 2021), five studies examined only women (Chocano-Bedoya et al., 2013; Jacka et al., 2010; Lucas et al., 2014; Rashidkhani et al., 2013; Saeidlou et al., 2021; Yin et al., 2021) and two studies examined only men (Bayes et al., 2022; Ruusunen et al., 2014).Where applicable, findings were collapsed across both sexes when findings were consistent across men and women for ease of interpretation. Twenty-two studies were conducted in Europe, 13 in the US, Canada or Australia, and the remaining nine studies were conducted in Iran, Brazil, Bahrain, and South Korea (Table 2).

Table 1
Ranking system for best-evidence synthesis (adapted from Lievense et al., 2001).

Level of evidence	Inclusion criteria
Strong evidence	Generally consistent findings in multiple high-quality cohort studies
Moderate evidence	Generally consistent findings in 1 high-quality cohort study and > 2 high-quality case-control studies
Limited evidence	Generally consistent findings in single cohort study, 1 or 2 case-control studies, or multiple cross-sectional studies
Conflicting evidence	Conflicting findings across studies (i.e., inconsistent findings in $>25\%$ of the studies)
No evidence	No studies found

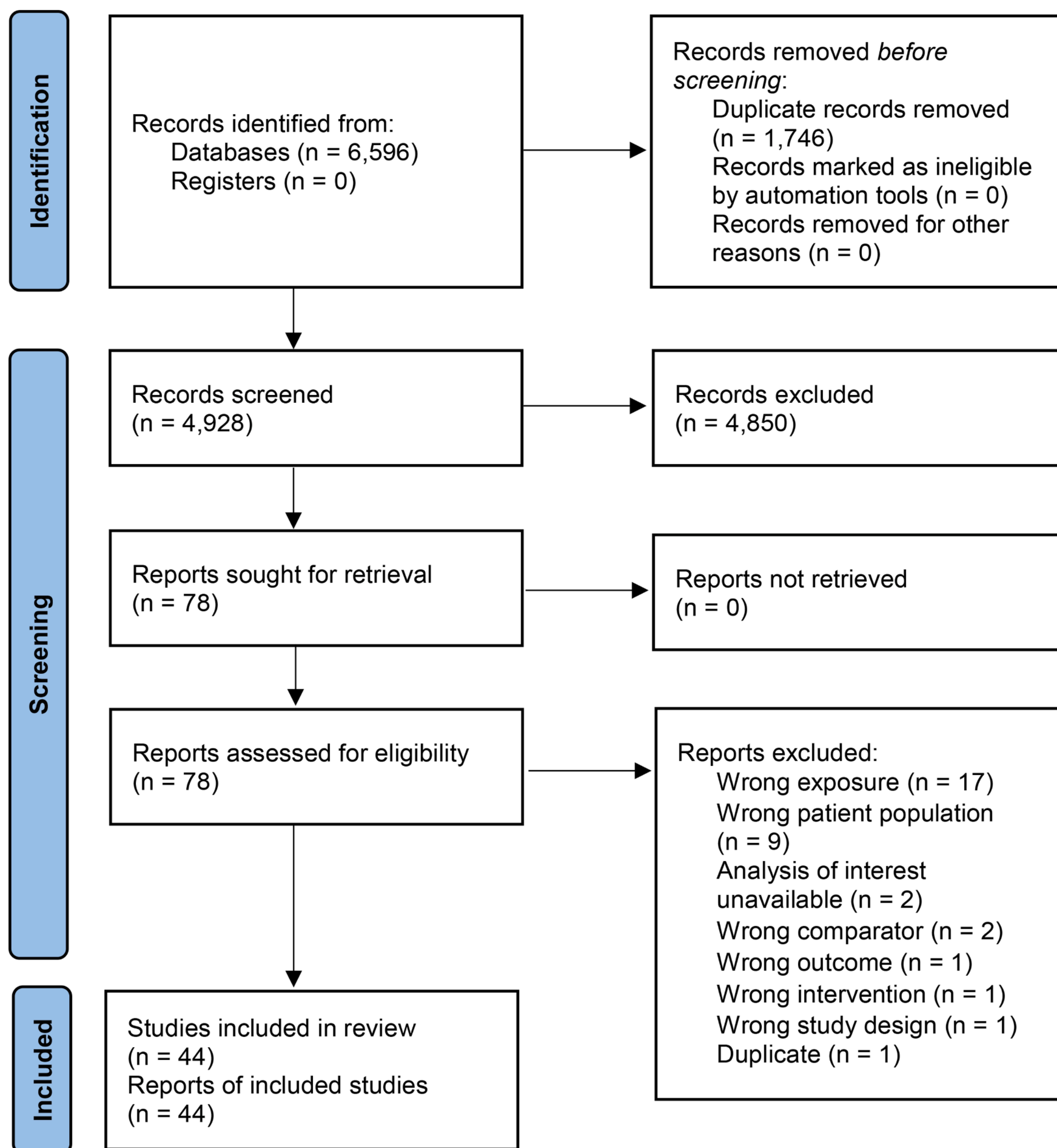

Fig. 1. PRISMA flow diagram of the selection process for including studies in the present review (COLOR TO BE USED IN PRINT).

2.3. Assessment of dietary intake and quality

Most studies used FFQs or structured self-report questionnaires to measure dietary intake ($n = 37$), whereas the remaining studies used 24-hour recall diaries ($n = 2$; Beydoun and Wang, 2010; Burrows et al., 2020), 7-day food diaries ($n = 1$; Jacka et al., 2017) or diet history interviews ($n = 1$; Forsyth et al., 2012). Two studies did not utilize a diet assessment instrument and instead directly measured adherence to a Mediterranean diet using the Mediterranean Diet Adherence Screener (MEDAS; Bayes et al., 2022; García-Toro et al., 2016). Thirty-one studies used dietary indices or scores which are determined by comparison of self-reported intake to *a priori* determined dietary guidelines/recommendations for what constitutes a healthy pattern of eating (McNaughton, 2010). While the specific food components and scoring criteria for each index can vary, higher scores on these indices generally represent closer adherence to a healthy diet. There are also dietary indices/scores that specifically measure unhealthy food intake, or aspects of unhealthy foods (e.g., their proinflammatory potential; Shivappa et al., 2013), where higher scores indicate closer adherence to an unhealthy diet. Nine studies utilized an *a posteriori* multivariate approach whereby factor or principal component analyses (FA/PCA) were used to extract dietary patterns that describe groupings of foods in a given sample. One study utilized a combination of these approaches (Jacka et al., 2010), while another study used a multivariate statistical method known as reduced rank regression (RRR; Lucas et al., 2014). RRR is a two-step process whereby differences in dietary intake are first used to predict intermediate outcomes (e.g., inflammatory biomarkers), and then relationships between the dietary pattern scores and outcome of interest are tested (McNaughton, 2010).

2.4. Measures of diet quality and dietary RCTs

The diet quality indices/scores used by the review literature included the Mediterranean Diet Score (MDS) or its variants ($n = 14$), the Healthy Eating Index (HEI) based on the Dietary Guidelines for Americans or its variants ($n = 6$), the Dietary Inflammatory Index (DII; $n = 3$; Burrows et al., 2020; Chen et al., 2021; Sánchez-Villegas et al., 2015b), the Dietary Approaches to Stop Hypertension (DASH) index (Gianfredi et al.,

Table 2
Overview of study details and main findings.

	Study, Location *Studies Included as Part of the Best-Evidence Synthesis*	Sample Details	Diet Quality Measure [and assessment]	Anxiety/Depression Assessment	Findings
1	Beydoun & Wang (2010), **USA** Cross-sectional NHANES	*N* = 2217 Females: *n* = 1240; 48±2.0% aged 20–29 years 52±2.0% aged 30–39 years Males: *n* = 977; 47.5 ± 1.9% aged 20–29 years, 52.5 ± 1.9% aged 30–39 years	HEI-2005 [24-h dietary recall]	Diagnosis: MDD diagnosis using CIDI (v 2.1), according to ICD-10 and DSM-IV criteria	HEI was not associated with MDD (Males β: −3.29, SEE: 2.12; Females β: −2.63, SEE: 1.96).
2	Chen et al. (2021), **Bahrain** Cross-sectional	*N* = 192 Depression: *n* = 96 (38.54% males), *M*age = 42.48±13.5 Controls: *n* = 96 (38.54% males), *M*age = 44.14±12.58	DII and E-DII [Validated 32-item FFQ (past month)]	Diagnosis: MDD diagnosis according to ICD-10 criteria by a multi-disciplinary psychiatric team Symptoms: BDI-II	Participants in the most pro-inflammatory E-DII group were almost three times as likely to have depression compared to the most anti-inflammatory group (OR: 2.75, 95% CI: 1.92–4.15).
3	Chocano-Bedoya et al. (2013), **USA** Prospective (12 years of follow-up) NHS Study	*N* = 50,605 females (3002 and 7413 incident depression cases under strict and broad definitions, respectively) Prudent diet pattern: Quintile 1: *M*age = 60.8 ± 6.9; Quintile 5: *M*age = 63.6 ± 6.8 Western diet pattern: Quintile 1: *M*age = 63.0 ± 6.8; Quintile 5: *M*age = 61.5 ± 7.0	Prudent and Western dietary patterns (PCA) [Validated 131-item semi-quantitative FFQs (past 12 months) collected every 4 years]	Diagnosis: Strict definition – both self-reported physician diagnosis of depression and antidepressant use	No associations were found between the Prudent (RR: 1.05, 95% CI: 0.91–1.20) and Western dietary pattern (RR: 1.05, 95% CI: 0.89–1.23) with the strict definition of depression.
4	Fresán et al. (2018), **Spain** Prospective (median 10.4 years of follow-up) SUN Cohort Study	*N* = 15,980 (9620 females; 666 incident depression cases) MIND Diet: Quartile 1: *n* = 4953 (52% females), *M*age = 35±11; Quartile 4: *n* = 2589 (68% females), *M*age = 40±12 Mediterranean Diet: Quartile 1: *n* = 5500 (61% females), *M*age = 34±11; Quartile 4: *n* = 3930 (59% females), *M*age = 40±13	MIND and MDS [*Validated* 136-*item semi-quantitative* FFQ (*past* 12 *months*)]	Diagnosis: Self-reported physician diagnosis of depression and/or antidepressant use Subsample validated using the SCID DSM-IV	The MDS was associated with reduced depression risk (HR: 0.75, 95% CI: 0.61–0.94). No associations were found for the MIND diet (HR: 0.88, 95% CI: 0.68–1.12).
5	Gall et al. (2016), **Australia** Prospective (5-year follow-up)	*N* = 1233 (769 females), *M*age = 31.65±2.6	'Healthy' diet scoring in 75th percentile of validated DGI	Diagnosis: Lifetime diagnoses of major depression and dysthymia per CIDI-Auto 2.1 according to DSM-IV criteria	No associations were found for the relationship between the DGI and any new episode of depression (RR: 1.02, 95% CI: 0.72–1.44, *p* = .902) first versus no episode of depression (RR: 0.71, 95% CI: 0.39–1.3, *p* = .273), and first versus no lifetime history of depression (RR: 0.72, 95% CI: 0.39–1.33, *p* = .295).
6	Gianfredi et al. (2021), **Netherlands** Prospective (median 6.1-year follow-up) but only cross-sectional analyses relevant	*N* = 2857 (50.1% females), *M*age = 59.7 ± 8.15 *n* = 89 with MDD at baseline (50.6% females, *M*age = 58.73±8.37	Dutch Health Diet (DHD), Mediterranean Diet, DASH [Validated, 253-item FFQ (past 12 months)]	Diagnosis: Prevalent and lifetime MDD per the MINI for DSM-IV	No associations were found between MDD and the DHD (OR: 1.09, 95% CI: 0.56–2.14), Mediterranean Diet (OR: 1.33, 95% CI: 0.76–2.35), and the DASH (OR: 1.55, 95% CI: 0.85–2.85).
7	Gibson-Smith et al. (2018), **Netherlands**[1] Cross-sectional NESDA Study	*N* = 1634 (1108 females), *M*age = 52.0 ± 13.2 Current Anxiety/Depression: *n* = 414 (296 females), *M*age = 52.6 ± 12.0 Controls: *n* = 334 (199 females), *M*age = 51.0 ± 14.6	AHEI and MDS [Validated 238-item semi-quantitative FFQ (past month)]	Diagnosis: Depressive and/or anxiety disorders per CIDI (v2.1) for DSM-IV Symptoms: IDS-SR BAI 15-item Fear Questionnaire (FEAR)	Current disorder group had lower MDS scores compared to controls (31.6 ± 9.8 vs 32.6 ± 11.0). AHEI scores did not differ between the current disorder and controls (56.8 ± 20.7 vs 57.6 ± 23.1). When stratified according to disorder type, only individuals with comorbid anxiety/ depression were associated with

(*continued on next page*)

Table 2 (*continued*)

	Study, Location *Studies Included as Part of the Best-Evidence Synthesis*	Sample Details	Diet Quality Measure [and assessment]	Anxiety/Depression Assessment	Findings
					diet quality, but not in the case where anxiety and depression were considered individually. Participants with more severe IDS, BAI and FEAR scores had lower MDS and AHEI scores compared to controls.
8	Gomes et al. (2021), **Brazil** Prospective (4-year follow-up) Pelotas Birth Cohort	*N* = 3331 (52.5% females) aged 18 years at baseline and 22 years at follow-up	BHEI-R (adapted according to the recommendations of the Brazilian Dietary Guidelines) [Semiquantitative 88-item FFQ (past 12 months)]	Diagnosis: MDD and GAD as diagnosed per the MINI for DSM-5	1-SD increase in BHEI-R scores at 18 years was associated with lower odds of MDD (OR: 0.77, 95% CI: 0.61–0.97). There was no association between the BHEI-R and GAD.
9	Hoveling et al. (2022), **Netherlands** Prospective (median 3.8 years follow-up) Lifelines Cohort	*N* = 76,045 (59.1% females), *Mage* = 44.5 ± 12.0, 1864 incident depression cases	Lifelines Diet Score (LLDS), based on the 2015 Dutch Dietary Guidelines [Semiquantitative 110-item FFQ (past month)]	Diagnosis: Current MDD diagnosed per the MINI for DSM-IV	No associations were found between poor or moderate diet quality (compared to high diet quality) and MDD onset (moderate diet quality OR: 0.85, 95% CI: 0.71–1.02; poor diet quality OR: 1.02, 95% CI: 0.81–1.28).
10	Jacka et al. (2010), **Australia** Cross-sectional Geelong Osteoporosis Study	*N* = 1046 females Anxiety/Depression: *n* = 121, *Mage* = 48 (IQR 33–59) Controls: *n* = 925, *Mage* = 52 (IQR 34–67)	Western, Traditional, and Modern dietary patterns (PCA) Diet quality score (DQS) [Validated 80-item FFQ (past 12 months)]	Diagnosis: Depressive or anxiety disorders per the SCID-I/Non-Patient Edition for DSM-IV-TR Symptoms: GHQ-12	A traditional dietary pattern was associated with lower odds of depression (OR: 0.65, 95% CI: 0.43–0.98) and anxiety (OR: 0.68, 95% CI: 0.47–0.99), whereas the Western dietary pattern was associated with higher GHQ-12 scores (β: 0.17, 95% CI: 0.06–0.29). No associations were found with the Modern and Western dietary patterns, or the DQS, in relation to disorder status. There was a negative association between the DQS and GHQ-12 scores (β: −0.08, 95% CI: −0.14, - 0.01) but not with anxiety or depressive disorders.
11	Lasserre et al. (2021), **Switzerland** Cross-sectional	*N* = 3554 Current Unspecified Depression: *n* = 125 (32% males), *Mage* = 54.7 ± 9.3 Controls: *n* = 1998 (54.4% males), *Mage* = 59.0 ± 10.8	Western, Mediterranean, and Sweet-Dairy dietary patterns (FA) [97-item semi-quantitative FFQ (past month)]	Diagnosis: Current MDD according to DSM-IV Semi-structured Diagnostic Interview for Genetic Studies (DIGS)	Current MMD was not associated with the Western dietary pattern (OR 1.07, 95% CI: 0.86–1.34), Mediterranean dietary pattern (OR 0.93, 95% CI: 0.76–1.13), and the Sweet-Dairy dietary pattern (OR 0.97, 95% CI: 0.79–1.19).
12	Lucas et al. (2014), **USA** Prospective (12-year follow-up) NHS Study	*N* = 43,685 females (2594 and 6446 incident depression cases under the strict and broad definitions, respectively) IDP: Quintile 1 *n* = 8202, *Mage* = 63.4 ± 6.7 .... Quintile 5 *n* = 8682, *Mage* = 60.9 ± 7.1	Inflammatory Dietary Pattern (IDP) identified using reduced-rank regression (RRR) [131-item semi-quantitative FFQ (every 4 years)]	Diagnosis: Strict definition – both self-reported physician diagnosis of depression and antidepressant use	The IDP was associated with a higher risk of depression under the strict definition of depression. (RR: 1.41, 95% CI: 1.22–1.63).
13	Marozoff et al. (2020), **Canada** Prospective (between 7 and 15-year follow-up) Alberta's Tomorrow Project [ATP]	*N* = 25,016 (62.82% females), *Mage* = 50.39±9.17 0 Physician Visits: *n* = 17,227 (57.30% females), *Mage* = 50.56±9.21 1–2 Physician Visits: *n* = 3881 (71.55% females), *Mage* = 50.49±9.28 3+ Physician Visits:	HEI-C 2015 and MMDS [124-item FFQ (past 12 months)]	Number of physician visits for depression via administrative health records (hospital discharge abstracts, physician claims, and prescription medication data) Depression identified via ICD-9th and −10th Revision codes from administrative health databases and diagnosis fields	Every 10-unit increase in HEI-C 2015 scores was associated with 4.68% fewer physician visits for depression (RR: 0.95, 95% CI: 0.92–0.98). For each 1-unit increase in MMDS scores, there was a 2.48% reduction in the number of physician visits (RR: 0.98, 95% CI: 0.96–0.99).

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	Study, Location *Studies Included as Part of the Best-Evidence Synthesis*	Sample Details	Diet Quality Measure [and assessment]	Anxiety/Depression Assessment	Findings
		$n = 3908$ (78.48% females), *Mage* = 49.50±8.87		from physician claims	
14	Paans et al. (2019), **Netherlands** Cross-sectional NESDA Study	$N = 1442$ (64.1% females), *Mage* = 51.7 ± 13.5 Remitted depressive disorder: $n = 880$ Current depressive disorder: $n = 234$ Controls: $n = 328$	MDS [Validated 238-item semi-quantitative FFQ (past month)]	Diagnosis: Presence of depressive disorder per the CIDI for DSM-IV Symptoms: IDS-SR	Patients with current depression had lower MDS scores compared to controls (B: −1.11, $p < .01$). Higher IDS-SR scores were associated with lower MDS scores (B: −0.63, $p < .001$).
15	Perez-Cornago et al. (2017), **Spain** Prospective (median 8-year follow-up) SUN Cohort Study	$N = 14{,}051$ (59.1% females), *Mage* = 37.5 ± 11.5 (113 and 410 incident depression cases under the strict and broad definitions, respectively) Dixon's DASH: ≤2 points $n = 4598$ (44.8% females), *Mage* = 38.5 ± 11.6; ≥5 points $n = 1752$ (87.9% females), *Mage* = 37.4 ± 11.9 Mellen's DASH: Quintile 1 $n = 3747$ (47.5% females), *Mage* = 34.8 ± 10.4; Quintile 5 $n = 2678$ (71.3% females), *Mage* = 40.7 ± 12.3 Fung's DASH: Quintile 1 $n = 3581$ (57.9% females), *Mage* = 33.3 ± 9.6; Quintile 5 $n = 2372$ (60.4% females), *Mage* = 42.1 ± 12.4 Günther's DASH: Quintile 1 $n = 3041$ (46.3% females), *Mage* = 35.4 ± 10.8; Quintile 5 $n = 2402$ (73.7% females), *Mage* = 39.5 ± 12.3	4 variations of DASH index [Validated 136-item semi-quantitative FFQ (past 12 months)]	Diagnosis: Strict definition – both self-reported diagnosis of MDD by medical doctor (lifetime) and antidepressant use Subsample validated using the SCID DSM-IV	Adherence to the Fung's DASH was negatively associated with depression risk for the strict depression definition (HR: 0.76, 95% CI: 0.61–0.94). No associations were found for the Mellen's, Dixon's or Günther's DASH indices with depression risk.
16	Rahe et al. (2015), **Germany**[2] Cross-sectional BiDirect Study	$N = 1660$ Depression: $n = 840$ (497 females), median age = 49.4 (Quartile 1: 49.4, Quartile 3: 55.6) Controls: $n = 820$ (414 females), median age = 53.5 (Quartile 1: 46.3, Quartile 3: 59.4)	Diet Quality Score (DQS) reflecting adherence to the nutrition recommendations of the German Nutrition Society [Validated 18-item FFQ (past 12 months)]	Diagnosis: Presence of clinical diagnosis of depressive episode or recurrent depression per ICD-10 criteria using the MINI structured interview Symptoms: HAM-D (17-item) CES-D (20-item)	No differences in DQS scores were found between participants with depression and controls (14.5 vs 14.4, p = .64, respectively). HAM-D (p = .45) and CES-D scores (p = .52) were also not associated with diet quality.
17	Richard et al. (2022), **Switzerland** Prospective cohort but only cross-sectional analyses conducted	$N = 3993$ (54.4% females), Mage = 57.7 ± 10.4, with 6392 observations across two follow-ups Follow-up 1: $n = 1209$ (54% females), Mage = 59.1 ± 11.2 Follow-up 2: $n = 385$ (51.4% females), Mage = 60.6 ± 9.5 Both follow-up 1 & 2: $n = 2399$ (55.1% females), Mage = 56.6 ± 10.0	AHEI [Validated 97-item semi-quantitative FFQ (past month)]	Diagnosis: Current anxiety disorders (including GAD, agoraphobia, social phobia, panic disorder) per the semi-structured Diagnostic Interview for Genetic Studies (DIGS) for DSM-IV	The AHEI was 1.2 points lower among participants with current anxiety disorders compared to those without (p = .016).
18	Ruiz-Estigarribia et al. (2019), **Spain** Prospective (median 10.4 year follow-up) SUN Cohort Study	$N = 14{,}908$ (8876 females), Mage = 36.7 ± 11.7 (774 incident cases of depression)	MDS [Validated 136-item semi-quantitative FFQ (past 12 months)]	Diagnosis: Self-reported physician-made diagnosis of clinical depression (lifetime) or habitual antidepressant use Subsample validated using the SCID DSM-IV	Medium-to-high MDS adherence was negatively associated with risk of depression (HR: 0.84, 95% CI: 0.73–0.98).

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	Study, Location *Studies Included as Part of the Best-Evidence Synthesis*	Sample Details	Diet Quality Measure [and assessment]	Anxiety/Depression Assessment	Findings
19	Ruusunen et al. (2014), **Finland** Cross-sectional and prospective analyses (16.5-year follow-up) KIHD Study	*N* = 1003 males, Mage = 56.1 ± 6.6 Human Population Laboratory Depression Scale (HPL) ≥ 5: *n* = 72, Mage = 55.8 ± 6.6 HPL < 5: *n* = 931, Mage = 56.2 ± 6.7	Prudent, Western, and Mixed dietary patterns (FA) [25-item FFQ (past 12 months)]	Diagnosis: A hospital discharge diagnosis of depression by a physician per ICD criteria Symptoms: HPL depression scale	In prospective analyses, the Prudent dietary pattern was negatively associated with depression risk (HR: 0.66, 95% CI: 0.47–0.93). There were no significant associations between depression risk and the Western or Mixed dietary patterns. In cross-sectional analyses, the Prudent dietary pattern was associated with a decreased prevalence of elevated HPL depressive symptoms (OR: 0.75, 95% CI: 0.57–0.99) whereas the Western diet was associated with a higher prevalence of elevated HPL depressive symptoms (OR: 1.41, 95% CI: 1.08–1.84). The Mixed dietary pattern was not associated with depressive symptoms.
20	A. Sánchez-Villegas et al. (2015a), **Spain**[3] Cross-sectional and prospective analyses (median follow-up 8.5 years) SUN Cohort Study	*N* = 15,093 (8847 females; 1051 incident cases of depression) Mediterranean Diet Score (MDS): Lowest adherence: *n* = 2512 (60.4% females), Mage = 34.4 Highest adherence: *n* = 3427 (54.5% females), Mage = 42.2 Pro-vegetarian Dietary Pattern (PDP): Lowest adherence: *n* = 3018 (56.9% females), Mage = 35.4 Highest adherence: *n* = 3019 (56.8% females), Mage = 41.9 Alternative HEI-2010: Lowest adherence: *n* = 3018 (54% females), Mage = 35.1 Highest adherence: *n* = 3018 (61.6% females), Mage = 42.7	MDS, PDP, AHEI-2010 [Validated 136-item semi-quantitative FFQ (past 12 months)]	Diagnosis: Self-reported physician-made diagnosis of clinical depression (lifetime) and/or self-reported habitual antidepressant use Subsample validated using the SCID DSM-IV	There were negative associations between moderate-to-high adherence to the MDS (HR: 0.80, 95% CI: 0.66–0.97), PDP (HR: 0.74, 95% CI: 0.61–0.89) and AHEI-2010 (HR: 0.60, 95% CI: 0.49–0.72) and depression risk as the cumulative average for dietary pattern prospectively, as well as at baseline (MDS - HR: 0.70, 95% CI: 0.56–0.85; PDP - HR: 0.78, 95% CI: 0.64–0.93; AHEI-2010 - HR: 0.72, 95% CI: 0.59–0.88).
21	A. Sánchez-Villegas et al. 2015b), **Spain** Cross-sectional and prospective analyses (median follow-up 8.5 years) SUN Cohort Study	*N* = 15,093 (8847 females; 1051 incident cases of depression) Lowest DII adherence: *n* = 3019 (58.4% females), Mage = 40.6 ± 12.9 Highest DII adherence: *n* = 3018 (51.5% females), Mage = 36.7 ± 11.4	DII [Validated 136-item semi-quantitative FFQ (past 12 months)]	Diagnosis: Self-reported physician-made diagnosis of clinical depression (lifetime) and/or self-reported habitual antidepressant use Subsample validated using the SCID DSM-IV	At baseline, there was a dose-response relationship between a higher depression risk with increased DII scores (HR: 1.37, 95% CI: 1.09–1.73). At follow-up, the association between extreme quintiles of the DII was even stronger (HR: 1.47, 95% CI: 1.17–1.85).
22	Sánchez-Villegas et al. (2016), **Spain** Prospective (median follow-up of 8.5 years) SUN Cohort Study	*N* = 11,800 (806 incident cases of depression) Lowest MDS adherence: 59.9% females, Mage = 34.3 ± 10.0 Highest MDS adherence: 56.9% females, Mage = 41.3 ± 12.4	Mediterranean diet [Validated 136-item semi-quantitative FFQ (past 12 months)]	Diagnosis: Self-reported physician-made diagnosis of clinical depression (lifetime) and/or self-reported habitual antidepressant use Subsample validated using the SCID DSM-IV	High Mediterranean diet adherence was not associated with lower risk of developing depression at follow-up compared to the lowest category of adherence (HR: 0.84, 95% CI: 0.71–1.00).
23	Voortman et al. (2017), **Netherlands** Prospective (median follow-up 10.9 years)	*N* = 9701 (58.1% females), 6217 incident depression cases Median age = 64.1 (95% range, 49.0–82.8)	Adherence to Dutch Dietary Guidelines 2015 [Validated FFQ]	Diagnosis: Incident depression data obtained from psychiatric examinations, self-reported histories of depression, medical records, and registration of	Adherence to the dietary guidelines was associated with a borderline lower risk of depression in the fully adjusted model (HR: 0.97, 95% CI: 0.95–0.999).

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	Study, Location *Studies Included as Part of the Best-Evidence Synthesis*	Sample Details	Diet Quality Measure [and assessment]	Anxiety/Depression Assessment	Findings
				antidepressant use	
24	Wilson et al. (2021), **Australia** Cross-sectional and prospective analyses (mean follow-up of 5 ± 0.3 and 7.5 ± 1.2 years) CDAH Study	CDAH-1: *N* = 1974 Females *n* = 991, Mage = 31.4 ± 2.6; Males *n* = 983, Mage = 31.6 ± 2.6 CDAH-2: *N* = 1480 Females *n* = 955, Mage = 36.4 ± 2.6; Males *n* = 525, Mage = 36.8 ± 2.6 CDAH-3: *N* = 1191 Females *n* = 655, Mage = 43.9 ± 2.9; Males *n* = 536, Mage = 44 ±2.8	Dietary Guidelines Index (DGI) [Validated FFQs (127-item at CDAH-1, 128-item at CDAH-2, 131-item at CDAH-3) over past 12 months, and food habits questionnaire]	Diagnosis: Lifetime diagnoses of major depression and dysthymia using CIDI-Auto per DSM-IV criteria	In cross-sectional analyses, a 10-point higher DGI score was not associated with reduced prevalence of mood disorders in any of the follow-ups (i.e., CDAH-1 to CDAH-3). In prospective analyses, the relative risk of mood disorder during any of the follow-ups was not associated with a 10-point higher DGI score in any of the follow-ups.
25	Yin et al. (2021), **Sweden** Prospective (mean follow-up of 20.4 years)	*N* = 42,515 females (Mage = 39.5 ± 5.6), 1677 incident depression cases	Mediterranean dietary pattern (MDP) [Validated 80-item FFQ]	Diagnosis: First clinical diagnosis of depression during follow-up, identified using Swedish revisions of ICD-10 (including diagnoses of severe depression)	A lower risk of depression was observed for medium-to-high MDP adherence compared to low MDP adherence (medium MDP: HR = 0.90, 95% CI = 0.81–1.00; high MDP: HR = 0.82, 95% CI = 0.71–0.94). Every unit increase of MDP adherence was associated with 5% reduction in the risk of depression (HR = 0.95, 95% CI = 0.92–0.98).
	Studies Not Included as Part of the Best-Evidence Synthesis (including RCTs and studies with shared samples)				
26	Bayes et al. (2022), **Australia** Intervention (12 weeks)	*N* = 72 (all males), Mage = 22 Mediterranean Diet Group (Active Intervention): *n* = 36, Mage = 21.5 ± 2.9 Befriending Group (Control): *n* = 34 (21 females), Mage = 22.5 ± 2.5	Dietary intervention: personalized dietary advice, motivational interviewing, goal setting, and mindful eating to support optimal adherence to the Mediterranean diet [Adapted 15-item MEDAS]	Diagnosis: Physician-diagnosed MDD Symptoms: BDI-II	Participants in the Mediterranean diet group showed reduced BDI-II scores compared to controls (mean difference = 14.4; 95% CI: 11.41, 17.39, p < .001) after 12 weeks. MEDAS scores were also significantly higher in the Mediterranean diet group compared to controls (mean difference = 7.8, 95% CI: 7.23, 8.37, p < .001) after 12 weeks.
27	Burrows et al. (2020), **USA** Cross-sectional	*N* = 103 Depression: MDD-IN (appetite increase): *n* = 22 (17 females), Mage = 31.41±8.53 MDD-DE (appetite decrease): *n* = 39 (25 females), Mage = 30.13±9.49 Controls: *n* = 42 (27 females), Mage = 31.33±8.56	HEI and DII [Automated Self-Administered 24-h Dietary Recall]	Diagnosis: Recurrent MDD and current MDE as diagnosed by the SCID for DSM-IV-TR Symptoms: HAM-D HAM-A	MDD groups had lower HEI scores compared to controls. For the HAM-D and HAM-A scores, there was a negative association with HEI scores (r = −0.038, p = .024 for both analyses) only in the MDD-DE group. For the DII, only the MDD-DE group had a higher (i.e., more pro-inflammatory) score compared to controls. Higher DII scores were associated with higher HAM-A scores in the MDD-DE group (r = 0.45, p = .016) but with lower HAM-A scores in the MDD-IN group (r = −0.48, p = .023). HAM-D results were not reported.
28	Forsyth et al. (2012), **Australia** Cross-sectional	*N* = 109 (77 females)	Aust-HEI [Diet history interview]	Diagnosis: General practitioner referral of patients being treated for depression and/or anxiety	Higher Aust-HEI scores were negatively correlated with DASS-21 scores (r = −0.39, p < .001), and with the depression and

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	Study, Location *Studies Included as Part of the Best-Evidence Synthesis*	Sample Details	Diet Quality Measure [and assessment]	Anxiety/Depression Assessment	Findings
				Symptoms: DASS-21	anxiety subscales (r = −0.37, p < .001; r = −0.26, p < .01, respectively)
29	Froud et al. (2017), **Australia** Cross-sectional	*N* = 242 Depression: Medication-free: *n* = 54 (40 females), Mage = 43.11 ±12.03; Antidepressant-use: *n* = 133 (96 females), Mage = 43.89±12.18 Controls: *n* = 55 (Demographic information not provided)	ADQS [Validated FFQ (past 12 months)]	Diagnosis: MDD diagnosis (past or current) per DSM-IV or DSM-5 based on the MINI 6.0 Symptoms: MADRS	A logistic regression model found that lower ADQS scores were associated with increased depression risk (B = −0.209, p = .037). Higher MADRS scores were associated with lower ADQS scores (F = 4.050, p = .046).
30	García-Toro et al. (2016), **Spain** Both cross-sectional and prospective analyses (12 months follow-up)	*N* = 166 (136 females), Mage = 51 years	MEDAS	Diagnosis: Major depression diagnosis per MINI for DSM-IV-TR Symptoms: BDI-II	At baseline, higher MEDAS scores were negatively associated with lower BDI scores (p = .007). Low MEDAS scores were not associated with the BDI at 12-month follow up (p = .136).
31	Gibson-Smith et al. (2020), **Netherlands**[1*] Cross-sectional NESDA Study	*N* = 1634 (1108 females), Mage = 52±13.2	MDS [Validated 238-item semi-quantitative FFQ (past month)]	Diagnosis: Depressive or anxiety disorders as diagnosed by the CIDI v2.1 for DSM-IV Symptoms: IDS-SR 21-item BAI 15-item FEAR	Higher MDS scores were associated with lower odds of current anxiety and/or depression compared to controls (OR: 0.80 per SD, 95% CI: 0.68–0.93), but not when remitted disorder group was compared to controls (OR: 0.98 per SD, 95% CI: 0.85–1.12). Higher MDS scores were associated with lower IDS (β: −0.13, CI: −0.18, −0.08), BAI (β: −0.11, CI: −0.16, −0.06) and FEAR (β: −0.08, CI: −0.13, −0.03) scores.
32	Jacka et al. (2017), **Australia** Intervention (12 weeks)	*N* = 67 (48 females), Mage = 40.3 ± 13.1 Dietary Support (Active Intervention): *n* = 33 (27 females), Mage = 37.5 ± 10.7 Social Support (Control): *n* = 34 (21 females), Mage = 43.1 ± 14.6	Dietary intervention: personalized dietary advice and counselling to support adherence to the 'ModiMedDiet' [7-day food diary and validated FFQ (past 12 months)]	Diagnosis: Diagnostic criteria for MDE according to DSM-IV Symptoms: MADRS HADS CGI-I	Participants in the dietary support intervention group showed reduced MADRS scores compared to controls (p < .001). This finding extended to the HADS-anxiety (p = .033) and HADS-depression subscales (p = .032), and the CGI-I (p = .013).
33	Khosravi et al. (2015), **Iran**[4] Cross-sectional	*N* = 330 Depression: *n* = 110 Controls: *n* = 220 No differences in age and sex between depression cases and controls (descriptives were not reported)	Healthy and Unhealthy dietary patterns (EFA) [Semi-quantitative FFQ (past 12 months)]	Diagnosis: MDD diagnosis per DSM-IV criteria	Participants in the highest quartile for the Healthy dietary pattern had lower odds of depression compared to the lowest quartile (OR: 0.76, 95% CI: 0.61–0.94). Participants in the highest quartile for the Unhealthy dietary pattern had higher odds of depression compared to the lowest quartile (OR: 1.38, 95% CI: 1.12–1.71).
34	Khosravi et al. (2020), **Iran**[4*] Cross-sectional	*N* = 330 Depression: *n* = 110 Controls: *n* = 220 (Age and sex descriptives not reported)	Healthy and Unhealthy dietary patterns (extracted using open Epi software) [Semi-quantitative FFQ (past 12 months)]	Diagnosis: MDD diagnosis per DSM-IV criteria	The Healthy dietary pattern was associated with lower odds of depression (OR: 0.75; 95% CI: 0.61–0.93), whereas the Unhealthy dietary pattern was associated with higher odds of depression (OR: 1.38, 95% CI: 1.12–1.71).
35	Nyboe et al. (2016), **Denmark** Prospective (1-year follow-up) but only cross-sectional analyses relevant	*N* = 102 Depression: *n* = 52 (26 females), median age = 25.6 (min. 18.7, max. 45.5) Controls: *n* = 50 (21 females), median age = 23.1 (min. 18.3, max. 42.8)	Higher sum from dietary questionnaire indicative of healthier diet [FFQ adapted from the Danish Health Examination Survey (2007–2008)]	Diagnosis: First-time hospitalized patients with depression per ICD-10 criteria	Patients with depression had poorer dietary habits compared to controls at baseline (Median 103.5 vs 110, p < .0001).

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	Study, Location *Studies Included as Part of the Best-Evidence Synthesis*	Sample Details	Diet Quality Measure [and assessment]	Anxiety/Depression Assessment	Findings
36	Rahe et al. (2016), **Germany**[2*] Cross-sectional BiDirect Study	*N* = 1420 Depression: *n* = 823 (480 females), median age = 49.4 (Quartile 1: 44.0, Quartile 3: 55.6) Subtypes of depression: 61.1% melancholic, 5.2% atypical, 9.8% mixed, 23.8% undifferentiated Controls: *n* = 597 (284 females), median age = 53.4 (Quartile 1: 46.4, Quartile 3: 59.5)	DQS as above [Validated 18-item FFQ (past 12 months)]	Diagnosis: Presence of clinical diagnosis of MDD per the MINI (German version 5.0.0) for DSM-IV Symptoms: HAM-D (17-item)	There was no association between DQS and MDD (OR: 0.98, 95% CI: 0.77–1.24), nor when stratified by depression subtype. No associations were found between the DQS and HAM-D scores.
37	Rashidkhani et al. (2013), **Iran** Cross-sectional	*N* = 135 females Depression: *n* = 45, Mage = 32.89±6.30 Controls: *n* = 90, Mage = 32.81±5.90	Healthy and Unhealthy dietary patterns (FA) [125-item semi-quantitative FFQ (past 12 months)]	Diagnosis: Presence of major depression per the SCID-I for DSM-IV Axis I Disorders	Participants with higher scores in the Healthy dietary pattern had lower odds of major depression (OR: 0.16, 95% CI: 0.06–0.44), whereas the odds of major depression in participants with higher adherence to the Unhealthy dietary pattern showed no association (OR: 1.65, 95% CI: 0.66–4.13).
38	Reynolds et al. (2014), **USA** Intervention (2-year follow-up with semi-annual boosters)	*N* = 247 (21 incident cases of depression) Problem-solving Therapy for Primary Care (PST-PC): *n* = 125 (86 females), Mage = 65.8 ± 10.9 Control (Dietary Coaching): *n* = 122 (90 females), Mage = 65.4 ± 11.0	Dietary coaching as the control condition: included reviewing general nutrition guidelines and getting specific help with meal preparation, reviewing dietary intake, and discussion of relevant topics	Diagnosis: Incident episodes of major depression, per the SCID section for mood disorders (DSM-IV) Symptoms: BDI	Participants in the PST-PC and dietary coaching control condition did not differ in the time to meet for incident diagnoses of depression. There was an average 4-point drop in BDI scores in both conditions, with improvements sustained over two years of follow-up. Higher BDI scores were a significant predictor of incident depressive episodes (HR: 1.17, 95% CI: 1.09–1.25).
39	Saeidlou et al. (2021), **Iran** Cross-sectional	*N* = 510 females Depression: *n* = 170, Mage = 36.97 ±11.28 Controls: *n* = 340, Mage = 36.07 ±10.58	Healthy, Sugar-Fast Food, Western, Traditional, and Unhealthy (red meat and oils) dietary patterns (PCA) [Validated 136-item semi-quantitative FFQ (past 12 months)]	Diagnosis: Major depression diagnosed by psychiatrist through a clinical examination and score of BDI ≥36	A Healthy dietary pattern was negatively associated with odds of depression (OR: 0.61, 95% CI: 0.46–0.81), while the Western dietary pattern increased odds of depression (OR: 1.29, 95% CI: 1.06–1.59). The Sugar-Fast Food, Traditional, and Unhealthy dietary patterns were not associated with depression.
40	Sánchez-Villegas et al. (2009), **Spain**[3*] Both cross-sectional and prospective analyses (median follow-up 4.4 years) SUN Cohort Study	*N* = 10,094 (480 incident depression cases) Lowest MDP adherence: *n* = 1949 (59.9% females), Mage = 33.3 ± 9.8 Highest MDP adherence: *n* = 2322 (56% females), Mage = 41.3 ± 12.1	MDP [Validated 136-item semi-quantitative FFQ (past 12 months)]	Diagnosis: Self-reported physician-made diagnosis of clinical depression and/or antidepressant use Subsample validated using the SCID DSM-IV	No difference in MDP adherence was found at or before baseline between depressed and non-depressed participants (β: 0.014, p = .79). Over follow-up, participants with higher MDP adherence were negatively associated with risk for self-reported depression (uppermost category of adherence, HR: 0.69, 95% CI: 0.50–0.96) even after excluding participants who only reported antidepressant use at follow-up.
41	Schweren et al. (2021), **Netherlands** Both cross-sectional and prospective analyses (mean 3.6 years follow-up) Lifelines Cohort	*N* = 121,008: 70,844 females, Mage = 44.38±12.98 50,164 males, Mage = 45.44 ±13.19	Lifelines Diet Score (LLDS), based on the 2015 Dutch Dietary Guidelines [Semiquantitative 110-item FFQ (past month)]	Diagnosis: Current depressive or anxiety disorder (including MDD, dysthymia, social anxiety disorder, panic disorder, agoraphobia, and GAD) diagnosed per the MINI for DSM-IV-TR	No associations were found between diet quality and depression/anxiety cross-sectionally (p = .018) or prospectively (p = .677) at the Bonferroni-adjusted alpha level of 0.002.

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	Study, Location *Studies Included as Part of the Best-Evidence Synthesis*	Sample Details	Diet Quality Measure [and assessment]	Anxiety/Depression Assessment	Findings
42	Seo & Je (2018), **South Korea** Cross-sectional KNHANES	*N* = 10,591 Depression: *n* = 246: 164 females, Mage = 42.2 ± 1.1 82 males, Mage = 40.5 ± 1.5 Controls: *n* = 10,345: 6201 females, Mage = 41.20±.2 4144 males, Mage = 40.4 ± 0.3	aMDS [Validated 112-item dish-based FFQ]	Diagnosis: Current self-reported physician-made diagnosis of depression	aMDS scores were lower in the depression group compared to controls for both men (2.82 vs 3.02, respectively) and women (2.87 vs 2.95, respectively), though these differences were not statistically significant between groups in either men (p = .358) or women (p = .599).
43	Sotoudeh et al. (2019) **Iran**[5] Cross-sectional	*N* = 330 Depression: *n* = 110, Mage = 35.8 ± 1.04 Controls: *n* = 220, Mage = 35.7 ± 0.72	Healthy and Unhealthy dietary patterns (EFA) [Validated 168-item semi-quantitative FFQ (past 12 months)]	Diagnosis: Presence of MDD per DSM-IV criteria Symptoms: BDI-II BAI-II	Participants in the highest quartile of the Healthy dietary pattern had lower odds of depression compared to participants in the lowest quartile (OR: 0.31, 95% CI: 0.14–0.68). Conversely, participants in the highest quartile of the Unhealthy dietary pattern had higher odds of depression compared to participants in the lowest quartile (OR: 2.7, 95% CI: 1.25–5.9).
44	Sotoudeh et al. (2020), **Iran**[5*] Cross-sectional	*N* = 330 Depression: *n* = 110, Mage = 35.85 ±10.86 Controls: *n* = 220, Mage = 35.69 ±10.75	Healthy and Unhealthy dietary patterns (EFA/PCA) [Validated 168-item semi-quantitative FFQ (past 12 months)]	Diagnosis: Depression diagnosis per DSM-IV criteria	The Healthy dietary pattern was associated with lower odds of depression (OR 0.39, 95% CI 0.17–0.92), while the Unhealthy dietary pattern was associated with increased odds of depression (OR 2.6, 95% CI 1.04–6.08).

Note. 1,2,3,4,5 = participant sample is shared; * = not included as part of overall data synthesis.
Study: CDAH = Childhood Determinants of Adult Health study; KNHANES = Korea National Health and Nutrition Examination Survey; KIHD = Kuopio Ischemic Heart Disease Risk Factor Study; NESDA = Netherlands Study of Depression and Anxiety; NHANES = National Health and Nutrition Examination Survey; NHS = Nurses' Health Study; SUN = Seguimiento Universidad de Navarra Cohort Study.
Dietary Assessment Instrument: CDHQ-I = Canadian Diet Health Questionnaire I; FFQ = Food Frequency Questionnaire.
Dietary Index/Score: ADQS = Australian Dietary Quality Score; AHEI = Alternative Healthy Eating Index; aMDS = alternate Mediterranean Diet Score; Aust-HEI =; BHEI-R = Brazilian Healthy Eating Index revised; DASH = Dietary Approaches to Stop Hypertension; DII = Dietary Inflammatory Index;; E-DII = Energy-adjusted Dietary Inflammatory Index; HEI = Healthy Eating Index; MDP = Mediterranean Dietary Pattern; MDS = Mediterranean Diet Score; MEDAS = Mediterranean Diet Adherence Screener; MIND = Mediterranean-DASH diet Intervention for Neurodegenerative Delay; PDP = Pro-vegetarian Dietary Pattern; UPF = Ultra-Processed Foods.
Anxiety/Depression Assessment: BAI = Beck Anxiety Inventory; BDI-II = Beck Depression Inventory – Second Edition; CES-D = center for Epidemiological Studies Depression Scale; CGI-I = Clinical Global Impression Improvement Scale; CIDI = Composite International Diagnostic Interview; DASS-21 = Depression, Anxiety and Stress Scale (21-item version); DSM-IV = Diagnostic and Statistical Manual for Mental Disorders, fourth edition; DSM-IV-TR = Diagnostic and Statistical Manual for Mental Disorders, fourth edition, text revision; DSM-5 = Diagnostic and Statistical Manual of Mental Disorders; GHQ-12/18 = General Health Questionnaire (12/18 items); HADS = Hospital Anxiety and Depression Scale; HAM-D = Hamilton Rating Scales for Depression; HAM-A = Hamilton Rating Scales for Anxiety; HPL = Human Population Laboratory Depression Scale; ICD-10 = International Statistical Classification of Diseases and Related Health Problems, 10th revision; IDS(-SR) = Inventory of Depressive Symptomatology-Self Report; MADRS = Montgomery–Asberg Depression Rating Scale; MDD = Major Depressive Disorder; MDE = Major Depressive Episode; MHI-5 = 5-item Mental Health Inventory; MINI = Mini International Neuropsychiatric Interview; SCID = Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders.
Measure of Association/Analysis: 95% CI = 95% Confidence Intervals; EFA = Exploratory Factor Analysis; FA = Factor Analysis; HR = Hazard Ratio; IQR = Inter-quartile Range; OR = Odds Ratio; PCA = Principal Component Analysis; PR = Prevalence Ratio; RR = Rate Ratio; SEE = Standard Error of the Estimate.
Other:.
SSRI = selective serotonin reuptake inhibitor.

2021; Perez-Cornago et al., 2017), and individual studies used the Mediterranean-DASH diet Intervention for Neurodegenerative Delay (MIND; Fresán et al., 2018), and the Pro-vegetarian Dietary Pattern (PDP; Sánchez-Villegas et al., 2015a). The remaining studies used scores measuring adherence to country-specific dietary guidelines/recommendations or that were part of a national health examination (*n* = 13; henceforth referred to as dietary guidelines). Seven studies compared multiple diet quality scores simultaneously (Burrows et al., 2020; Fresán et al., 2018; Gianfredi et al., 2021; Gibson-Smith et al., 2018; Marozoff et al., 2020; Perez-Cornago et al., 2017; Sánchez-Villegas et al., 2015a).

The studies that used *a posteriori* dietary patterns varied according to study location and method for extracting the dietary patterns, however, two main dietary patterns emerged: a 'Healthy' or 'Prudent' dietary pattern characterized by high intakes of fruit, vegetables, wholegrains, and fish (*n* = 8 studies); in contrast to an 'Unhealthy' or 'Western' diet high in processed and fried foods, refined grains, sweets, and alcohol (*n* = 8). Higher adherence to these dietary patterns hence indicates an increased adherence to a healthier, and unhealthier pattern of eating, respectively. Two studies extracted dietary patterns that did not neatly fit into either of the above two categories, containing a combination of healthy and unhealthy food items and henceforth referred to as 'Mixed' dietary patterns (Ruusunen et al., 2014; Saeidlou et al., 2021). Using the RRR approach, Lucas et al. (2014) extracted an Inflammatory Dietary

Pattern (IDP), where a higher score indicates a more pro-inflammatory diet.

Of the three RCTs that were identified, two involved dietary interventions based on nutritional counselling and individual dietary advice according to the Mediterranean diet (Bayes et al., 2022; Jacka et al., 2017), relative to social/befriending support sessions as the control condition. The other RCT investigated a problem-solving therapy condition as the main intervention, relative to the control condition which involved dietary coaching around general nutrition guidelines (such as the US Department of Agriculture food pyramid), preparation of weekly menus and grocery lists, discussions around access, costs, and preparation of healthy food, and review of dietary intake (Reynolds et al., 2014).

2.5. Anxiety and depression diagnostic tools

Out of 44 studies, all assessed participants for the presence of depressive disorders but only six studies also assessed participants for anxiety disorders. Of these, two studies assessed the presence of either anxiety and/or depression (Forsyth et al., 2012; Schweren et al., 2021), while the other studies assessed for the presence of anxiety as distinct from depression (Gibson-Smith et al., 2018, 2020; Gomes et al., 2021; Jacka et al., 2010). Only one study assessed participants for anxiety disorders alone, without consideration of depression (Richard et al., 2022). Most studies utilized diagnostic criteria to classify depression and/or anxiety status, including the Diagnostic and Statistical Manual of Mental Disorders (fourth/fifth edition, DSM-IV/5; $n = 23$) and the International Classification of Diseases (tenth revision, ICD-10; $n = 6$). In these studies, diagnostic criteria were sometimes assessed using clinical interview schedules such as the Structured Clinical Interview for the DSM-5 (SCID-5; $n = 4$), the Mini International Neuropsychiatric Interview (MINI; $n = 7$), the Composite International Diagnostic Interview (CIDI; $n = 5$), and the Diagnostic Interview for Genetic Studies (DIGS; $n = 2$).

Five studies from the Seguimiento Universidad de Navarra (SUN) cohort assessed participants for depression using a self-reported diagnosis of depression by a physician and/or regular antidepressant use. A validation study using a subsample of the SUN cohort showed that self-report of physician-made diagnoses demonstrated acceptable validity against the SCID for DSM-IV administered by experienced psychiatrists (Sánchez-Villegas et al., 2008). While antidepressants are sometimes prescribed for conditions other than depression (e.g., Schneider et al., 2019), it was reported by authors that this would be highly unusual in Spain, validating their choice to consider regular antidepressant use as a proxy for diagnosis (Sánchez-Villegas et al., 2016). Another four studies assessed participants for depression using a stricter definition of both a self-reported physician-made diagnosis and habitual antidepressant use, and a broad definition of either of these assessments. In these instances, only the strict definition of depression was used in the synthesis of results.

The remaining studies assessed for depression via a medical practitioner referral of patients being treated for depression and/or anxiety (Forsyth et al., 2012), via a physician-made diagnosis (Bayes et al., 2022; Seo and Je, 2018), via a physician-made diagnosis and a Beck Depression Inventory (BDI) score ≥36 (Saeidlou et al., 2021), number of physician visits for depression based on administrative health records (Marozoff et al., 2020), or from data obtained via psychiatric examinations, medical records, and self-reported depression and antidepressant use history (Voortman et al., 2017). Several studies also used self-report symptom questionnaires in addition to diagnostic outcomes, including the BDI, the Hamilton Rating Scale for Depression (HAM-D), and the Inventory of Depressive Symptomatology (IDS; $n = 14$). Finally, a few studies assessed anxiety symptoms using the Hamilton Rating Scale for Anxiety (HAM-A), the Depression, Anxiety and Stress Scale (DASS-21), the Beck Anxiety Inventory (BAI), and the Hospital Anxiety and Depression Scale.

2.6. Quality assessment and best-evidence synthesis

The quality of included studies was considered 'high' if it exceeded the mean assessment score of all reviewed observational studies (i.e., 61%, range of 18–86%), in line with procedures of previous reviews (e.g., Quirk et al., 2013; see Supplementary Table S2). Only the 25 studies that scored above the mean were included in the best-evidence synthesis: nine involving cross-sectional findings (including three studies in anxiety), 12 involving prospective findings (including one study in anxiety), and four studies combining cross-sectional and prospective findings in depression. The quality of the dietary RCTs ranged between 57% to 71%. The results of all eligible observational studies were also considered for a complete overview of findings (i.e., those not assessed as part of the best-evidence synthesis were aggregated with the highest quality studies) and are discussed in Supplementary Materials but will not be a focus of the present review. Figures presenting the findings across the best-evidence synthesis and all studies are summarized in Table 3 and further detailed below.

2.6.1. Results from best-evidence synthesis

Cross-sectional Findings – Depression. Cross-sectional findings for the associations between various dietary measures and depression at the disorder level are presented in Fig. 2A. In line with the criteria for the best-evidence synthesis (Table 1), the Mediterranean diet provided conflicting evidence for the association with depression outcomes (Gianfredi et al., 2021; Gibson-Smith et al., 2018; Paans et al., 2019; Sánchez-Villegas et al., 2016). Similarly, the Healthy Eating Index (HEI; or its variants) indicated conflicting evidence for the association with depression (Beydoun and Wang, 2010; Gibson-Smith et al., 2018; Sánchez-Villegas et al., 2015a). There was also limited, but consistent, evidence showing no associations between depression and dietary indices informed by national dietary guidelines (Gianfredi et al., 2021; Jacka et al., 2010; Rahe et al., 2015; Wilson et al., 2021). Furthermore, there was limited but consistent evidence showing an association between higher odds/risk of depression with higher adherence to the Dietary Inflammatory Index (DII; Chen et al., 2021; Sánchez-Villegas et al., 2015b).

As there were only single studies found in relation to the Pro-vegetarian Dietary Pattern (PDP) and the Dietary Approaches to Stop Hypertension (DASH) diets, there was *very* limited evidence indicating a positive association for the PDP with reduced depression risk (Sánchez-Villegas et al., 2015a), and no association between the DASH and depression (Gianfredi et al., 2021).

In relation to empirically-derived dietary patterns, there was limited (but generally consistent) evidence for no associations between depression and Healthy dietary patterns, and limited evidence indicating no associations between depression and Unhealthy dietary patterns (Jacka et al., 2010; Lasserre et al., 2021).

Cross-sectional Findings – Anxiety. Overall, the cross-sectional findings for the associations between various dietary measures and anxiety at the disorder level indicated little evidence for any notable trends (Fig. 2B). There was limited and conflicting evidence for the association between the Alternative HEI (AHEI) and anxiety disorders (Gibson-Smith et al., 2018; Richard et al., 2022). There were only single studies assessing the associations between the Mediterranean diet (Gibson-Smith et al., 2018), and dietary indices informed by national dietary guidelines (Jacka et al., 2010), both of which indicated very limited evidence for no associations with anxiety outcomes. There was also only one study that explored associations between empirically-derived dietary patterns and anxiety, indicating conflicting (but very limited) evidence for an association with a Healthy dietary pattern, and very limited evidence for a lack of association with a Western dietary pattern (Jacka et al., 2010).

Prospective Findings – Depression. Prospective findings for the associations between various dietary measures and depression at the disorder level are presented in Fig. 3. There was strong evidence for

Table 3
Overview of results figures.

	Depression (disorder level)	Anxiety (disorder level)	Depression symptoms	Anxiety symptoms
Best evidence synthesis	Cross-sectional-studies: Fig. 2A Prospective studies: Fig. 3	Cross-sectional studies: Fig. 2B *1 prospective study only (not displayed)*	Cross-sectional studies: Fig. 4	*2 cross-sectional studies only (not displayed)*
All studies	Cross-sectional studies: **Fig S1A in Supplementary Materials** *Prospective findings unchanged*	*Cross-sectional and prospective findings unchanged*	Cross-sectional studies: **Fig S1B in Supplementary Materials**	Cross-sectional studies: **Fig S2 in Supplementary Materials**

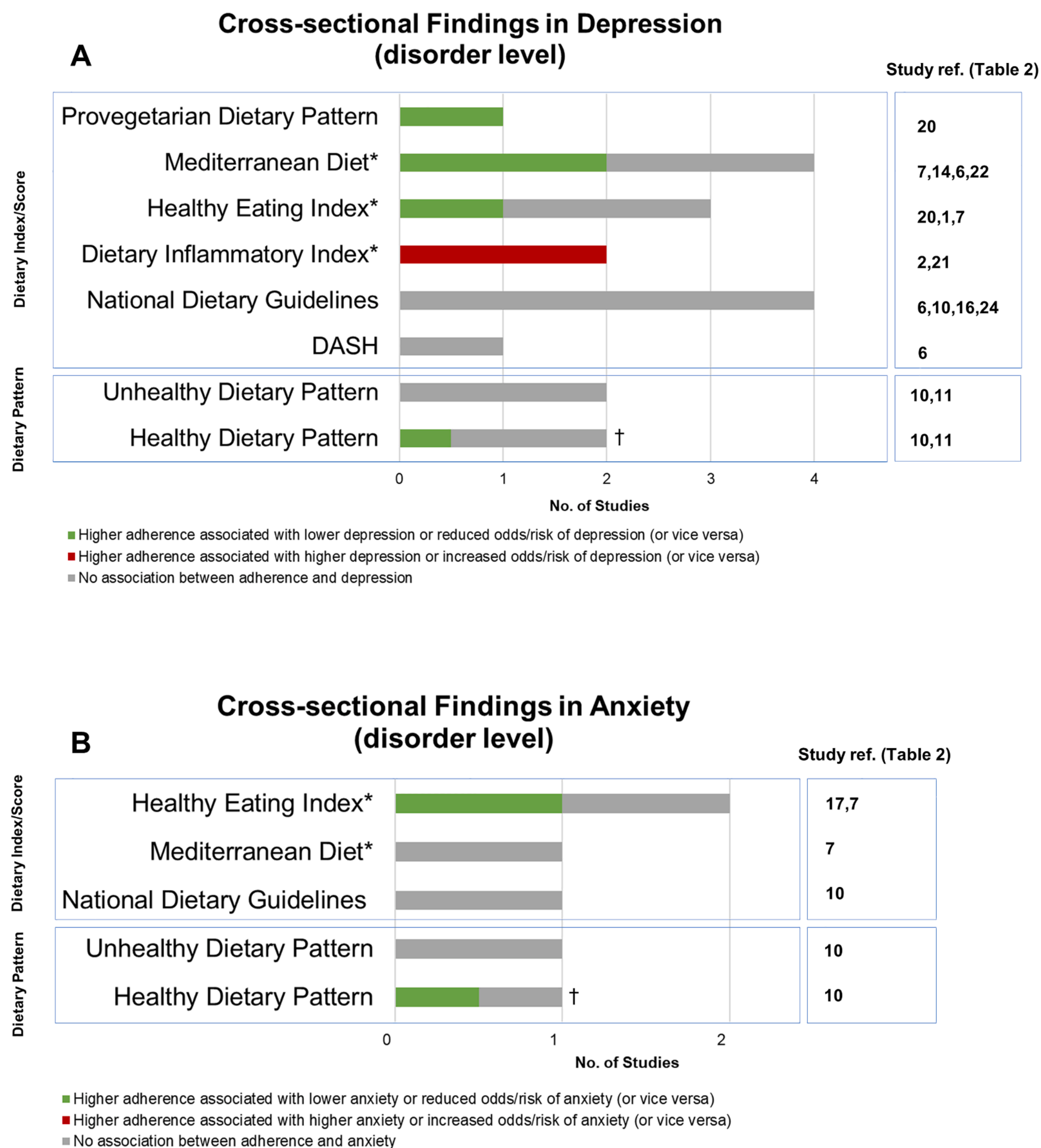

Fig. 2. Overview of the cross-sectional findings (disorder level) across studies for A) Depression and B) Anxiety. DASH = Dietary Approaches to Stop Hypertension. * = findings based on the variants of the shown dietary indices are included. Please note that studies marked with † indicate that several variants of the same dietary measure were used within the same study.

reduced odds/risk of depression with higher adherence to the Mediterranean diet (Fresán et al., 2018; Marozoff et al., 2020; Ruiz-Estigarribia et al., 2019; Sánchez-Villegas et al., 2015a; Yin et al., 2021), with only one study indicating no significant associations (Sánchez-Villegas et al., 2016). There was conflicting evidence for the association between dietary indices based on national dietary guidelines and odds/risk of depression over follow-up (Gall et al., 2016; Gomes et al., 2021; Hoveling et al., 2022; Marozoff et al., 2020; Voortman et al., 2017; Wilson et al., 2021).

The remaining findings were based on only single studies, thereby indicating very limited evidence for significant associations between higher PDP and AHEI adherence and reduced odds/risk of depression

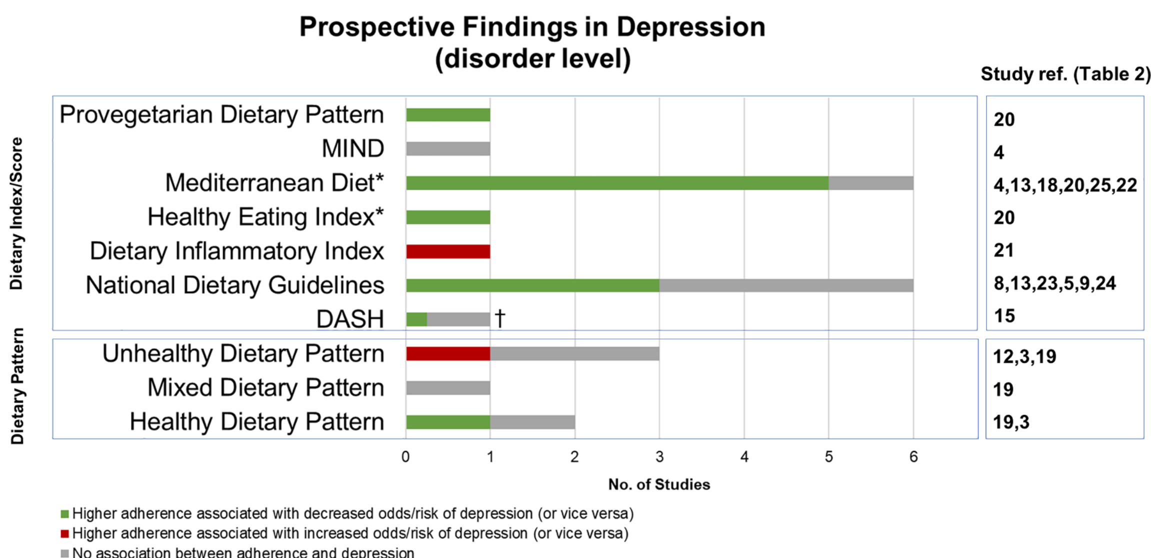

Fig. 3. Overview of the prospective findings (disorder level) across studies for Depression. The 'Unhealthy' dietary pattern includes the Inflammatory Dietary Pattern (IDP; Lucas et al., 2014). The 'Mixed' dietary pattern refers to a diet high in sweet coffee breads, fresh and frozen berries, porridge, sweet snacks, sweet soft drinks and juices, and low in alcohol consumption (Ruusunen et al., 2014). DASH = Dietary Approaches to Stop Hypertension; MIND = Mediterranean-DASH diet Intervention for Neurodegenerative Delay. * = findings based on the variants of the shown dietary indices are included. Please note that studies marked with † indicate that several variants of the same dietary measure were used within the same study.

(Sánchez-Villegas et al., 2015a), and no associations for depression outcomes with the Mediterranean-DASH diet Intervention for Neurodegenerative Delay (MIND) diet (Fresán et al., 2018). Moreover, there was very limited evidence showing a significant association between the DII and higher risk for depression (Sánchez-Villegas et al., 2015a), and there was very limited (but generally consistent) evidence within one study showing no overall associations between the DASH and depression risk (Perez-Cornago et al., 2017).

In relation to empirically-derived dietary patterns, there was conflicting evidence for the associations between depression and Healthy dietary patterns (Chocano-Bedoya et al., 2013; Ruusunen et al., 2014), as well as with Unhealthy dietary patterns (Chocano-Bedoya et al., 2013; Lucas et al., 2014; Ruusunen et al., 2014). Lastly, there was very limited evidence indicating no associations between depression and a Mixed dietary pattern (Ruusunen et al., 2014).

Prospective Findings – Anxiety. There was very limited evidence indicating no associations between the Brazilian HEI-revised (BHEI-R) and GAD (Gomes et al., 2021).

Anxiety and Depression Symptoms. Several studies reported on the associations of anxiety and depression symptoms with various diet quality measures. As shown in Fig. 4, there was limited (but consistent) evidence that higher adherence to the Mediterranean diet is associated with lower depression symptoms (Gibson-Smith et al., 2018; Paans et al., 2019). There was also very limited evidence indicating that higher AHEI scores are associated with lower depression symptoms (Gibson-Smith et al., 2018), while there was limited and conflicting evidence for dietary indices based on national dietary guidelines (Jacka et al., 2010; Rahe et al., 2015). In relation to empirically-derived dietary patterns,

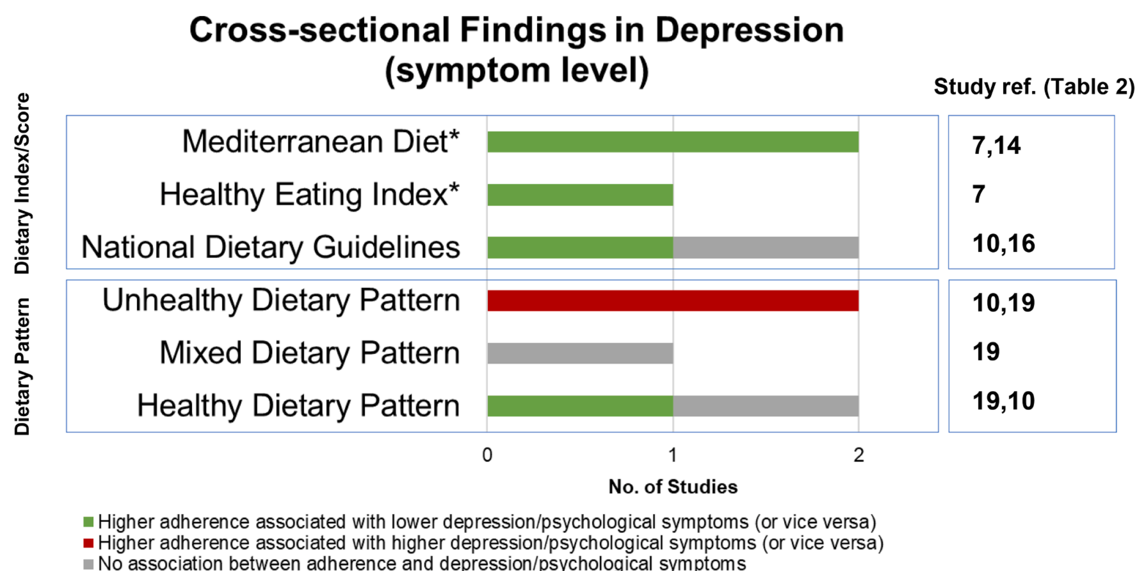

Fig. 4. Overview of the cross-sectional findings (symptom level) across studies for Depression. The 'Mixed' dietary pattern refers to a diet high in sweet coffee breads, fresh and frozen berries, porridge, sweet snacks, sweet soft drinks and juices, and low in alcohol consumption (Ruusunen et al., 2014). * = findings based on the variants of the shown dietary indices are included.

there was limited but consistent evidence indicating a positive association between the Unhealthy dietary pattern with depressive symptoms (Jacka et al., 2010; Ruusunen et al., 2014). Finally, there was conflicting evidence for a Healthy dietary pattern (Jacka et al., 2010; Ruusunen et al., 2014), and very limited evidence for no associations between depressive symptoms and a Mixed dietary pattern (Ruusunen et al., 2014).

There were two findings from the same study which investigated the associations between anxiety symptoms and diet quality, indicating that higher adherence to the MDS and AHEI were both associated with lower anxiety symptoms (Gibson-Smith et al., 2018).

2.6.2. Results from overall findings (All studies)

A comparison of the best-evidence findings to those derived from all included studies indicated no considerable change in the results for the Mediterranean diet, HEI, or DII (see Figure S1). However, there was conflicting evidence for dietary indices based on national dietary guidelines and depression outcomes, relative to the consistent lack of associations reported in the best-evidence synthesis. Similarly, there was conflicting evidence for Unhealthy dietary patterns in relation to depression, compared to the lack of associations reported in the best-evidence synthesis. Lastly, there was limited but consistent evidence for an association between Healthy dietary patterns and lower depression, as opposed to the conflicting evidence reported in the best-evidence synthesis. The findings for prospective findings in depression (disorder level), and cross-sectional and prospective findings in anxiety (disorder level) remained completely unchanged. Symptom-level findings for depression remained largely unchanged, whereas more specific findings were indicated for anxiety symptoms among depression cohorts stratified according to changes in appetite (discussed in further detail in Supplementary Materials; see Figure S2).

2.7. Intervention studies

Of the three RCTs included in the present review, Bayes et al. (2022) and Jacka et al. (2017) both found that participants in a dietary support intervention based on encouraging adherence to a Mediterranean diet showed significantly reduced depression symptoms compared to the control group after 12 weeks. Jacka et al. (2017) also reported significant reductions in anxiety symptoms in the dietary support group, and that remission for depression was achieved for 32.3% of participants in the dietary support group (defined as a MADRS score <10) compared to 8% in the control group. The intervention study by Reynolds et al. (2014), which coached participants on general nutrition guidelines as part of the control group (relative to a problem-solving therapy condition), found that the groups did not differ in time to develop a major depressive episode, and that incidence of such episodes was low compared to published rates of care as usual. There was also an equivalent 4-point reduction in BDI scores across the two groups after 2 years of follow-up.

3. Discussion

3.1. Main findings

This systematic review is the first to provide a comprehensive overview of the literature exclusively examining associations between clinical anxiety and/or depression and a wide range of diet quality measures. It also provides an update of previous meta-analyses which only included small numbers of studies with clinical depression as an outcome as part of sensitivity analyses (e.g., Lassale et al., 2018; Molendijk et al., 2018). The best-evidence synthesis provided strong evidence for associations between consumption of a Mediterranean-based diet and reduced odds/risk of depression in prospective studies, although the evidence was conflicting in cross-sectional studies. One study indicated no associations between the Mediterranean diet and anxiety disorders (when considered on their own) but reported a significant association relative to comorbid anxiety and depression. There was conflicting evidence for associations between diet indices based on country-specific dietary guidelines and anxiety or depression prospectively, while no associations were reported in cross-sectional studies in anxiety or depression. The findings for the remaining diet quality measures indicated either conflicting or too sparse a level of evidence to draw any meaningful conclusions. The overall findings from all studies were broadly consistent with those from the best-evidence synthesis, though risk of bias due to ambiguous or inconsistent methods for recruitment, inadequate assessment measures for dietary intake and anxiety/depression, and lack of consideration of confounders may skew the overall findings (see Table S3). Finally, although there was some indication for the positive effects of dietary interventions on diagnosed depression, the scope of the existing evidence is limited. The following sections will discuss the main findings and relevant implications in relation to the best-evidence synthesis and intervention studies, followed by key considerations for future studies as informed by this review.

3.2. Mediterranean diet

In line with previous reviews and meta-analyses (e.g., Altun et al., 2019; Gianfredi et al., 2022; Lassale et al., 2018), we found that the Mediterranean diet is strongly associated with improved depression outcomes over follow-up. While one systematic review failed to find any prospective links between the Mediterranean diet and depression risk (Shafiei et al., 2019), a considerable body of research has implicated the Mediterranean dietary pattern as a 'gold standard' intervention for the prevention of mental health disorders, particularly in the case of depression (for a review, see Opie et al., 2017). Several characteristic elements distinguish the Mediterranean diet from other healthy diets, such as its emphasis on increased intake of omega-3 fats and polyphenols, regular red wine consumption during meals, as well as the use of olive oil as the principal source of fat (Bach-Faig et al., 2011). These distinctive food components may therefore be candidate links for understanding the Mediterranean diet's protective associations with depression (Bayes et al., 2020; Grosso et al., 2014). For instance, high consumption of plant-based foods and healthy fats confer anti-inflammatory, anti-oxidative, and endothelial effects which can protect against neuronal damage and counteract the inflammatory status associated with the development and severity of depressive, and potentially, anxiety disorders (Berk et al., 2013; Renna et al., 2018). The Mediterranean diet has also been shown to improve plasma levels of brain-derived neurotrophic factor (BDNF) – a key protein involved in neurogenesis and neuronal survival – which has been shown to be reduced in patients with depression (Sánchez-Villegas et al., 2011).

The gut microbiota, whose composition and function are strongly influenced by diet (Oriach et al., 2016), has also been implicated as a key modulator of the effects of diet on mental health (Berding et al., 2021). Emerging evidence indicates that there are gut microbiota differences in anxiety and depression cohorts relative to healthy controls, potentially due to the role of gut microbes in cognitive and affective processes (Foster and McVey Neufeld, 2013; Simpson et al., 2021). Gut microbiota disruptions can lead to low-level intestinal inflammation, abnormalities in hypothalamic-pituitary-adrenal (HPA) axis function, and imbalances in neurotransmitter metabolism via the microbiota-gut-brain axis, which can all contribute to the pathogenesis of mental disorders (Huang et al., 2019; Kelly et al., 2016). Adherence to the Mediterranean diet has been associated with a reduced abundance of inflammatory and pathogenic bacterial species, including *Escherichia coli,* while increasing the abundance of mutualistic taxa, such as *Bifidobacteria* and *Faecalibacterium prausnitzii,* which produce anti-inflammatory metabolites (Gutierrez-Diaz et al., 2017). As the importance of the Mediterranean diet for gut microbiota continues to be elucidated, it is increasingly necessary for nutritional intervention studies to consider the impacts of diet on gut

microbiota composition and function in the context of mental health (Bear et al., 2020).

3.3. Diets based on national dietary guidelines

While past reviews have found that measures of adherence to dietary guidelines were associated with positive outcomes for depression (e.g., Lassale et al., 2018; Ljungberg et al., 2020), the present review indicated conflicting findings for both anxiety and depressive disorders in relation to a variety of indices spanning Australian, Dutch, and German dietary guidelines. Additionally, the HEI (and its variants) – which are based on US dietary guidelines – were inconsistently associated with depression in cross-sectional studies, with limited evidence for a protective association in prospective studies of anxiety or depression. This is somewhat contrary to previous reviews, which have generally shown a consistent cross-sectional (Nicolaou et al., 2020) and prospective link (Lassale et al., 2018) between depression risk and the HEI/AHEI, but it supports findings for a lack of associations prospectively (Nicolaou et al., 2020) or between different versions of the AHEI (Nicolaou et al., 2020; Wu et al., 2021). An important caveat to consider is that existing reviews have mainly focused on studies examining subclinical levels of depression. In their meta-analysis, Molendijk et al. (2018) observed an inverse diet-depression association in studies using depression symptom severity scales but not when restricted to studies with a formal diagnosis as outcome. The authors argue that such scales could overestimate the diet-depression link because they may be capturing aspects of depression that are also closely linked to cardiometabolic conditions (e.g., fatigue and weight gain) in the absence of core symptoms, such as depressed mood. This would lead to higher scores on a symptom severity scale but would not be sufficient to meet diagnostic criteria for depression, which provide a more thorough and standardized assessment that is generally preferable to symptom scales (Wilson et al., 2021). Moreover, given that clinical diagnoses tend to be more severe and chronic, the present review focused on diagnosed populations because increased functional impairment would be expected to negatively influence long-term dietary choices more so than subclinical anxiety or depression.

Another explanation for the observed heterogeneity in findings is that country-specific dietary guidelines capture all aspects of dietary intake and do not specifically target those dietary components that have been closely associated with anxiety or depression, such as polyphenolic compounds and omega-3 fatty acids (Opie et al., 2017). Dietary guidelines are developed in various countries based on current evidence to meet nutritional requirements and to reduce the risk of diet-related noncommunicable diseases (NCDs), such as cancer, diabetes, and cardiovascular diseases (Schneeman, 2003).While mental health disorders fall under the category of NCDs, research on their potential relation to whole-of-diet has only emerged within the last decade (Sarris et al., 2015). Existing guidelines arguably have not yet targeted mental health disorders as an outcome (Myers et al., 2013), or have done so with limited or inconclusive evidence (e.g., National Health and Medical Research Council, 2013). The inconsistent associations between depression and dietary guidelines in this review may indicate that the existing recommendations which promote physical health may not do so for mental health. It could also be that there is a lack of variation in dietary intake at the population level, or that dietary guidelines are too varied in how they measure dietary quality (McNaughton, 2010). Given the complex interactions between nutrients, the shift towards whole-of-diet pattern analysis, as opposed to single nutrients, has been an important step in nutritional epidemiology (Hu, 2002). Future studies are encouraged to be selective with the use of diet quality measures to ensure these are evidence-driven in relation to anxiety and depressive disorders.

3.4. Empirically derived dietary patterns

There was conflicting evidence for the association between *a posteriori* dietary patterns and anxiety or depression in both cross-sectional and prospective studies. This is not consistent with previous reviews, which have generally found that empirically-derived healthy dietary patterns are protective for mental health while unhealthy dietary patterns contribute to higher odds/risk of depression (Li et al., 2017; Rahe et al., 2014). On the other hand, a review by Quirk et al. (2013) similarly found conflicting evidence regarding the links between both healthy and unhealthy dietary patterns and depression in cross-sectional and cohort studies deemed of high quality. A possible reason for the lack of consistency is that empirically derived dietary patterns may be subjective in their selection of food groups, number of factors/principal components to retain, cut-offs for factor/component loadings, and in the naming of extracted patterns (Zhao et al., 2021). The dietary patterns derived in one study are therefore not always generalizable to other populations, particularly if specific characteristics of a given sample predispose to, or protect against, mental health disorders, such as sex, age, body weight, socioeconomic status, and lifestyle factors, among others (Firth et al., 2020; Jacka et al., 2014). Importantly, data-driven dietary patterns are based on existing food intake data without prior hypotheses, while the derived 'healthy' dietary patterns do not necessarily represent optimal diets for mental health, potentially contributing to the conflicting associations in this review.

3.5. Dietary RCTs

Of the three RCTs reviewed, one showed that participants in a dietary coaching condition – meant to serve as the control group – achieved comparable improvements in depression symptoms over follow-up as the active condition (Reynolds et al., 2014). Dietary coaching was by its very nature considered an active intervention as it taught participants how to address challenges to implementing healthy eating practices via homework activities, along with its strong social aspect by virtue of the face-to-face delivery. While promising, several methodological constraints, such as the lack of a dietary intake measure (meaning actual intake was not assessed) and high drop-out rate, mean that further replication of these findings is necessary. The other two interventions (Bayes et al., 2022; Jacka et al., 2017), which supported participants to adopt a Mediterranean diet model, both showed improvements in depression symptoms. While none of the included RCTs were conducted in patients with anxiety disorders, the intervention led by Jacka et al. (2017) additionally led to improvements in anxiety symptoms. However, areas for improvement that are highlighted across these RCTs include issues around potential expectancy effects, differential drop-out rates between groups, and short duration times. Consequently, the long-term effects of the Mediterranean diet for clinical depression remains to be determined. Indeed, another RCT in a clinical depression cohort based on a Mediterranean diet supplemented with either extra virgin olive oil or mixed nuts found no significant associations with depression risk compared to the control group (Sánchez-Villegas et al., 2013). However, this study was not eligible for inclusion in the present review as it specifically assessed individuals with type 2 diabetes or cardiovascular risk factors and hence may have led to misclassification in the detection of depression cases. Further intervention studies with longer follow-up periods are necessary to establish the role of the Mediterranean diet on anxiety and depressive disorders.

Interestingly, a recent systematic analysis of dietary interventions for depression demonstrated that the benefits of a healthy diet on depression tend to be overstated in narrative reviews relative to systematic or meta-analytic syntheses (Thomas-Odenthal et al., 2020). This is despite inconclusive evidence regarding the efficacy of dietary interventions when Thomas-Odenthal et al. (2020) conducted an updated meta-analysis of known RCTs to date. Compared to pharmacological trials, dietary intervention studies are often limited methodologically

due to difficulties in blinding participants to the nature of the intervention, lack of adequate allocation and evaluation of treatment conditions, heterogeneity in sample characteristics, lack of biomarkers to stratify within and across populations, and small sample sizes (Adan et al., 2019). Methodologically rigorous and adequately powered experimental population studies are hence imperative to providing new mechanistic insights into the relationships between dietary factors and anxiety/depression disorders to inform the development of effective interventions. Moreover, while carefully controlled RCTs will be required to test for causality, no dietary interventions have been compared to psychotropic medication use to date (Firth et al., 2019). Dietary changes are relatively easy to implement and cost-effective, hence their efficacy in relation to existing treatments needs to be further elucidated.

3.6. *Key considerations for future studies*

Much work remains to be undertaken before a full understanding of the role of diet in mental health disorders is established. Despite the high methodological quality of studies in the best-evidence synthesis, there was a considerable level of heterogeneity in relation to measures of diet quality and study sample characteristics, as discussed extensively in previous reviews (Lassale et al., 2018; Quirk et al., 2013). For instance, while sex-stratified analyses were beyond the scope of the present review, indications for sex differences in relation to dietary associations with anxiety and depression were incongruent among several studies (e.g., Beydoun and Wang, 2010; Gomes et al., 2021; Wilson et al., 2021). Even with the exclusion of studies solely using depression symptom scales, there was considerable inter-study variability in the assessment of depression. While diagnostic interviews are considered preferable in that they have been validated for estimating disorder prevalence (Thombs et al., 2018), they are difficult to implement in studies with large samples, meaning big cohort studies tend to rely on self-reported physician diagnoses and/or antidepressant medication use. Unsurprisingly, the latter are not as informative as diagnostic interviews which collect additional information that may be relevant to diet. For instance, different anxiety disorders or subtypes of depression (i.e., melancholic vs atypical depression) have been reported to be differentially associated with diet quality due to alterations in appetite and weight gain (Burrows et al., 2020; Lasserre et al., 2021; Rahe et al., 2015; Richard et al., 2022). Another study in our review demonstrated that maladaptive eating styles – such as emotional or external eating (i.e., an increased tendency to eat in response to external cues, such as sight or smell of food) – exacerbated unhealthy food intake independently of depression (Paans et al., 2019). The issue of reverse causality, too, needs to be further assessed given that a history of depression was associated with healthier dietary choices in some studies (Gibson-Smith et al., 2018) but not others (Lasserre et al., 2021; Paans et al., 2019). The role of distinct anxiety disorders, depression subtypes, eating styles, and disorder history in relation to diet quality hence remain important areas of investigation for future studies.

Anxiety, by contrast, continues to be understudied in relation to diet. Of the few studies which assessed for anxiety disorders, there were no conclusive trends in relation to any diet quality measures. Although the dietary RCT by Jacka et al. (2017) improved self-reported anxiety symptoms, a meta-analysis of dietary interventions reported benefits for depressive symptoms but not for anxiety (Firth et al., 2019). While this meta-analysis only included sub-clinical populations, it remains to be seen how diet quality relates to anxiety in clinical cohorts. Challenges in distinguishing anxiety from depression in terms of assessment arise not only due to their high comorbidity but also due to an overlap in symptoms (e.g., fatigue, sleep disturbances, irritability; Kalin, 2020), poor discriminant validity of self-report measures and diagnostic assessments of anxiety and depression (Eysenck and Fajkowska, 2018), as well as temporal variability of symptoms which can make it difficult to determine whether an individual is experiencing one or both conditions (Starr and Davila, 2012). It is also important to acknowledge any cumulative effects of co-occurring anxiety and depression disorders on diet quality. Gibson-Smith et al. (2018) was the only study to specifically tease apart associations between diet quality and disorder comorbidity, showing that patients with comorbid presentations had lower diet quality compared to controls, but not when the disorders were considered individually. Instead, it was the severity of the disorders that primarily related to diet quality, wherein individuals with comorbid disorders had significantly more severe symptoms than those with just one disorder. Given the high comorbidity between anxiety and depression (Kalin, 2020), it is warranted that future prospective and intervention studies examine these disorders in parallel.

3.7. *Strengths and limitations*

With anxiety and depression among the leading causes of non-fatal disease burden, our review contributes to the growing efforts to identify the role of nutrition in these disorders and inform points of intervention. Critically, we used a comprehensive screening approach to include only those studies with clinical anxiety and depression cohorts as no prior reviews have done so before. Identifying potentially modifiable risk factors is important given the high prevalence, costs, adverse effects on quality of life, and considerable morbidity and mortality associated with anxiety and depressive disorders (Cuijpers et al., 2020). Moreover, the high co-occurrence of anxiety disorders alongside depression was considered, as comorbidity conveys important information about shared risk factors and pathological processes that may be relevant to treatment (Kotov et al., 2017). A best-evidence synthesis of high-quality studies was conducted to minimize any biases concerning the internal validity of the findings. We also excluded any study populations susceptible to developing depression, such as those specifically recruited with chronic health conditions, which may act as confounders in the relationship between diet and mental health (Quirk et al., 2013). Lastly, the wide inclusion criteria with regard to study designs and diet quality measures allowed us to capture a broad overview of the cross-sectional, prospective, and interventional relationships between anxiety and depression and a variety of diet quality measures.

The heterogenous exposure and outcome measures captured, however, made it challenging to observe trends in the findings and precluded us from conducting a meta-analysis. While this review focused on clinical anxiety and depressive disorders, we included studies which considered a disorder present if participants self-reported physician-diagnosed depression and/or antidepressant use, which can lead to a higher probability of misclassification as compared to utilizing standardized, diagnostic criteria (Sánchez-Villegas et al., 2015a). Notwithstanding these limitations, physician-made diagnoses have previously demonstrated acceptable validity (Sanchez-Villegas et al., 2008), and the use of antidepressants for conditions other than depression is considered highly unusual for the relevant study population (i.e., SUN cohort in Spain; Sánchez-Villegas et al., 2015a). The best-evidence synthesis is also limited by its subjective cut-off for determining methodological rigor based on the mean total quality assessment score within the reviewed literature, rather than an external benchmark. However, the cut-off value used in the present review aligns with previously published studies following the same procedures (e.g., Lievense et al., 2001). Furthermore, we acknowledge that the choice to exclude gray literature and dissertations limits the ability of the present review to represent the complete evidence base. In terms of exclusion criteria, we did not apply an age limit on the adult samples despite evidence of changes in appetite and dietary quality with progressing age (Wu et al., 2021, Wu et al., 2020). Finally, many studies were conducted in mid-to-high average income regions (e.g., Europe, Australia, USA) which limits the generalizability of our findings to lower average income countries.

4. Conclusions

The present review provides observational and interventional evidence which suggests that adherence to Mediterranean-based diets is associated with better depression outcomes over time. This suggests the potential for the Mediterranean diet as a cost-effective, safe, and easily modifiable adjunct alongside existing therapies for depression. Examination of the biological mechanisms that are potentially driving these relationships will be critical for designing efficacious interventions. The evidence surrounding other measures of diet quality in relation to both anxiety and depressive disorders is less conclusive, hence further rigorous prospective and intervention studies are required. Future research will also strongly benefit from implementing clinical diagnoses of both anxiety and depressive disorders to improve the validity of assessment. Elucidating the efficacy of dietary interventions on their own, and combined with existing treatments, will be the necessary step forward in understanding the role of diet in the context of mental health disorders.

5. Contributors

DE designed the systematic review protocol and methodology, conducted systematic searches and filtering, quality assessment, and drafted and wrote the manuscript. CS conducted systematic searches and filtering, quality assessment, and assisted with methodology design, interpretation, and manuscript revision. OS and JS assisted with methodology design, interpretation, and manuscript revision. AL and NH assisted with interpretation and manuscript revision. All authors contributed to and have approved the final manuscript.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

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