

Dietary intake of adults with eating disorders: a systematic review and meta-analysis

Article

Published Version

Creative Commons: Attribution 4.0 (CC-BY)

Open Access

Jenkins, P. E. ORCID: <https://orcid.org/0000-0003-1673-2903>, Proctor, K. and Snuggs, S. ORCID: <https://orcid.org/0000-0001-5191-9517> (2024) Dietary intake of adults with eating disorders: a systematic review and meta-analysis. *Journal of Psychiatric Research*, 175. pp. 393-404. ISSN 1879-1379 doi: 10.1016/j.jpsychires.2024.05.038 Available at <https://centaur.reading.ac.uk/116475/>

It is advisable to refer to the publisher's version if you intend to cite from the work. See [Guidance on citing](#).

To link to this article DOI: <http://dx.doi.org/10.1016/j.jpsychires.2024.05.038>

Publisher: Elsevier

All outputs in CentAUR are protected by Intellectual Property Rights law, including copyright law. Copyright and IPR is retained by the creators or other copyright holders. Terms and conditions for use of this material are defined in the [End User Agreement](#).

www.reading.ac.uk/centaur

CentAUR

Central Archive at the University of Reading

Reading's research outputs online



Dietary intake of adults with eating disorders: A systematic review and meta-analysis

Paul E. Jenkins^{*}, Katy Proctor, Sarah Snuggs

School of Psychology and Clinical Language Sciences, University of Reading, Reading, RG6 6ES, UK, United Kingdom

ARTICLE INFO

Keywords:

Macronutrients
Micronutrients
Energy intake
Anorexia nervosa
Bulimia nervosa
Binge-eating disorder

ABSTRACT

Studies have confirmed the link between altered dietary intake and eating disorders (EDs), although no systematic assessment of this research exists. Rigorous synthesis of dietary intake in anorexia nervosa (AN), bulimia nervosa (BN), binge-eating disorder (BED), and similar EDs is needed to explore similarities and differences. In accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement, we conducted a systematic review and quantitative synthesis of studies of dietary intake. Searches of three electronic databases resulted in thirty-nine included studies. Meta-analyses of subsets of these studies were undertaken to summarise macronutrient intake across AN, BN, and BED. Study quality was assessed using the American Academy of Nutrition and Dietetics Quality Criteria Checklist, with ratings either Positive ($k = 27$) or Neutral ($k = 12$). Adults with AN had low energy intake and those with BED reported elevated macronutrient intake. Individuals with BN reported wide variation in energy intake, including some of the highest estimates. Individuals with AN were likely to under-consume key micronutrients, with sodium potentially over-consumed in BN and BED. Vitamin D was under-consumed across all disorders. This meta-analysis highlights important diagnostic differences and synthesises dietary intake in EDs, with particular relevance to risk assessment and treatment.

1. Introduction

Eating disorders (EDs) are mental illnesses associated with a range of adverse psychological and physical complications. Adequate nutrition is crucial in supporting basic biological needs (Reiter and Graves, 2010) and disturbed eating patterns represent both predisposing and maintenance factors in EDs. For example, evidence suggests that individuals with anorexia nervosa (AN) have a low total energy intake compared to those without AN (Schebendach et al., 2019), whereas those with binge-eating disorder (BED) have a high total energy intake (Raymond et al., 2007); both patterns can result in negative health outcomes. Irregular dietary patterns are a key component of ED assessment (National Institute for Health and Care Excellence [NICE], 2017) and are targeted across evidence-based treatments for EDs (e.g., Fairburn, 2008; Lock and Le Grange, 2013).

Intake of protein, carbohydrates, and fats (collectively referred to as macronutrients) provides energy and is essential for sustaining life (Venn, 2020). Individuals with AN frequently avoid consuming energy-dense foods, particularly fats (Schebendach et al., 2019), in contrast to those with BED or bulimia nervosa (BN) who typically

consume an excess of carbohydrates and fats (Segura-García et al., 2014). Similarly, inadequate intake of micronutrients – a term covering essential vitamins and trace minerals – can also negatively affect health (Black, 2003), and is often variable in EDs (Setnick, 2010).

Whilst evidence regarding the role of restricted dietary intake in the development of EDs is mixed (Stewart et al., 2022), it is likely that dietary intake interacts with ED symptoms to influence both physiological and cognitive processes (e.g., Datta et al., 2021) and detail about dietary intake can be used to inform diagnostic criteria. For instance, DSM-5 (American Psychiatric Association [APA], 2013) refers to an “altered consumption” of food intake (p. 329) and there is evidence of diagnostic differences in food choice (e.g., Eichin et al., 2023) and eating patterns under controlled conditions (e.g., see Mourilhe et al., 2021).

Understanding the dietary intake of those with EDs can enhance early intervention, prevent the development of more severe illness, and improve chances of recovery (Treasure et al., 2015). In addition to clarifying differences between diagnoses, providing data on dietary intake can inform pathology findings, given that the varying dietary practices seen across EDs may not correspond to nutrient levels seen in blood samples (Setnick, 2010).

^{*} Corresponding author. School of Psychology and Clinical Language Sciences, University of Reading, Reading, RG6 6ES, United Kingdom.

E-mail address: pej106@gmail.com (P.E. Jenkins).

<https://doi.org/10.1016/j.jpsychires.2024.05.038>

Received 8 November 2023; Received in revised form 9 April 2024; Accepted 15 May 2024

Available online 16 May 2024

0022-3956/© 2024 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

The aim of this systematic review and meta-analysis is to synthesise and report the dietary intake of adults with EDs, with reference to specific numerical values. Doing so will pull together findings from diverse samples and afford a more complete description of dietary intake, including investigation of diagnostic differences. The findings will be of use to clinicians and researchers assessing dietary intake in EDs, and can assist efforts at early detection, prevention, and treatment of EDs, as well as informing risk management.

2. Material and methods

The current review followed and is reported in line with the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Page et al., 2021) (Supplementary Table 1).

2.1. Search strategy

An online search was conducted using three electronic databases (Scopus, Medline, Web of Science) to identify relevant papers published to December 6, 2022 (with no date restriction for inception). The search terms selected were: (“dietary intake” OR nutrition* OR “nutritional content” OR “food intake” OR “energy intake”) AND (“eating disorder*” OR “anorexia nervosa” OR “bulimia nervosa” OR bulimi* OR “binge eating disorder” OR BED OR OSFED OR “other specified feeding or eating disorder” OR EDNOS OR “eating disorder not otherwise specified”) AND adult. Reference lists of relevant publications were also searched to identify studies not picked up by the electronic search. Upon completion of the initial search, records from different databases were merged, duplicates removed, and Titles and Abstracts of selected studies were reviewed independently by two authors (PEJ, KP). Selected full-texts were then reviewed by two authors using criteria agreed *a priori* to establish whether studies were eligible for inclusion (see below); any disagreements were resolved through discussion. The eligibility criteria were piloted on a sample of six studies, after which minor changes were made to the criteria (e.g., clarification on age cutoff).

2.2. Inclusion and exclusion criteria

Studies were eligible for inclusion if they met the following criteria: (1) participants had a current, clinically verified, diagnosis of AN, BN, BED, eating disorder not otherwise specified (EDNOS), or other specified feeding or eating disorder (OSFED) according to ICD or DSM criteria; (2) empirical studies published in peer-reviewed academic journals; (3) dietary intake was referenced with a specific numerical value; (4) the dietary recall period was no more than one month; (5) participants were 18 years of age or over (given different nutritional needs in children; Wiklund et al., 2022); (6) texts in the English language. As the change from DSM-IV (APA, 1994) to DSM-5 (APA, 2013) involved the inclusion of OSFED and the removal of EDNOS, both terms were used in this review. Case studies of individuals were excluded. Individuals with a sole diagnosis of specific disorders under the ‘other specified’ categories (i.e., purging disorder, night eating syndrome) or other feeding and eating disorders (i.e., pica, rumination disorder, avoidant/restrictive food intake disorder) were excluded. This was done to retain a focus on disorders resembling AN, BN, and BED and due to unclear causes and inconsistent definitions around some of these syndromes (e.g., Beauchamp et al., 2021; Vander Wal, 2012). Studies where participants were in an active treatment which would likely have affected reported intake, reported factors which might have affected interpretation of the findings (e.g., pregnancy), or where data collection took place outside the natural environment (e.g., in a laboratory or whilst being treated in hospital) were excluded. Participants who were starting treatment, including as inpatients, and recalled their intake prior to treatment were not excluded.

2.3. Data extraction

A data extraction table was developed, and two reviewers (PEJ, SS) independently extracted the data from the final sample based on: author, year of publication, country, design, sample size, ED diagnosis, sample characteristics (gender, age, race, ethnicity, socioeconomic status, body mass index [BMI], setting), nutritional assessment method, and dietary information reported (calories, macronutrients, micronutrients). In instances where energy intake was reported as joules this was converted into kilocalories (239 kilocalories = 1 MJ). Nutritional data are summarised as mean (SD).

2.4. Quality assessment

The quality of each full-text was assessed using the American Academy of Nutrition and Dietetics Quality Criteria Checklist for primary research (QCC; Academy of Nutrition and Dietetics, 2012; see Supplementary Table 2), which has been used in similar reviews (e.g., Lai et al., 2014; Teasdale et al., 2019) and is “based on the quality constructs and domains identified in the Agency for Healthcare Research and Quality report on Systems to Rate the Strength of Scientific Evidence” (Handu et al., 2016, p. 317). Papers were rated based on four relevance questions and ten validity questions. Each question was assigned “yes” if the criterion was met, “no” if the criterion was not met, “unclear” if it was not made clear, or “Not Applicable” if it did not apply. An overall quality score is generated as follows: (a) negative (six or more answers are marked “no”); (b) neutral (questions 2, 3, 6, 7 marked as “no”); (c) positive (most of the answered marked as “yes” including 2, 3, 6, 7). All studies were included in the review, as the sample was expected to be heterogenous (with several small studies) and this was a descriptive study of dietary intake. To detect publication bias, we looked at funnel plots and applied Egger’s regression test to quantify the risk of publication bias influencing findings for key outcomes.

2.5. Statistical analysis

Meta-analysis of means was undertaken using the *metamean* function in R version 4.1.2 (package *meta* version 6.5-0; Schwarzer, 2007) and combined using a random-effects model to produce pooled estimates and 95% confidence intervals; Egger’s test was also conducted using this function. Heterogeneity was assessed using the Cochran’s Q and I^2 statistics. For studies that did not report SDs alongside means, values were imputed where possible using the ‘modified range’ method (Walter and Yao, 2007). In light of expected heterogeneity by diagnosis, meta-analysis for subgroups was not considered if samples were small (i.e., $k < 10$ studies; Schwarzer et al., 2015) or where diagnostic groups were mixed.

3. Results

The systematic review identified 10990 eligible studies. After removing duplicates, 10519 unique titles were identified. Review of Titles and Abstracts resulted in the exclusion of 10400 articles, leaving 119 full texts for review. Two further articles were found through hand-searching (Cheng et al., 2020; Rossiter et al., 1992). We were unable to access the full text for eight articles. Upon screening full-texts, 39 articles were included in the systematic review (Fig. 1). Where possible, dietary intake data from sub-samples (e.g., different ED diagnoses) were extracted for inclusion in meta-analyses.

3.1. Study characteristics

Study characteristics are presented in Table 1. Fifteen studies were conducted in the USA ($N = 511$), five studies in Germany ($N = 161$), four studies in the UK ($N = 126$), three in Italy ($N = 186$), two studies each in Sweden ($N = 523$), Brazil ($N = 84$), Canada ($N = 23$), and the

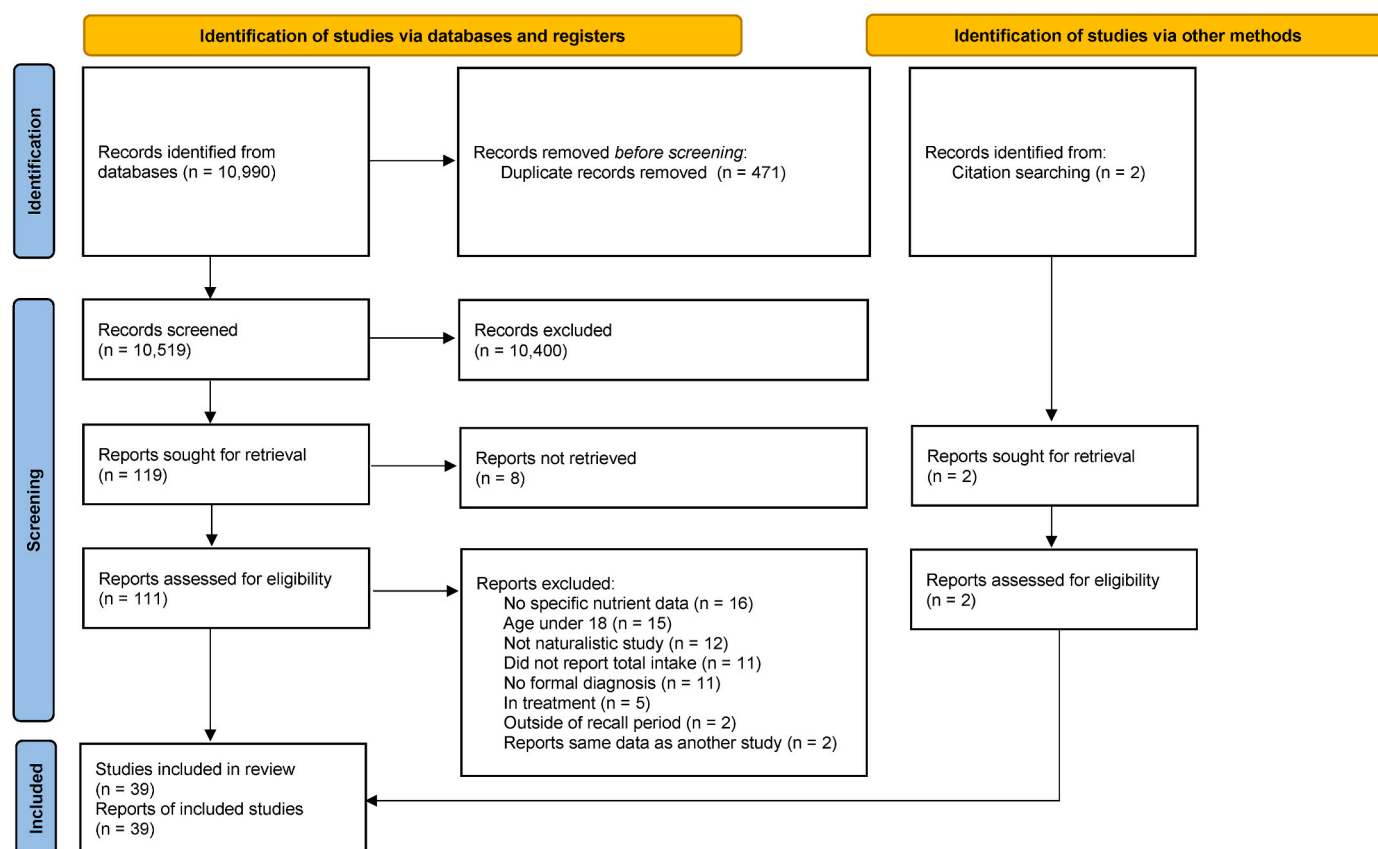


Fig. 1. PRISMA flow diagram of study search and selection.

Netherlands ($N = 32$), and one each in Belgium ($N = 42$), China ($N = 84$), France ($N = 120$), and Israel ($n = 59$). The earliest included study was published in 1985.

In total, 1941 participants were included in the review, 621 of whom were diagnosed with AN, 484 BED, 366 BN, and 470 in mixed diagnostic groups. There were no studies of those receiving a formal diagnosis of OSFED related to AN, BN, or BED, although one study (Burd et al., 2009) included some individuals with “subsyndromal AN” according to DSM-IV criteria (p. 372); many of these individuals would likely meet criteria for AN in DSM-5 (given the broader diagnostic criteria; Hoek, 2014) and were therefore included. DSM-IV (APA, 1994) was most commonly used in the included studies ($k = 24$), with all DSM manuals since DSM-III (APA, 1980) used. Sample sizes ranged from 8 to 430 (median = 28.5), with an age range of 18–65 years. The sample consisted of predominantly female participants ($n = 1738$; male $n = 131$; not reported/Other $n = 72$). Mean BMI was reported in 31 studies, ranging from 13.5 to 49.8 kg/m². Nine studies reported race or ethnicity, and six reported socioeconomic status (see Table 1).

A range of different nutritional assessment methods was used to obtain information on dietary intake, principally using self-report. The most commonly used was a 24-h dietary recall (in 12 studies), and a 7-day food diary was used in eight studies. Other methodologies included different timeframes and one study used ecological momentary assessment over the course of one week. Of the 39 studies, quality ratings were all Neutral ($k = 12$) or Positive ($k = 27$). Quality criteria less frequently addressed (or unclear) included: handling of study dropouts and missing data; incorporation of blinding; and declaration of funding.

Egger’s test suggested no evidence of publication bias for studies of energy intake ($p = 0.43$), carbohydrate intake ($p = 0.54$), or protein intake ($p = 0.85$). The result for fat intake, however, was suggestive of publication bias ($t = 2.35$, $df = 15$, $p = 0.033$; see Supplementary Fig. 1).

3.2. Data synthesis

Fig. 2 provides a summary of the energy intake of the 47 diagnostic sub-samples included in the systematic review. Meta-analysis was conducted on studies of different diagnostic groups including macronutrients (overall energy intake, protein, carbohydrate, fat). Micronutrients were reported in a small number of studies and meta-analysis was not deemed appropriate.

3.3. Macronutrients

Table 2 provides a summary of the energy intake and macronutrients consumed by adults with EDs with recommended dietary intake (RDI) included for comparison (taken from Public Health England [PHE], 2016). Meta-analysis suggested a mean energy intake of 2102 kcal/day across all EDs (95% CIs = 1842–2364 kcal); there were insufficient data from five studies to include in the meta-analysis. Dietary intake differed across disorders, which may explain the substantial heterogeneity detected ($I^2 = 98.4\%$, $Q = 2459.2$, $df = 40$, $p < 0.0001$). Average protein intake across all samples ($k = 16$) was 69.3 g/day (95% CIs: 55.1–86.6g/day), slightly above the RDI, average carbohydrate intake was 229.0g/day ($k = 16$, CIs: 192.9–265.0g/day), and average fat intake was 62.0g/day ($k = 17$, CIs: 44.7–79.3g/day).

Looking at samples by diagnosis, subgroup analyses of energy intake indicated a significant effect of diagnosis ($p < 0.001$). Specifically, those with AN ($k = 15$) reported a mean energy intake of 1311 kcal (95% CIs: 1114–1509 kcal), significantly lower than those with BED 2429 kcal ($k = 12$, CIs: 2275–2583 kcal) and those with BN 2696 kcal ($k = 10$, CIs: 2008–3383 kcal); see also Supplementary Table 3. Subgroup analyses were not conducted for other nutrients due to small sample sizes, particularly in the BN group (e.g., see Cuijpers et al., 2021; Schwarzer et al., 2015).

Table 1
Characteristics of studies included in the systematic review.

| First Author, year | Country | Sample | Setting | Gender | Mean age, years (range) | Race/Ethnicity | Socioeconomic status | Mean BMI (kg/m ²) | Nutritional assessment method |
|----------------------------------|---------|--|------------------------------|---|-----------------------------------|---|---|-------------------------------|--|
| Alpers and Tuschen-Caffier 2004 | Germany | BN (N = 39) | Outpatient/treatment-seeking | Female | 24.8 (NR) | NR | NR | 20.4 | 2-day dietary diary |
| Alvarenga et al., 2003 | Brazil | BN (N = 30) | Outpatient | Female | 27.2 (NR) | Majority White | Majority had University degree | 25.5 | 14-day dietary diary |
| Burd et al., 2009 | USA | AN/"subsyndromal" ^a AN (N = 84) | Community | Female | 24.4 (18–51) | 96.4% Caucasian, Other NR | NR | 17.2 | 24-h dietary recall |
| Cheng et al., 2020 | China | BED (N = 84) | Outpatient | Female (n = 43) Male (n = 41) | 32.8 ^a (18–40) | NR | NR | 28.38 ^b | 24-h dietary survey |
| Chiurazzi et al., 2017 | Italy | AN-R (N = 13) | Outpatient | Female | 21.8 (18–29) | NR | NR | 14.7 | 7-day food diary |
| Crisp (2006) | UK | AN-R (n = 19), AN-BP (n = 11) | Treatment-seeking | Female | AN-R: 20.7 (NR), AN-BP: 21.3 (NR) | NR | NR | AN-R: 14.6, AN-BP: 16.2 | 24-h dietary recall |
| Elmore and de Castro 1991 | USA | BN (N = 19) | Community | Female | 22 (18–35) | NR | NR | NR | 7-day food diary |
| Engel et al., 2009 | USA | BED (N = 9) | Community | NR | 37.3 (NR) | 100% Caucasian | NR | 42.3 | 7-day Ecological Momentary Assessment |
| Fichter et al., 1990 | Germany | BN (N = 24) | Community or Outpatients | Female | 26.7 (NR) | NR | NR | NR | 21-day diary |
| Fitzgibbon and Blackman 1999 | USA | BED (n = 35), BN (n = 42) | Treatment-seeking | Female (n = 70) Male (n = 7) | BN: 28.0 (NR), BED: 40.3 (NR) | White (87%), Other NR | Over 75% had some University education | BED: 41.1, BN: 23.5 | Self-report (not specified) |
| Goodman et al., 2018 | USA | BED (N = 26) | Community | Female (n = 22) Male (n = 4) | 38.04 (18–57) | White (88%) African American (8%) Other (4%) | NR | 34.49 | 24-h dietary recall x 3 |
| Greeno and Wing 1996 | USA | BED (N = 38) | Community | Female | 39.07 (18–55) | NR | NR | 37.41 | 6-day food diary |
| Hadigan et al., 2000 | USA | AN (N = 30) | Research facility | Female | 23.8 (18–35) | NR | NR | NR | One-month diet history |
| Hilbert and Tuschen-Caffier 2007 | Germany | BED (n = 20), BN (n = 20) | Community | Female | BED = 36.65 (NR), BN = 24.47 (NR) | NR | BED = 70% 'Low', 30% 'High', BN = 45% 'Low', 55% 'High' | BED: 32.99, BN: 23.13, | Food diary |
| Horvath et al., 2015 | Brazil | BED (N = 54) | Outpatient | Female (n = 26), Male (n = 22), Other (n = 6) | 42.32 (NR) | NR | NR | 49.8 | 24-h dietary records x 3 (food weighed) |
| Jacoangeli et al., 2002 | Italy | AN (N = 49) | Outpatient | Female | 23.17 (NR) | NR | NR | 16.7 | NR |
| Kirkley et al., 1985 | USA | BN (N = 22) | Outpatient | Female | NR (18–46) | NR | NR | NR | 7-day food diary |
| Lacey and Gibson 1985 | UK | BN (N = 30) | Outpatient | Female | NR (18+) | NR | NR | NR | 14-day dietary diary (only "middle 5 days" analysed) |
| Latzet et al., 2020 | Israel | BN (n = 12), BED (n = 22), BN/BED + NES (n = 25) | Outpatient | Female | 27.5 (18–60) | Israeli (84.5%) Other (15.5%) | Working (93.8%), Not working (6.2%); Education (12.7 years) | 25.3 | 7-day food diary |
| Lear et al., 1997 | Canada | AN (N = 15) | Outpatient | Female | 28 (19–49) | NR | NR | 16.8 | 3-day food diary |
| Leyrolle et al., 2021 | Belgium | BED (N = 42) | Outpatient | Male and female (ns NR) | NR | NR | NR | 35.3 | 24-h dietary recall |
| Masheb et al., 2016 | USA | BED (N = 50) | Treatment-seeking | Female (n = 38) Male (n = 12) | 45.83 (29–60) | Caucasian (n = 40), African American (n = 9), Hispanic American (n = 1) | 42 (84%) attended or finished University | 39.2 | 24-h dietary recall x 2 |

(continued on next page)

Table 1 (continued)

| First Author, year | Country | Sample | Setting | Gender | Mean age, years (range) | Race/Ethnicity | Socioeconomic status | Mean BMI (kg/m ²) | Nutritional assessment method |
|-------------------------------------|-------------|--|--------------------------------|---------------------------------|--|--|--|--|-------------------------------------|
| Milosevic et al., 1997 | UK | AN + BN (N = 15) | Outpatient | NR | 25.7 (18–43) | NR | NR | 21.3 | 1-week food record |
| Onur et al., 2005 | Germany | AN (N = 28) | Pre-admission | Female | 25 (NR) | NR | NR | 15.1 | 3-day food record |
| Patsalos et al., 2021 | UK | AN (N = 51) | NR | Female | 24 (NR) | Caucasian (88.2%), Black/Asian/Minority Ethnic group (11.8%) | NR | 16.1 | Food Frequency Questionnaire |
| Raatz et al., 2015 | USA | AN-R (n = 46), AN-BP (n = 29) | Community | Female | 22.5 (19–30) | NR | NR | 17.2 | 24-h dietary recall x 3 |
| Raymond et al., 2003 | USA | BED (N = 12) | Community | Female | 37.9 (18–55) | NR | NR | 39.6 | 24-h recall x 6 |
| Raymond et al., 2012 | USA | BED (N = 17) | Community | Female | 30.8 (18–45) | NR | NR | 34.8 | 24-h recall x 6 |
| Rigaud et al., 2009 | France | AN-R (n = 83); AN-BP (n = 37) | Inpatient (prior to refeeding) | 96% female | 26.0 (NR) | NR | NR | 13.5 | Dietary recall x 3 |
| Rossiter et al., 1988a | USA | BN (N = 20) | Outpatient and Community | Female | 30.9 (21–48) | NR | NR | NR | 1-week food diary |
| Rossiter et al., 1988b | USA | BN (N = 10) | Outpatient and Community | Female | 30.4 (18–65) | NR | NR | NR | 1-week food diary |
| Rossiter et al., 1992 | USA | BED (N = 22) | Outpatient | Female | 44.4 (NR) | NR | NR | 33.0 | 7-day food diary |
| Segura-García et al., 2014 | Italy | AN-R (n = 37), AN-BP (n = 18), BN (n = 40), BED (n = 29) | Outpatient | Female | AN-R: 21.1 (NR), AN-BP: 25.3 (NR), BN-P: 24.0 (NR), BED: 33.5 (NR) | 100% Caucasian | “Low-middle socioeconomic class, with secondary or higher education level” | AN-R: 16.2, AN-BP: 16.6, BN: 22.1, BED: 35.7 | 7-day food diary |
| van Binsbergen et al., 1988 | Netherlands | AN (N = 20) | Outpatient | Female | 24.7 (18–35) | NR | NR | 14.4 | Dietary history |
| van der Ster Wallin et al., 1995 | Sweden | AN-R (n = 31) | Inpatient (pre-admission) | Female | 27.0 (7.1) | NR | NR | NR | 24-h dietary recall |
| van Marken Lichtenbelt et al., 1997 | Netherlands | AN (N = 12) | Community | Female | 34.3 (21–46) | NR | NR | 16.5 | 7-day food diary |
| Waisberg and Woods 2002 | Canada | AN (N = 8) | Outpatient clinic | Female (n = 7), Male (n = 1) | 27.2 (20–38) | NR | NR | 18.3 | Food records (duration unspecified) |
| Wiklund et al., 2022 | Sweden | BN & BED (N = 430) | Community | Female (n = 391), Male (n = 39) | Female: 28.2, Male: 28.9 (Range = 18–51) | NR | NR | Female: 26.0, male: 26.1 | Food frequency questionnaire |
| Woell et al., 1989 | Germany | BN (N = 30) | NR | Female | 27.0 (20–41) | NR | NR | 20.54 ^b | 24-h dietary recall for 3 weeks |

Note. AN, anorexia nervosa; AN-BP, anorexia nervosa–binge-purge subtype; AN-R, anorexia nervosa–restrictive subtype; BN, bulimia nervosa; BED, binge-eating disorder; ED, eating disorder; NES, night eating syndrome; NR, not reported.

^a The authors use this term to refer to those meeting DSM-IV-TR criteria for AN, except for one symptom.

^b Calculated by authors, ^cCalorie intake for a group of 10 women treated with imipramine are reported in both source papers, so this was only accounted for once (Rossiter et al., 1988a).

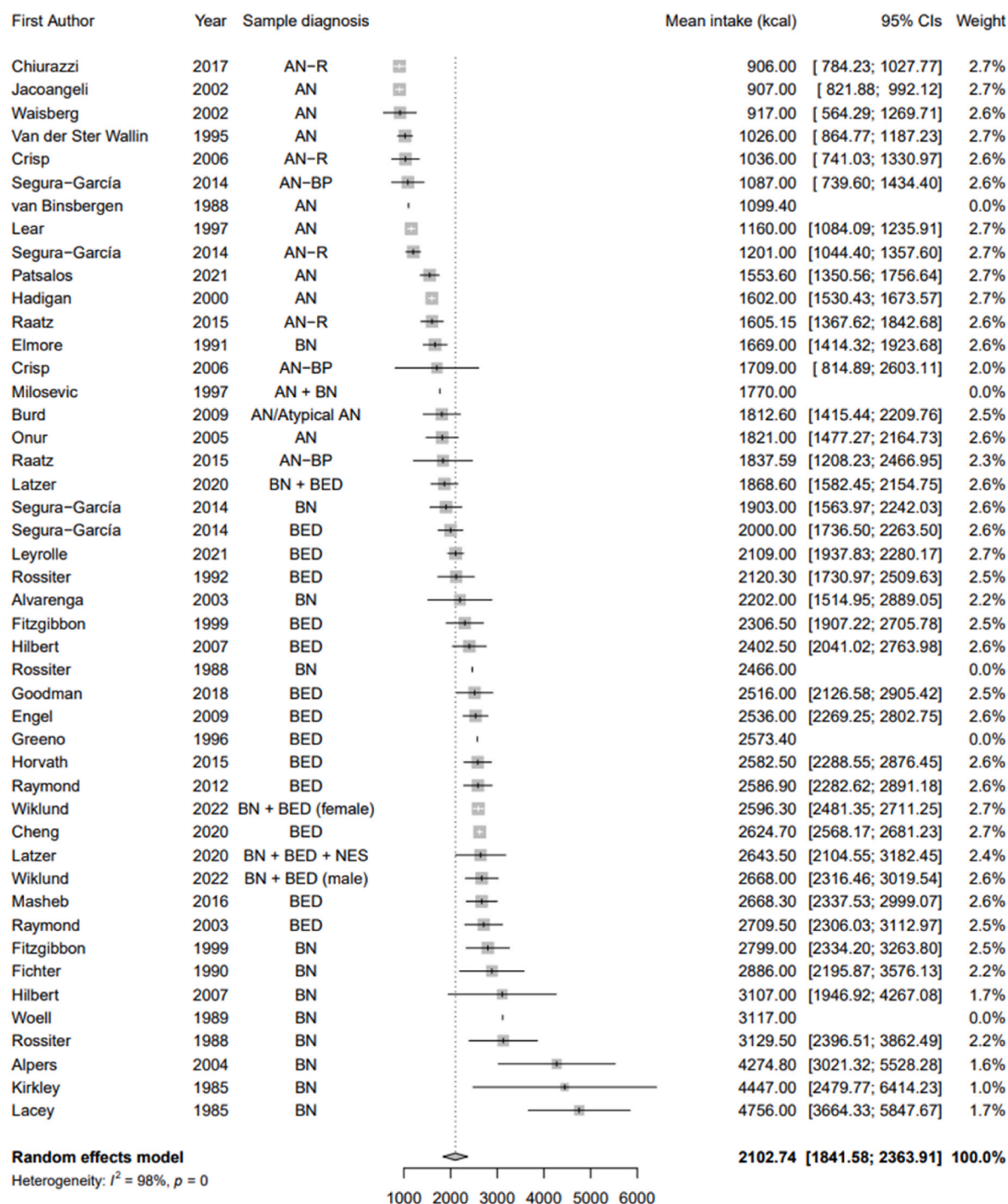


Fig. 2. Forest plot of mean energy intake (kcal) for studies included in meta-analysis. Note. AN, anorexia nervosa; AN-BP, anorexia nervosa–binge-purge subtype; AN-R, anorexia nervosa–restrictive subtype; BN, bulimia nervosa; BED, binge-eating disorder; NES, night eating syndrome.

Participants with AN consumed the lowest energy intake (range: 906–1838 kcal/day), with the mean of every sample falling below the minimum recommendation of 2000 kilocalories per day (PHE, 2016). Protein intake ($k = 9$, mean = 53.7g/day, range: 38.7–77.0g/day) was similar to the RDI, and both carbohydrate ($k = 8$, mean = 193.2g/day, range: 128.0–265.5g/day) and fat ($k = 10$, mean = 37.5g/day, range: 23.6–64.8g/day) intakes were lower than recommendations (PHE, 2016).

The mean energy intake of individuals with BED ranged between 2000 and 2710 kcal/day, generally exceeding the RDI for women. Protein intake ($k = 5$, mean = 97.6g/day, range: 71.6–142.2g/day) was

around double the RDI, carbohydrate intake was similar to the RDI ($k = 5$, mean = 256.4g/day, range: 216.0–325.7g/day), and fat intake ($k = 5$, mean = 98.3g/day, range: 79.0–127.8g/day) was also higher.

Energy intake of those with BN ranged between 1669 and 4756 kcal/day. Protein ($k = 2$, mean = 68.9g/day, range: 68.6–69.2g/day), carbohydrate ($k = 2$, mean = 301.8g/day, range: 241.2–369.6g/day), and fat ($k = 2$, mean = 91.2g/day, range: 73.1–115.0g/day) intakes all exceeded the RDI, using data from two studies.

Table 2

Energy and macronutrient intake of adults with an ED expressed as mean and standard deviation (SD).

| First author, year | Sample | Energy (kcal/day) | Protein (g/day) | Carbohydrate (g/day) | Fat (g/day) |
|----------------------------------|--|-------------------------------|----------------------------|----------------------------|---------------------------|
| Recommended daily intake | | W: 2000 M: 2500 | W: 45 M: 55.5 | W: ≥267 M: ≥333 | W: <78 M: <97 |
| Alpers, 2004 | BN (N = 38) | 4274.8 (3942.4) | NR | NR | NR |
| Alvarenga et al., 2003 | BN (N = 30) | 2202.0 (1920.0) | NR | NR | NR |
| Burd et al., 2009 | AN/"subsyndromal" ^{a,b} AN (N = 84) | 1812.6 (1857.2) | NR | NR | NR |
| Cheng et al., 2020 | BED (N = 84) | 2624.7 (264.35) ^a | 142.20 (31.8) ^a | 228.5 (46.9) ^a | 127.8 (31.8) ^a |
| Chiurazzi et al., 2017 | AN-R (N = 13) | 906.0 (224.0) | 50.8 (15.6) | 128.0 (42.2) | 23.6 (10.3) |
| Crisp (2006) | AN-R (N = 19) | 1036.0 (656.0) | 45 (NR) | 143 (NR) | 35 (NR) |
| Crisp (2006) | AN-BP (N = 11) | 1709.0 (1513.0) | 77 (NR) | 226 (NR) | 59 (NR) |
| Elmore, 1991 | BN (N = 19) | 1669.0 (566.39) ^a | NR | NR | NR |
| Engel et al., 2009 | BED (N = 9) | 2536.0 (408.3 ^a) | NR | NR | NR |
| Fichter, 1990 | BN (N = 24) | 2886.0 (1725.0) | NR | NR | NR |
| Fitzgibbon, 1999 | BED (N = 35) | 2306.5 (1205.2) | 71.6 (37.1) | 266.1 (176.0) | 107.2 (61.6) |
| Fitzgibbon, 1999 | BN (N = 42) | 2799.0 (1536.9) | 69.2 (40.4) | 369.6 (183.2) | 115.0 (79.5) |
| Goodman et al., 2018 | BED (N = 26) | 2516.0 (1013.1) ^a | NR | NR | NR |
| Greeno, 1996 | BED (N = 38) | 2573.4 ^a (NR) | 93.0 (NR) | 288.0 (NR) | 117.0 (NR) |
| Hadigan et al., 2000 | AN (N = 30) | 1602.0 (200.0) | 63.1 (7.1) | 265.5 (25.3) | 36.1 (10.0) |
| Hilbert, 2007 | BED (n = 20) | 2402.5 (824.8) | NR | NR | NR |
| Hilbert, 2007 | BN (n = 20) | 3107.0 (2647.0) | NR | NR | NR |
| Horvath et al., 2015 | BED (N = 54) | 2582.5 (1343.6) ^a | 113.4 (83.1) ^a | 325.7 (147.4) ^a | 84.4 (43.5) ^a |
| Jacoangeli et al., 2002 | AN (N = 49) | 907.0 (304.0) | NR | NR | NR |
| Kirkley et al., 1985 | BN (N = 22) | 4447.0 (4707.8) | NR | NR | NR |
| Lacey, 1985 | BN (N = 30) | 4756.0 (3050.74) ^a | NR | NR | NR |
| Latzer et al., 2020 | BN + BED (n = 34) | 1868.6 (851.3) | NR | NR | NR |
| Latzer et al., 2020 | BN + BED, with comorbid NES (n = 25) | 2643.5 (1374.9) | NR | NR | NR |
| Lear et al., 1997 | AN (N = 15) | 1160.0 (150.0) | NR | NR | NR |
| Leyrolle et al., 2021 | BED (N = 42) | 2109.0 (566.0) | 88.2 (19.3) | 216.0 (52.7) | 91.4 (41.8) |
| Masheb et al., 2016 | BED (n = 41) | 2668.3 (1080.6) | NR | NR | NR |
| Milosevic et al., 1997 | AN + BN (n = 15) | 1770.0 (NR) | 61.3 (NR) | 208.5 (NR) | 76.8 (NR) |
| Onur et al., 2005 | AN (N = 28) | 1821.0 (928.0) | NR | NR | NR |
| Patsalos et al., 2021 | AN (N = 51) | 1553.6 (739.8) | 63.9 (31.4) | 204.4 (108.7) | 57.4 (35.3) |
| Raatz et al., 2015 | AN-R (N = 46) | 1605.2 (822.0) ^a | 64.1 (30.2) ^a | 234.3 (116.2) ^a | 47.0 (33.1) ^a |
| Raatz et al., 2015 | AN-BP (N = 29) | 1837.6 (1729.2) ^a | 64.7 (67.8) ^a | 260.3 (224.0) ^a | 64.8 (74.4) ^a |
| Raymond et al., 2003 | BED (N = 12) | 2709.5 (713.1) | NR | NR | NR |
| Raymond et al., 2012 | BED (N = 17) | 2586.9 (640.1) | NR | NR | NR |
| Rigaud et al., 2009 | AN (N = 120) | NR | NR | NR | 29.0 (18.0) |
| Rossiter et al., 1988a | BN (n = 20) | 3129.5 (1672.5) ^a | NR | NR | NR |
| Rossiter et al., 1988b | BN (N = 10) | 2466.0 (NR) | NR | NR | NR |
| Rossiter et al., 1992 | BED (N = 22) | 2120.3 (931.7) ^a | NR | NR | NR |
| Segura-García et al., 2014 | AN-R (n = 37) | 1201.0 (486.0) | 53.2 (22.3) | 162.2 (71.5) | 41.5 (19.8) |
| Segura-García et al., 2014 | AN-BP (n = 18) | 1087.0 (752.0) | 41.0 (24.2) | 151.8 (116.4) | 37.8 (29.9) |
| Segura-García et al., 2014 | BN (n = 40) | 1903.0 (1094.0) | 68.6 (32.2) | 241.2 (134.0) | 73.1 (48.5) |
| Segura-García et al., 2014 | BED (n = 29) | 2000.0 (724.0) | 74.4 (20.6) | 256.2 (94.9) | 79.0 (35.4) |
| van Binsbergen et al., 1988 | AN (N = 20) | 1099.4 ^a (NR) | NR | NR | NR |
| van der Ster Wallin et al., 1995 | AN (n = 31) | 1026.0 (458.0) | 44.0 (24.0) | 155.0 (80.0) | 25.0 (14.0) |
| Waisberg and Woods, 2002 | AN (N = 8) | 917.0 (509.0) | 38.7 (24.6) | NR | 25.2 (17.1) |
| Wiklund et al., 2022 | BN and BED (female-only, n = 391) | 2596.3 (1159.7) ^a | NR | NR | NR |
| Wiklund et al., 2022 | BN and BED (male only, n = 39) | 2668.0 (1120.1) ^a | NR | NR | NR |
| Woell et al., 1989 | BN (N = 30) | 3117.0 ^a (NR) | NR | NR | NR |

Note. AN, anorexia nervosa; AN-BP, anorexia nervosa–binge-purge subtype; AN-R, anorexia nervosa–restrictive subtype; BN, bulimia nervosa; BED, binge-eating disorder; ED, eating disorder; NR, not reported; kcal, calories; g, grams. Recommended daily intake derived from Public Health England (2016).

^a value(s) computed by authors.

^b The authors use this term to refer to those meeting DSM-IV-TR criteria for AN, except for one symptom.

3.4. Micronutrients

Summaries of mineral and trace element and vitamin intake can be found in Tables 3 and 4, alongside RDIs.

3.4.1. Mineral intake

Details of mineral intake were provided in ten studies, sampling individuals with AN, BED, and BN. The most commonly reported (in nine samples) was calcium intake, which varied from 427 mg/day to 1703 mg/day, straddling the RDI of 700 mg (PHE, 2016). Individuals with AN generally consumed less than those with BED or BN, who usually consumed above the RDI. It is possible that iron and potassium are also under-consumed in AN samples, with intake of most minerals appearing adequate (on average) across non-underweight binge-eating disorders. Three studies included an estimate of sodium, which indicated potential over-consumption in BN (Woell et al., 1989) and BED (Horvath et al.,

2015), and relatively low intake in AN (Chiurazzi et al., 2017). All studies including an estimate of phosphorous intake suggested average consumption above the RDI.

3.4.2. Vitamin intake

A summary of the intake of vitamins in adults with EDs can be found in Table 4 alongside RDIs. Seven samples were included, although not all included assessments of certain vitamins. The small sample suggests that participants with AN may consume an inadequate intake of some vitamins (particularly Vitamin A and Vitamin D) although many were in-line with the RDI. Individuals with BN and BED typically exceeded RDIs, with the exception of Vitamin D, although sample sizes were small.

4. Discussion

The aim of this systematic review was to synthesise and report the

Table 3

Daily dietary mineral intake of adults with an ED expressed as mean and standard deviation (SD).

| First Author, year | Sample | Sodium (mg/day) | Potassium (mg/day) | Calcium (mg/day) | Phosphorus (mg/day) | Iron (mg/ day) | Zinc (mg/ day) | Iodine (mg/day) | Magnesium (mg/day) |
|--|--|--------------------|-----------------------|---------------------|------------------------|----------------------|----------------------|--------------------|-----------------------|
| Recommended daily intake (mg) | | 1600 | W: 3500 M: 3500 | W: 700 M: 700 | W: 550 M: 550 | W: 14.8 M: 8.7 | W: 7 M: 9.5 | W: 140 M: 140 | W: 270 M: 300 |
| Alvarenga et al., 2003 | BN (<i>n</i> = 19) | NR | NR | 1286.2 (NR) | 1030.9 (NR) | 12.5 (NR) | 9.3 (NR) | NR | 245.6 (NR) |
| Chiurazzi et al., 2017 | AN-R (<i>n</i> = 13) | 729.0 (372.0) | 1845.0 (743.0) | 427.0 (158.0) | 736.0 (180.0) | 8.0 (2.91) | 4.82 (2.18) | 124.0 (108.0) | NR |
| Horvath et al., 2015 | BED (<i>N</i> = 54) | 4523.8 (NR) | 3211.2 (NR) | 785.0 (NR) | NR | 16.6 (NR) | 15.8 (NR) | NR | NR |
| Jacoangeli et al., 2002 | AN (<i>N</i> = 49) | NR | NR | 1059.0 (463.0) | NR | NR | NR | NR | NR |
| Patsalos et al., 2021 | AN (<i>N</i> = 51) | NR | NR | NR | NR | 10.9 (5.2) | 7.3 (3.2) | NR | 319.6 (129.6) |
| van der Ster Wallin et al., 1995 | AN (<i>n</i> = 31) | NR | NR | NR | NR | 8.7 (5.0) | NR | NR | NR |
| van Marken Lichtenbelt et al., 1997 | AN (<i>N</i> = 12) | NR | NR | 973.0 (433.0) | NR | NR | NR | NR | NR |
| Waisberg, 2002 | AN (<i>N</i> = 8) | NR | NR | 472.3 (449.1) | NR | 9.2 (7.9) | NR | NR | NR |
| Wiklund et al., 2022 | BN and BED (female-only, <i>n</i> = 391) | NR | 3574.4 (1503.5) | 1109.0 (648.8) | 1775.5 (910.6) | 15.3 (8.4) | 15.4 (8.3) | 267.4 (133.2) | 479.3 (229.7) |
| Wiklund et al., 2022 | BN and BED (male only, <i>n</i> = 39) | NR | 3555.3 (1326.4) | 1082.6 (564.1) | 1763.8 (832.7) | 15.7 (8.6) | 14.9 (7.2) | 255.6 (100.6) | 491.3 (149.2) |
| Woell et al., 1989 | BN (<i>N</i> = 30) | 3400 (NR) | 3200.0 (NR) | 1703.0 (NR) | 1608.5 (NR) | 16.0 (NR) | 11.2 (NR) | NR | 395.8 (NR) |

Note. AN, anorexia nervosa; AN-R, anorexia nervosa–restrictive subtype; ED, eating disorder; mg, milligrams. Recommended daily intake derived from [British Nutrition Foundation \(2021\)](#) based on age 19–50 years.

Table 4

Daily vitamin intake of adults with an ED expressed as mean and standard deviation (SD).

| First Author, year | Sample | Vitamin A (µg/day) | Vitamin b- 6 (mg/ day) | Vitamin b- 12 (µg/ day) | Vitamin C (mg/day) | Vitamin D (µg/ day) | Vitamin E (mg/day) | Thiamine (mg/day) | Riboflavin (mg/day) | Niacin (mg/ day) | Folate (µg/day) |
|-----------------------------|--|--------------------------------|------------------------------|-------------------------------|-----------------------|---------------------------|---------------------------|----------------------|------------------------|------------------------|----------------------------|
| Recommended daily intake | | W: 600 M: 700 | W: 1.2 M: 1.4 | W: 1.5 M: 1.5 | W: 40 M: 40 | W: 10 M: 10 | | W: 0.80 M: 0.90 | W: 1.1 M: 1.3 | W: 17 M: 16 | W: 200 M: 200 |
| Alvarenga et al., 2003 | BN (<i>n</i> = 19) | 8679.4 | 1.6 (NR) | 6.9 (NR) | 296.8 (NR) | 15.8 ^a (NR) | 11.8 ^b (NR) | NR | 2.1 (NR) | 22.1 (NR) | 225.1 ^c (NR) |
| Chiurazzi et al., 2017 | AN-R (<i>n</i> = 13) | 551.0 (399.0) ^d | 0.6 (0.5) | 3.5 (1.4) | 123.0 (73.8) | 0.9 (1.1) | 3.3(3.0) ^e | 0.58 (0.17) | 1.20 (0.67) | 9.41 (3.47) | 127.0 (86.1) |
| Horvath et al., 2015 | BED (<i>N</i> = 54) | 673.42 (NR) | 2.00 (NR) | 5.21 (NR) | NR | 0.18 (NR) | 5.06 (NR) | NR | NR | NR | NR |
| Patsalos et al., 2021 | AN (<i>N</i> = 51) | 251.89 (368.00) | 1.83 (0.89) | 4.27 (3.69) | 146.15 (90.44) | 2.04 (2.32) | 12.58 (5.53) | 1.51 (0.81) | 1.81 (1.12) | 20.51 (10.60) | 323.52 (183.11) |
| Wiklund et al., 2022 | BN and BED (female- only, <i>n</i> = 391) | 1067.2 (621.0) ^f | 2.2 (1.0) | 4.6 (3.2) | 89.1 (51.9) | 5.6 (3.9) | 14.9 (7.0) | 1.6 (0.9) | 1.9 (1.1) | 43.6 (23.2) | 433.1 (215.4) |
| Wiklund et al., 2022 | BN and BED (male only, <i>n</i> = 39) | 977.7 (537.8) ^f | 2.2 (1.1) | 4.5 (2.7) | 89.2 (49.0) | 5.8 (3.7) | 14.9 (6.9) | 1.6 (1.0) | 1.9 (1.1) | 42.0 (21.8) | 429.0 (180.8) |
| Woell et al., 1989 | BN (<i>N</i> = 30) | 700 (NR) | 1.6 (NR) | 5.4 (NR) | 80.0 (NR) | 4.4 (NR) | 12.7 (NR) | NR | NR | NR | 168.0 (NR) ^c |

Note. AN-R, anorexia nervosa–restrictive subtype; AN, anorexia nervosa; ED, eating disorder; mg, milligrams; µg, microgram. Recommended daily intake derived from [British Nutrition Foundation \(2021\)](#) based on age 19–50 years.

^a Reported in source paper as 15.8 mg.

^b Reported in source paper as α tocopherol equivalents.

^c Reported in source paper as Folic acid.

^d Reported in source paper as 551.0 mg.

^e Reported in source paper as 3.33 µg.

^f Reported in source paper as retinol equivalent.

dietary intake of adults with EDs with reference to specific numerical values. This is the first systematic review of the literature, combining data from 39 studies and more than 1900 participants. Individuals with AN, BN, and BED were included, summarising energy intake, macronutrients, and micronutrients. Data were combined with meta-analysis to quantify the overall macronutrient intake of adults with EDs.

The intake of the overall sample was in line with guidelines for the energy intake of adult women (e.g., PHE, 2016; see also [Zhou et al., 2003](#)), although subgroup analyses identified differences between individuals with different ED diagnoses, as expected. When looking further at diagnostic differences, a below-average total energy intake was frequently reported, in line with previous research (e.g., [Marzola](#)

et al., 2013). When compared to the RDI, adults with AN had considerably lower calorie, carbohydrate, and fat intakes, an issue which is consistently reported across the literature (e.g., Marzola et al., 2013; Schebendach et al., 2019) and commensurate with current diagnostic criteria (e.g., APA, 2013). Low fat intake can lead to numerous adverse health outcomes due to the energy dense profile of fats and the consequences of lipid depletion (Duerksen and McCurdy, 2005), and may explain the malnutrition seen in AN (Lloyd et al., 2021). Similarly, avoidance of carbohydrates is consistently reported across participants, which is often in the pursuit of avoiding energy-dense foods (Segura-García et al., 2014). Protein intake of individuals with AN was generally in line with the RDI, supporting the findings of controlled studies (e.g., Fernstrom et al., 1994).

Adults with BED reported an elevated energy intake, suggesting that calorie consumption is consistently higher than the RDI, a finding which is in line with laboratory studies (e.g., Raymond et al., 2007). Fat and protein intake followed a similar pattern – on average, exceeding the RDI – although carbohydrate intake was similar to the RDI for women (257 vs. 267g/day). Whilst elevated consumption of carbohydrate and fat during binge episodes has been well-documented (e.g., Presseller et al., 2023), the finding that overall protein intake was high relative to the RDI was unexpected. Although the results of some studies have suggested that protein intake in EDs on a “typical” day is low (Ayton et al., 2021, p. 2), experimental studies, such as that of Schmidt et al. (2023), found higher protein intake in individuals with BED compared to individuals without BED, although this difference did not reach the conventional criterion for statistical significance ($p = 0.052$). Inconsistent findings could reflect the small sample sizes typically used in dietary intake studies, the methods used to recall intake (e.g., Mourilhe et al., 2021), or the higher overall energy intake of individuals with BED (see also Bottera and De Young, 2023).

There was less data available for meta-analysis from studies of individuals with BN, although data from these samples included some of the highest reported energy intakes. This is consistent with a recent review looking specifically at episodes of binge eating in the laboratory (Mourilhe et al., 2021) and supports, to some extent, the theory that dieting and compensatory behaviours (such as purging) serve to increase overall calorie intake (e.g., Fairburn et al., 2003), often leading to ‘vicious cycles’ whereby continued compensation reinforces further binge eating. Wide variation was seen within the BN samples in particular; Kirkley et al. (1985), for instance, reported a range of intakes between 450 kcal and 18,202 kcal per day. Consumption of all macronutrients (protein, carbohydrates, and fat) exceeded guidelines, and supports previous findings that there are some differences in eating behaviour between individuals with BED and those with BN (Walsh and Boudreau, 2003). Further study seems warranted given the small samples sizes and wide confidence intervals around many of the estimates for BN samples.

Overall, few studies reported micronutrient intake in EDs, although some consistent findings emerged. Low levels of calcium intake were seen exclusively in AN samples, which can be detrimental and result in low bone density (Misra et al., 2006) and increased fracture risk (Fazeli and Klibanski, 2014). Similarly, intake of Vitamin D, which is essential for calcium absorption, was low compared to the RDI in all studies, with sample means ranging from 0.18 to 5.8 µg/day (RDI = 10 µg/day; PHE, 2016). This adds support to suggestions that Vitamin D deficiency needs to be addressed in recovery from an ED (Velickovic et al., 2013), and clinicians should be aware that this occurs across the ED spectrum (i.e., not solely in the presence of low body weight). Intake of other micronutrients, such as Zinc, was observed to be low in a small number of studies in this review. Low zinc levels are also seen in blood and urine tests, and have been suggested as maintaining factors in EDs (e.g., McClain et al., 1992). In addition to representing important treatment targets, these findings might help explain the self-prescription of nutritional supplements in individuals with EDs (Setnick, 2010).

4.1. Strengths and limitations

This review summarises what is known regarding the dietary intake of adults with AN, BN, and BED, with samples including those who are severely unwell and those living in the community. A large number of eligible studies were reviewed across several databases and the study adopted double-screening throughout. To some extent we were also able to explore the macronutrient and micronutrient intake across these disorders, although research was limited. Further research in this area, including larger samples, would be beneficial to improve overall understanding of the dietary intake of adults with EDs and more consistent reporting (including as many nutrients as possible) would also permit more thorough comparison across studies.

The current review was limited to papers written in English and grey literature was not reviewed. Lack of prospective registration may have introduced bias and decreased transparency. Whilst an effort was made to include all relevant literature (and over 10,000 unique articles were evaluated), case studies were excluded to manage heterogeneity and a minority of studies reported macronutrients in a format that could not be converted and were therefore excluded. Although tests for publication bias were generally not significant, findings, particularly related to fat intake, should be interpreted in light of this possibility, particularly given the suggestion that Egger’s test may not work well for certain measures of effect size (Pustejovsky and Rodgers, 2019). Quality ratings were acceptable across studies, with similar design shortcomings to those noted in other reviews of dietary intake (e.g., Teasdale et al., 2019). Although studies were not excluded based on quality, alternative ratings of study quality were considered and may have resulted in different conclusions due to different weightings of study criteria, for instance (e.g., see O’Connor et al., 2015).

As nutritional needs of children differ to those of adults (British Nutrition Foundation, 2021; Wiklund et al., 2022), several studies were excluded as a number of participants were aged under 18 years, which limited the articles available for review. For many studies, samples were either exclusively female or combined intake from both men and women (cf. Wiklund et al., 2022). Given the different dietary needs of men and women, further studies should look at the dietary intake of men with EDs as the sample included here was small and heterogenous.

Whilst a strength of the review was coverage of a large time period and aggregation of data from over 1900 individuals, different diagnostic manuals were used in the included studies, which might have introduced heterogeneity within ED subgroups. Due to small sample sizes for those diagnosed according to DSM-5 (which included broader diagnostic criteria than the preceding DSM-IV; Hoek, 2014), subgroup analyses were not conducted to investigate whether use of different diagnostic manuals was related to dietary intake and some feeding and eating disorders (e.g., night eating syndrome) were not included. Similarly, all studies looked at individuals at one point in time, and thus it was not possible to consider diagnostic movement and investigate how dietary intake might change longitudinally within the same individual. This might represent an important prognostic factor given that ‘movement’ between AN and BN in particular can reduce the likelihood of remission from an eating disorder (Schaumberg et al., 2019).

A range of dietary assessment methods were used, with most papers using a form of self-report measure, which is potentially subject to recall bias and needs to strike a balance between accurate recall and a sufficient timeframe (e.g., Subar et al., 2020). Participants who felt ashamed of their dietary intake may have underreported due to social desirability bias, with research suggesting that those who are overweight are more likely to misreport dietary intake (Livingstone and Black, 2003). Similarly, those with ‘restricted’ dietary intakes may have been biased towards over-reporting (e.g., Hadigan et al., 2000; see also Ravelli and Schoeller, 2020), although a strength of the meta-analysis used here is aggregation of data from different methods of dietary report. Comparisons against the RDI can be problematic as these values will vary according to a range of factors, such as activity levels, which cannot be

accounted for. In addition, the RDI was based on those aged 19–64 years in England, although age in particular related closely to the range of those included in the review. Finally, the samples were predominately comprised of middle-aged White/Caucasian women, limiting generalisability and knowledge of male and other minority groups.

4.2. Future recommendations

Based on the present review, more research is needed to advance knowledge and understanding of the dietary intake of adults with EDs, such as those with OSFED and several aspects of those with BN. Future studies should aim to recruit (and describe) more inclusive and diverse samples and explore micronutrient intake in particular. Including at least mean and SD intake will also facilitate straightforward comparisons, and it might be of interest to consider whether modifications to diagnostic criteria are related to different dietary intakes between EDs. Finally, using technology, such as a mobile app, to collect information on dietary intake across a long-term period might reduce recall bias and improve accuracy (Ambrosini et al., 2018).

4.3. Implications

The findings of this review synthesise knowledge regarding the dietary intake of adults with EDs and can be used to inform interventions, nutritional counselling, and psychoeducation used in the treatment of EDs, in addition to informing guidelines for the nutritional management of EDs (e.g., Royal College of Psychiatrists, 2005). Given that medication such as selective serotonin reuptake inhibitors may be less effective in the presence of malnutrition (see Haleem, 2012), the findings might also inform pharmacologic interventions, particularly for those with AN who frequently reported an inadequate dietary intake, consistent with current diagnostic criteria. The findings also suggest that providing education regarding the importance of micronutrients, fat intake, and regular eating is well-supported. Finally, clinicians are advised to be mindful of, and sensitive to, the presence of both nutritional deficiencies and the risks of over-consumption frequently seen across EDs.

CRedit authorship contribution statement

Paul E. Jenkins: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Katy Proctor:** Conceptualization, Methodology, Writing – original draft. **Sarah Snuggs:** Formal analysis, Writing – review & editing.

Declaration of competing interest

No potential conflicts of interest are declared.

Acknowledgement

This research was supported by the Undergraduate Research Opportunities Programme, which provides opportunities for University of Reading undergraduates to undertake summer research positions at the University.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpsychires.2024.05.038>.

References

Denotes inclusion in the systematic review

Academy of Nutrition and Dietetics, 2012. Evidence Analysis Manual: Steps in the Academy Evidence Analysis Process. ADA Research and Strategic Business Development, Chicago, IL.

- Alpers, G.W., Tuschen-Caffier, B., 2004. Energy and macronutrient intake in bulimia nervosa. *Eat. Behav.* 5 (3), 241–249. <https://doi.org/10.1016/j.eatbeh.2004.01.013>.
- * Alvarenga, M.S., Negrão, A.B., Philippi, S.T., 2003. Nutritional aspects of eating episodes followed by vomiting in Brazilian patients with bulimia nervosa. *Eat. Weight Disord.* 8, 150–156. <https://doi.org/10.1007/BF03325005>.
- Ambrosini, G.L., Hurworth, M., Giglia, R., Trapp, G., Strauss, P., 2018. Feasibility of a commercial smartphone application for dietary assessment in epidemiological research and comparison with 24-h dietary recalls. *Nutr. J.* 17 (1), 1–10. <https://doi.org/10.1186/s12937-018-0315-4>.
- American Psychiatric Association, 1980. Diagnostic and Statistical Manual of Mental Disorders, third ed. American Psychiatric Association, Washington, D.C.
- American Psychiatric Association, 1994. Diagnostic and Statistical Manual of Mental Disorders, fourth ed. American Psychiatric Association, Washington, D.C.
- American Psychiatric Association, 2013. Diagnostic and Statistical Manual of Mental Disorders, fifth ed. American Psychiatric Association, Arlington.
- Ayton, A., Ibrahim, A., Dugan, J., Galvin, E., Wroe Wright, O., 2021. Ultra-processed foods and binge eating: a retrospective observational study. *Nutrition* 84, 111023. <https://doi.org/10.1016/j.nut.2020.111023>.
- Beauchamp, M.T., Allison, K.C., Lundgren, J.D., 2021. The nature of night eating syndrome: using network analysis to understand unique symptomological relationships. *Int. J. Eat. Disord.* 54 (5), 733. <https://doi.org/10.1002/eat.23497>, 744.
- Black, R., 2003. Micronutrient deficiency: an underlying cause of morbidity and mortality. *Bull. World Health Organ.* 81 (2), 79, 79.
- Bottera, A.R., De Young, K.P., 2023. Characterizing naturalistic meal timing, energy intake, and macronutrient intake among individuals with loss of control eating. *Appetite* 184, 106524. <https://doi.org/10.1016/j.appet.2023.106524>.
- British Nutrition Foundation, 2021. Nutritional requirements. Retrieved from. <https://www.nutrition.org.uk/media/nmmewdug/nutrition-requirements.pdf>.
- * Burd, C., Mitchell, J.E., Crosby, R.D., Engel, S.G., Wonderlich, S.A., Lystad, C., et al., 2009. An assessment of daily food intake in participants with anorexia nervosa in the natural environment. *Int. J. Eat. Disord.* 42 (4), 371–374. <https://doi.org/10.1002/eat.20628>.
- * Cheng, C., Liu, X., Zhu, S., Dong, C., Liu, L., Lin, W., et al., 2020. Clinical study on electroacupuncture for obese patients with binge eating disorder: a retrospective study. *Medicine* 99 (49). <https://doi.org/10.1097/MD.00000000000023362>.
- * Chirurazzi, C., Cioffi, I., De Caprio, C., De Filippo, E., Marra, M., Sammarco, R., et al., 2017. Adequacy of nutrient intake in women with restrictive anorexia nervosa. *Nutrition* 38, 80–84. <https://doi.org/10.1016/j.nut.2017.02.004>.
- * Crisp, A.H., 2006. 1.3. Food intake in anorexia nervosa: patterns reported over a 25-year period, 1967–1992. *Eur. Eat Disord. Rev.* 14, 153–158. <https://doi.org/10.1002/erv.701>.
- Cuijpers, P., Griffin, J.W., Furukawa, T.A., 2021. The lack of statistical power of subgroup analyses in meta-analyses: a cautionary note. *Epidemiol. Psychiatr. Sci.* 30, e78. <https://doi.org/10.1017/S2045796021000664>.
- Datta, N., Bidopia, T., Datta, S., Mittal, G., Alphin, F., Herbert, B.M., Marsh, E.J., Fitzsimons, G.J., Strauman, T.J., Zucker, N.L., 2021. Internal states and interoception along a spectrum of eating disorder symptomatology. *Physiol. Behav.* 230, 113307. <https://doi.org/10.1016/j.physbeh.2020.113307>.
- Duerksen, D., McCurdy, K., 2005. Essential fatty acid deficiency in a severely malnourished patient receiving parenteral nutrition. *Dig. Dis. Sci.* 50 (12), 2386–2388. <https://doi.org/10.1007/s10620-005-3068-9>.
- Eichin, K.N., Arend, A.-K., Blechert, J., 2023. Food preference and choice across eating and weight disorders: the roles of anorexia nervosa and external eating. *PsyArXiv*. <https://doi.org/10.31234/osf.io/re52k>.
- * Elmors, D.K., de Castro, J.M., 1991. Meal patterns of normal, untreated bulimia nervosa and recovered bulimic women. *Physiol. Behav.* 49 (1), 99–105. [https://doi.org/10.1016/0031-9384\(91\)90238-J](https://doi.org/10.1016/0031-9384(91)90238-J).
- * Engel, S.G., Kahler, K.A., Lystad, C.M., Crosby, R.D., Simonich, H.K., Wonderlich, S.A., Peterson, C.B., Mitchell, J.E., 2009. Eating behavior in obese BED, obese non-BED, and non-obese control participants: a naturalistic study. *Behav. Res. Ther.* 47 (10), 897–900. <https://doi.org/10.1016/j.brat.2009.06.018>.
- Fairburn, C.G., 2008. *Cognitive Behaviour Therapy and Eating Disorders*. Guilford Press.
- Fairburn, C.G., Cooper, Z., Shafran, R., 2003. Cognitive behaviour therapy for eating disorders: a “transdiagnostic” theory and treatment. *Behav. Res. Ther.* 41 (5), 509–528. [https://doi.org/10.1016/S0005-7967\(02\)00088-8](https://doi.org/10.1016/S0005-7967(02)00088-8).
- Fazeli, P.K., Klibanski, A., 2014. Anorexia nervosa and bone metabolism. *Bone* 66, 39–45. <https://doi.org/10.1016/j.bone.2014.05.014>.
- Fernstrom, M.H., Weltzin, T.E., Neuberger, S., Srinivasagam, N., Kaye, W.H., 1994. Twenty-four-hour food intake in patients with anorexia nervosa and in healthy control subjects. *Biol. Psychiatr.* 36 (10), 696–702. [https://doi.org/10.1016/0006-3223\(94\)91179-7](https://doi.org/10.1016/0006-3223(94)91179-7).
- * Fichter, M.M., Pirke, K.M., Pöllinger, J., Wolfram, G., Brunner, E., 1990. Disturbances in the hypothalamo-pituitary-adrenal and other neuroendocrine axes in bulimia. *Biol. Psychiatr.* 27 (9), 1021–1037. [https://doi.org/10.1016/0006-3223\(90\)90038-4](https://doi.org/10.1016/0006-3223(90)90038-4).
- * Fitzgibbon, M.L., Blackman, L.R., 1999. Binge eating disorder and bulimia nervosa: differences in the quality and quantity of binge eating episodes. *Int. J. Eat. Disord.* 27 (2), 238–243. [https://doi.org/10.1002/\(SICI\)1098-108X\(200003\)27:2%3C238::AID-EAT12%3E3.0.CO;2-Q](https://doi.org/10.1002/(SICI)1098-108X(200003)27:2%3C238::AID-EAT12%3E3.0.CO;2-Q).
- * Goodman, E.L., Breithaupt, L., Watson, H.J., Peat, C.M., Baker, J.H., Bulik, C.M., Brownley, K.A., 2018. Sweet taste preference in binge-eating disorder: a preliminary investigation. *Eat. Behav.* 28, 8–15. <https://doi.org/10.1016/j.eatbeh.2017.11.005>.
- Greeno, C.G., Wing, R.R., 1996. A double-blind, placebo-controlled trial of the effect of fluoxetine on dietary intake in overweight women with and without binge-eating

- disorder. *Am. J. Clin. Nutr.* 64 (3), 267–273. <https://doi.org/10.1093/ajcn/64.3.267>.
- * Hadigan, C.M., Anderson, E.J., Miller, K.K., Hubbard, J.L., Herzog, D.B., Klibanski, A., Grinspoon, S.K., 2000. Assessment of macronutrient and micronutrient intake in women with anorexia nervosa. *Int. J. Eat. Disord.* 28 (3), 284–292. [https://doi.org/10.1002/1098-108X\(200011\)28:3<284::AID-EAT5>3.0.CO;2-G](https://doi.org/10.1002/1098-108X(200011)28:3<284::AID-EAT5>3.0.CO;2-G).
- Haleem, D.J., 2012. Serotonin neurotransmission in anorexia nervosa. *Behav. Pharmacol.* 23 (5 & 6), 478–495. <https://doi.org/10.1097/FBP.0b013e328357440d>.
- Handu, D., Moloney, L., Wolfram, T., Ziegler, P., Acosta, A., Steiber, A., 2016. Academy of nutrition and Dietetics methodology for conducting systematic reviews for the evidence analysis library. *J. Acad. Nutr. Diet.* 116 (2), 311–318. <https://doi.org/10.1016/j.jand.2015.11.008>.
- * Hilbert, A., Tuschen-Caffier, B., 2007. Maintenance of binge eating through negative mood: a naturalistic comparison of binge eating disorder and bulimia nervosa. *Int. J. Eat. Disord.* 40 (6), 521–530. <https://doi.org/10.1002/eat.20401>.
- Hoek, H.W., 2014. Epidemiology of eating disorders in persons other than the high-risk group of young Western females. *Curr. Opin. Psychiatr.* 27 (6), 423–425. <https://doi.org/10.1097/YCO.0000000000000104>.
- * Horvath, J.D.C., Kops, N.L., de Castro, M.L.D., Friedman, R., 2015. Food consumption in patients referred for bariatric surgery with and without binge eating disorder. *Eat. Behav.* 19, 173–176. <https://doi.org/10.1016/j.eatbeh.2015.09.007>.
- * Jacoangeli, F., Zoli, A., Taranto, A., Staar Mezzasalma, F., Ficoneri, C., Pierangeli, S., Menzinger, G., Bollea, M.R., 2002. Osteoporosis and anorexia nervosa: relative role of endocrine alterations and malnutrition. *Eat. Weight Disord.* 7, 190–195. <https://doi.org/10.1007/BF03327456>.
- * Kirkley, B.G., Agram, W.S., Weiss, J.J., 1985. Nutritional inadequacy in the diets of treated bulimics. *Behav. Ther.* 16 (3), 287–291. [https://doi.org/10.1016/S0005-7894\(85\)80016-2](https://doi.org/10.1016/S0005-7894(85)80016-2).
- * Lacey, J.H., Gibson, E., 1985. Controlling weight by purgation and vomiting: a comparative study of bulimics. *J. Psychiatr. Res.* 19, 337–341. <https://doi.org/10.1016/B978-0-08-032704-4.50041-3>.
- Lai, J.S., Hiles, S., Bisquera, A., Hure, A.J., McEvoy, M., Attia, J., 2014. A systematic review and meta-analysis of dietary patterns and depression in community-dwelling adults. *Am. J. Clin. Nutr.* 99 (1), 181–197. <https://doi.org/10.3945/ajcn.113.069880>.
- * Latzer, Y., Yutal, A.E., Givon, M., Kabakov, O., Alon, S., Zuckerman-Levin, N., et al., 2020. Dietary patterns of patients with binge eating disorders with and without night eating. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity* 25 (2), 321–328. <https://doi.org/10.1007/s40519-018-0590-2>.
- * Lear, S.A., Pauly, R.P., Birmingham, C.L., 1997. Body fat, caloric intake, and plasma leptin levels in women with anorexia nervosa. *Int. J. Eat. Disord.* 26 (3), 283–288. [https://doi.org/10.1002/\(SICI\)1098-108X\(199911\)26:3<283::AID-EAT5>3E3.0.CO;2-K](https://doi.org/10.1002/(SICI)1098-108X(199911)26:3<283::AID-EAT5>3E3.0.CO;2-K).
- * Leyrolle, Q., Cserjesi, R., Mulders, M.D.G.H., Zamariola, G., Hiel, S., Gianfrancesco, M. A., Rodriguez, J., Porthault, D., Adamieq, C., Leclercq, S., Bindels, L.B., Neyrinck, A.M., Cani, P.D., Karkkainen, O., Hanhineva, K., Lanthier, N., Trefois, P., Paquet, N., Cnop, M., Thissen, J.P., Klein, O., Luminet, O., Delzenne, N.M., 2021. Specific gut microbial, biological, and psychiatric profiling related to binge eating disorders: a cross-sectional study in obese patients. *Clin. Nutr.* 40 (4), 2035–2044. <https://doi.org/10.1016/j.clnu.2020.09.025>.
- Livingstone, M.B.E., Black, A.E., 2003. Markers of the validity of reported energy intake. *J. Nutr.* 133 (3), 895S–920S. <https://doi.org/10.1093/jn/133.3.895S>.
- Lloyd, E.C., Powell, C., Schebendach, J., Walsh, B.T., Posner, J., Steinglass, J.E., 2021. Associations between mealtime anxiety and food intake in anorexia nervosa. *Int. J. Eat. Disord.* 54 (9), 1711–1716. <https://doi.org/10.1002/eat.23589>.
- Lock, J., Le Grange, D., 2013. *Treatment Manual for Anorexia Nervosa: a Family-Based Approach*, second ed. Guilford Press.
- McClain, C.J., Stuart, M.A., Vivian, B., McClain, M., Talwalker, R., Snelling, L., Humphries, L., 1992. Zinc status before and after zinc supplementation of eating disorder patients. *J. Am. Coll. Nutr.* 11 (6), 694–700. <https://doi.org/10.1080/07315724.1992.10718269>.
- Marzola, E., Nasser, J.A., Hashim, S.A., Shih, P.A.B., Kaye, W.H., 2013. Nutritional rehabilitation in anorexia nervosa: review of the literature and implications for treatment. *BMC Psychiatr.* 13 (1), 1–13. <https://doi.org/10.1186/1471-244X-13-290>.
- * Masheb, R.M., Dorflinger, L.M., Rolls, B.J., Mitchell, D.C., Grilo, C.M., 2016. Binge abstinence is associated with reduced energy intake after treatment in patients with binge eating disorder and obesity. *Obesity* 24 (12), 2491–2496. <https://doi.org/10.1002/oby.21664>.
- * Milosevic, A., Brodie, D.A., Slade, P.D., 1997. Dental erosion, oral hygiene, and nutrition in eating disorders. *Int. J. Eat. Disord.* 21 (2), 195–199. [https://doi.org/10.1002/\(SICI\)1098-108X\(199703\)21:2<195::AID-EAT11>3.0.CO;2-1](https://doi.org/10.1002/(SICI)1098-108X(199703)21:2<195::AID-EAT11>3.0.CO;2-1).
- Misra, M., Tsai, P., Anderson, E.J., Hubbard, J.L., Gallagher, K., Soyka, L.A., et al., 2006. Nutrient intake in community-dwelling adolescent girls with anorexia nervosa and in healthy adolescents. *Am. J. Clin. Nutr.* 84 (4), 698–706. <https://doi.org/10.1093/ajcn/84.4.698>.
- Mourilhe, C., Moraes, C.E., Veiga, G.D., da Luz, F.Q., Pompeu, A., Nazar, B.P., Coutinho, E.S.F., Hay, P., Appolinario, J.C., 2021. An evaluation of binge eating characteristics in individuals with eating disorders: a systematic review and meta-analysis. *Appetite* 162, 105176. <https://doi.org/10.1016/j.appet.2021.105176>.
- National Institute for Health and Care Excellence, 2017. *Eating disorders: recognition and treatment [NICE Guideline 69]*. <http://nice.org.uk/guidance/ng69>.
- O'Connor, S.R., Tully, M.A., Ryan, B., Bradley, J.M., Baxter, G.D., McDonough, S.M., 2015. Failure of a numerical quality assessment scale to identify potential risk of bias in a systematic review: a comparison study. *BMC Res. Notes* 8, 224. <https://doi.org/10.1186/s13104-015-1181-1>.
- * Onur, S., Haas, V., Bosy-Westphal, A., Hauer, M., Paul, T., Nutzinger, D., et al., 2005. L-tri-iodothyronine is a major determinant of resting energy expenditure in underweight patients with anorexia nervosa and during weight gain. *Eur. J. Endocrinol.* 152 (2), 179–184. <https://doi.org/10.1530/eje.1.01850>.
- Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., et al., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 372, n71. <https://doi.org/10.1136/bmj.n71>.
- * Patsalos, O., Dalton, B., Kyrianiou, C., Firth, J., Shivappa, N., Hébert, J.R., Schmidt, U., Himmerich, H., 2021. Nutrient intake and dietary inflammatory potential in current and recovered anorexia nervosa. *Nutrients* 13 (12), 4400. <https://doi.org/10.3390/2Fnu13124400>.
- Presseller, E.K., Kabbassi, N., Gian, C., Juarascio, A.S., 2023. Unequivocally large, but not enormous: an examination of the nutritional content of objective and subjective binge-eating episodes using ecological momentary assessment data. *Int. J. Eat. Disord.* <https://doi.org/10.1002/eat.24016>.
- Public Health England, 2016. *Government Dietary Recommendations*. Retrieved from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/618167/government_dietary_recommendations.pdf.
- Pustejovsky, J.E., Rodgers, M.A., 2019. Testing for funnel plot asymmetry of standardized mean differences. *Res. Synth. Methods* 10 (1), 57–71. <https://doi.org/10.1002/jrsm.1332>.
- * Raatz, S.K., Jahns, L., Johnson, L.K., Crosby, R., Mitchell, J.E., Crow, S., et al., 2015. Nutritional adequacy of dietary intake in women with anorexia nervosa. *Nutrients* 7 (5), 3652–3665. <https://doi.org/10.3390/nu7053652>.
- Ravelli, M.N., Schoeller, D.A., 2020. Traditional self-reported dietary instruments are prone to inaccuracies and new approaches are needed. *Front. Nutr.* 7, 90. <https://doi.org/10.3389/fnut.2020.00090>.
- * Raymond, N.C., Neumeyer, B., Warren, C.S., Lee, S.S., Peterson, C.B., 2003. Energy intake patterns in obese women with binge eating disorder. *Obes. Res.* 11 (7), 869–879. <https://doi.org/10.1038/oby.2003.120>.
- Raymond, N.C., Bartholome, L.T., Lee, S.S., Peterson, R.E., Raatz, S.K., 2007. A comparison of energy intake and food selection during laboratory binge eating episodes in obese women with and without a binge eating disorder diagnosis. *Int. J. Eat. Disord.* 40 (1), 67–71. <https://doi.org/10.1002/eat.20312>.
- * Raymond, N.C., Peterson, R.E., Bartholome, L.T., Raatz, S.K., Jensen, M.D., Levine, J. A., 2012. Comparisons of energy intake and energy expenditure in overweight and obese women with and without binge eating disorder. *Obesity* 20 (4), 765–772. <https://doi.org/10.1038/oby.2011.312>.
- Reiter, C.S., Graves, L., 2010. Nutrition therapy for eating disorders. *Nutr. Clin. Pract.* 25 (2), 122–136. <https://doi.org/10.1177/0884533610361606>.
- * Rigaud, D., Tallonneau, I., Vergès, B., 2009. Hypercholesterolaemia in anorexia nervosa: frequency and changes during refeeding. *Diabetes Metabol.* 35 (1), 57–63. <https://doi.org/10.1016/j.diabet.2008.08.004>.
- * Rossiter, E.M., Agram, W.S., Losch, M., 1988a. Changes in self-reported food intake in bulimics as a consequence of antidepressant treatment. *Int. J. Eat. Disord.* 7 (6), 779–783. [https://doi.org/10.1002/1098-108X\(198811\)7:6<779::AID-EAT2260070607>3E3.0.CO;2-4](https://doi.org/10.1002/1098-108X(198811)7:6<779::AID-EAT2260070607>3E3.0.CO;2-4).
- * Rossiter, E.M., Agram, W.S., Losch, M., Telch, C.F., 1988b. Dietary restraint of bulimic subjects following cognitive-behavioral or pharmacological treatment. *Behav. Res. Ther.* 26 (6), 495–498. [https://doi.org/10.1016/0005-7967\(88\)90145-3](https://doi.org/10.1016/0005-7967(88)90145-3).
- * Rossiter, E.M., Agram, W.S., Telch, C.F., Bruce, B., 1992. The eating patterns of non-purging bulimic subjects. *Int. J. Eat. Disord.* 11 (2), 111–120. [https://doi.org/10.1002/1098-108X\(199203\)11:2<111::AID-EAT2260110203>3.0.CO;2-J](https://doi.org/10.1002/1098-108X(199203)11:2<111::AID-EAT2260110203>3.0.CO;2-J).
- Royal College of Psychiatrists, 2005. *Guidelines for the nutritional management of anorexia nervosa. Council Report (CR130)*.
- Schaumberg, K., Jangmo, A., Thornton, L.M., Birgegård, A., Almqvist, C., Norring, C., Larsson, H., Bulik, C.M., 2019. Patterns of diagnostic transition in eating disorders: a longitudinal population study in Sweden. *Psychol. Med.* 49, 819–827. <https://doi.org/10.1017/S0033291718001472>.
- Schebendach, J.E., Uniacke, B., Walsh, B.T., Mayer, L.E., Attia, E., Steinglass, J., 2019. Fat preference and fat intake in individuals with and without anorexia nervosa. *Appetite* 139, 35–41. <https://doi.org/10.1016/j.appet.2019.04.008>.
- Schmidt, R., Wandrer, H., Boutelle, K.N., Kiess, W., Hilbert, A., 2023. Associations between eating in the absence of hunger and executive functions in adolescents with binge-eating disorder: an experimental study. *Appetite* 186, 106573. <https://doi.org/10.1016/j.appet.2023.106573>.
- Schwarzer, G., 2007. meta: an R package for meta-analysis. *R. News* 7 (3), 40–45.
- Schwarzer, G., Carpenter, J.R., Rücker, G., 2015. *Meta-Analysis with R*. Springer.
- * Segura-García, C., De Fazio, P., Sinopoli, F., De Masi, R., Brambilla, F., 2014. Food choice in disorders of eating behavior: correlations with the psychopathological aspects of the diseases. *Compr. Psychiatr.* 55 (5), 1203–1211. <https://doi.org/10.1016/j.comppsy.2014.02.013>.
- Setnick, J., 2010. Micronutrient deficiencies and supplementation in anorexia and bulimia nervosa: a review of literature. *Nutr. Clin. Pract.* 25 (2), 137–142. <https://doi.org/10.1177/0884533610361478>.
- Stewart, T.M., Martin, C.K., Williamson, D.A., 2022. The complicated relationship between dieting, dietary restraint, caloric restriction, and eating disorders: is a shift in public health messaging warranted? *Int. J. Environ. Res. Publ. Health* 19 (1), 491. <https://doi.org/10.3390/ijerph19010491>.
- Subar, A.F., Potischman, N., Dodd, K.W., Thompson, F.E., Baer, D.J., Schoeller, D.A., et al., 2020. Performance and feasibility of recalls completed using the automated self-administered 24-Hour dietary assessment tool in relation to other self-report tools and biomarkers in the interactive diet and activity tracking in AARP (IDATA) study. *J. Acad. Nutr. Diet.* 120 (11), 1805–1820. <https://doi.org/10.1016/j.jand.2020.06.015>.
- Teasdale, S.B., Ward, P.B., Samaras, K., Firth, J., Stubbs, B., Tripodi, E., Burrows, T.L., 2019. Dietary intake of people with severe mental illness: systematic review and

- meta-analysis. *Br. J. Psychiatr.* 214 (5), 251–259. <https://doi.org/10.1192/bjp.2019.20>.
- Treasure, J., Stein, D., Maguire, S., 2015. Has the time come for a staging model to map the course of eating disorders from high risk to severe enduring illness? An examination of the evidence. *Early Intervention in Psychiatry* 9 (3), 173–184. <https://doi.org/10.1111/eip.12170>.
- * van Binsbergen, C.J., Hulshof, K.F., Wedel, M., Odink, J., Coelingh Bennink, H.J., 1988. Food preferences and aversions and dietary pattern in anorexia nervosa patients. *Eur. J. Clin. Nutr.* 42 (8), 671–678.
- * van der Ster Wallin, G., Norring, C., Lennernäs, M.A.C., Holmgren, S., 1995. Food selection in anorexics and bulimics: food items, nutrient content and nutrient density. *J. Am. Coll. Nutr.* 14 (3), 271–277. <https://doi.org/10.1080/07315724.1995.10718507>.
- Vander Wal, J.S., 2012. Night eating syndrome: a critical review of the literature. *Clin. Psychol. Rev.* 32 (1), 49–59. <https://doi.org/10.1016/j.cpr.2011.11.001>.
- * van Marken Lichtenbelt, W.D., Heidendal, G.A.K., Westerterp, K.R., 1997. Energy expenditure and physical activity in relation to bone mineral density in women with anorexia nervosa. *Eur. J. Clin. Nutr.* 51, 826–830. <https://doi.org/10.1038/sj.ejcn.1600492>.
- Velickovic, K.M.C., Makovey, J., Abraham, S.F., 2013. Vitamin D, bone mineral density and body mass index in eating disorder patients. *Eat. Behav.* 14 (2), 124–127. <https://doi.org/10.1016/j.eatbeh.2013.01.010>.
- Venn, B.J., 2020. Macronutrients and human health for the 21st century. *Nutrients* 12 (8), 2363. <https://doi.org/10.3390/nu12082363>.
- * Waisberg, J.L., Woods, M.T., 2002. A nutrition and behaviour change group for patients with anorexia nervosa. *Can. J. Diet Pract. Res.* 63 (4), 202–205. <https://doi.org/10.3148/63.4.2002.202>.
- Walsh, B.T., Boudreau, G., 2003. Laboratory studies of binge eating disorder. *Int. J. Eat. Disord.* 34 (Suppl. 1), S30–S38. <https://doi.org/10.1002/eat.10203>.
- Walter, S.D., Yao, X., 2007. Effect sizes can be calculated for studies reporting ranges for outcome variables in systematic reviews. *J. Clin. Epidemiol.* 60 (8), 849–852. <https://doi.org/10.1016/j.jclinepi.2006.11.003>.
- * Wiklund, C.A., Igudesman, D., Kuja-Halkola, R., Bälter, K., Thornton, L.M., Bulik, C.M., 2022. Intake and adherence to energy and nutrient recommendations among women and men with binge-type eating disorders and healthy controls. *Clinical Nutrition ESPEN* 48, 186–195. <https://doi.org/10.1016/j.clnesp.2022.02.111>.
- * Woell, C., Fichter, M.M., Pirke, K.-M., Wolfram, G., 1989. Eating behavior of patients with bulimia nervosa. *Int. J. Eat. Disord.* 8 (5), 557–568. [https://doi.org/10.1002/1098-108X\(198909\)8:5<557::AID-EAT2260080507>3.0.CO;2-8](https://doi.org/10.1002/1098-108X(198909)8:5<557::AID-EAT2260080507>3.0.CO;2-8).
- Zhou, B.F., Stamler, J., Dennis, B., Moag-Stahlberg, A., Okuda, N., Robertson, C., Zhao, L., Chan, Q., Elliott, P., 2003. Nutrient intakes of middle-aged men and women in China, Japan, United Kingdom, and United States in the late 1990s: the INTERMAP Study. *J. Hum. Hypertens.* 17, 623–630. <https://doi.org/10.1038/sj.jhh.1001605>.