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Restrained eating behaviour, anorexia nervosa and food consumption between children and adolescents: a scoping review

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Abstract

Anorexia nervosa (AN) and restrained eating behaviour (REB) are characterised by reduced food intake to achieve body weight loss. This scope review aimed to describe the existing evidence on the association between AN, restrictive eating behaviour and food consumption. Studies with children and adolescents of both sexes of all races and ethnicities were included. Experimental and observational studies, systematic reviews, meta-analysis, case reports or series, conference abstracts, dissertations and theses were also included. The search was conducted in ten electronic databases and grey literature without language restriction on 14 November 2020. Twenty-four studies met the inclusion criteria. Most studies included girls and identified lower intake of energy content, fat and certain micronutrients. There was also a higher intake of caffeine, fibre, vegetables, legumes and fruits and a lower intake of low-quality snack, fast food, sweets and foods with high carbohydrate and fat contents. The need to improve the quality of the diet among study participants was also identified. Thus, it is recommended that the evaluation of food consumption be careful to develop effective prevention strategies for the development of AN/REB and minimise nutritional deficiencies in these individuals.

Key words: **Eating disorder: Dieting: Food intake: Review scoping**

Anorexia nervosa (AN) is a psychiatric syndrome characterised by distortion of body image and adoption of persistent and inappropriate eating behaviours for weight control, even if the person has a body weight below the recommended for age and sex[1]. It consists of one of the most serious eating disorders and has the highest mortality rate among psychiatric diseases[2,3]. Additionally, the results of studies indicate that individuals may develop behaviours that usually precede an eating disorder, such as eating restriction[4,5].

Restrained eating behaviour (REB) is considered a behavioural and cognitive dysfunctional strategy adopted by individuals to control body weight[6]. A common characteristic among individuals with AN, such as those with REB, is concerned with weight-related eating[3,5] which can be expressed through the omission of meals, adoption of restrictive diets, fasting, episodes of self-induced vomiting and use of laxatives[4,7] and may compromise the state of health and nutrition throughout life[7,8].

In childhood and adolescence, a period of greatest vulnerability, eating disorders and dysfunctional behaviours, in addition to food consumption, may be influenced by biological and psychosocial changes inherent to the phase, as well as by the interference of family, friends, media, personal and cultural beliefs[7,8], especially when associated with dissatisfaction or distortion of body image[9]. Among the most frequent characteristics of food consumption in the course of AN and REB are low food intake in quantity and quality[10,11] with a significant reduction in energy intake, carbohydrates, fats and dietary deficiencies of certain micronutrients[12,13].

Epidemiological studies have evaluated the association between AN/REB and food consumption[12,14,15]; however, the knowledge produced to date is not fully understood. This relationship imposes multiple interactions involving genetic and environmental factors, in addition to the complexity and challenges in the evaluation of food intake, especially in individuals with ED[16,17].

Abbreviations: AN, anorexia nervosa; BN, bulimic nervosa; DRI, dietary recommended intake; HEI, Healthy Eating Index; REB, restrained eating behaviour.

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Individuals with AN/REB are usually less accurate when reporting on their food intake, although they seek to obtain more knowledge about specific aspects of food than the general population[15,17]. Nevertheless, the various methods of food surveys available have limitations, such as specific errors inherent to the interviewer, the individual, dietary measurement and data analysis that may favour bias in the results[16,18,19]. However, in the analysis of dietary intake, some procedures can be used to minimise these errors, which include correction of coefficients and risk measures considering the intra-individual variability to the adjustment for energy intake in investigations of the association of food intake and health outcomes. In this sense, it is also important to observe the choice and application of robust and adequate tests to analyse both nutrients (e.g. probabilistic approach) and dietary patterns (e.g. factor analysis, cluster, structural equation modelling and latent classes)[20].

Given the lack of evidence synthesis available in this field, this scope review may contribute to the advancement of knowledge in the area and to the development of strategies to prevent the development of AN/REB and nutritional deficiencies. Thus, the objective of this study is to systematically explore studies that evaluated the association between AN/REB and food consumption, as well as to identify the existing knowledge gaps from the following questions: (1) what is the extent and breadth of the existing literature on the relationship between AN/REB and food consumption in children and adolescents? and (2) what approaches and methods are used to identify food consumption in children and adolescents with AN/REB?

Methods

This scope review was reported according to the recommendations of the Preferred Reporting Items for Systematic Review and Meta-Analysis Extension for Scoping Reviews[21].The checklist Preferred Reporting Items for Systematic Review and Meta-Analysis Extension for Scoping Reviews (Appendix) was applied. The protocol was developed according to the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols guidelines[22] and the Joanna Briggs Institute manual[23] with registration in the Open Science Framework (https://osf.io/wm79y).

Eligibility criteria

The research question and eligibility criteria were defined using the acronym PCC (Participant, Concept and Context). Experimental and observational studies (cross-sectional, cohort and case–control), systematic reviews and meta-analyses, conference abstracts, dissertations and theses were included in this scoping review. Studies with case reports or series, ecological studies, narrative reviews, communications, editorials, book chapters and study protocols were excluded. The inclusion and exclusion criteria for the selection of studies are described in Table 1.

Sources of information and search strategy

The search was performed on 14 November 2020. The articles were independently searched by two reviewers in the Medline/PubMed databases, Embase via Elsevier, Cochrane Library Databanks, Lilacs, Cumulative Index to Nursing and Allied Health Literature, Scopus, PsycINFO, PsyARTICLES, EPPI-Center database of health promotion research (BiblioMap), Epistemonikos, and in the grey literature by Index to Theses, ProQuest Dissertations and Theses Database and Psicodoc, OpenGrey and Google Scholar. The search strategies were performed in three stages. First, the following terms and their respective synonyms were selected in the Medical Subject Headings of PubMed: 'food pattern', 'food consumption', 'food', 'food variety', 'dietary pattern', 'dietary intake', 'diet', 'diet variety', 'diet quality', 'dietary quality', 'dietary quality index' and 'dieting', 'dietary restriction', 'dietary restraint', 'dieting restrictive', 'feeding and eating disorder', 'disordered eating behaviour', 'eating disorder', 'eating disorder symptoms', 'anorexia nervosa', 'restrained eating' and 'restrained eating behaviour'. Next, to identify other terms not obtained in the first step, a limited search was performed in Medline/PubMed. At this stage, the terms 'nutrients', 'macronutrients', 'micronutrients' and 'energy' were identified in the titles, abstracts and keywords of the retrieved documents. Finally, all terms and their synonyms were selected from Medical Subject Headings, Embase Subject Headings (Emtree) and Health Sciences Descriptors (DeSC), added to the search strategy and applied to all databases. The Boolean operators 'AND' and 'OR' were used. The reference lists of all selected studies were searched to identify additional studies not indexed in the databases but relevant for inclusion in this review.

Selection of evidence sources and data extraction

The selection of studies was performed by a pair of independent reviewers. Data extraction was performed by a reviewer, and the researcher confirmed the accuracy of the information collected. Any disagreement in the selection of sources of evidence and data collected was discussed and resolved with a third reviewer. Endnote® was used to load all publications retained from the databases and to remove duplicates. During the screening, the titles and abstracts of the publications were read, followed by the complete reading and selection of eligible studies.

The data were extracted in a *Microsoft Office® Excel* spreadsheet. The information extracted was article title, authors, date of publication, study site, study design, sample size, participant characteristics, inclusion and exclusion criteria, and data on dietary intake (statistical methods and techniques for assessing intake), tools used to measure feeding behaviour and AN. Missing information was requested by e-mail to the corresponding author.

Data synthesis

The collected data were presented in tables or graphs. The results were grouped according to the study design and evaluation of dietary intake and AN/REB.

Results

Flow of selection of evidence sources

The search strategy in the ten databases and in the grey literature retrieved 22·283 records, remaining after removal of duplicates,

Table 1. Eligibility criteria for the selected studies

Criterion	Participants	Concept	Context
Inclusion	Children/adolescents (6–19 years and 11 months) with restrained eating behaviour or diagnosis of anorexia nervosa of both sexes and all races and ethnicities	Anorexia nervosa defined by the classification system, for example, by the CID, DSM and semi-structured clinical interview (e.g. Structured Clinical Interview for Axis I Disorders (SCID-I) and Eating Disorder Examination (EDE) Restrained eating behaviour assessed by screening instruments and specific questions about eating restriction with a view to weight loss or diagnostic subscale for eating disorder over eating restriction Food consumption defined through *a priori* approaches (i.e. diet quality index), *a posteriori* (multivariate analysis techniques, such as cluster analysis, factor analysis, among others) or food intake (fruits, vegetables, fish, etc.), drinks or by determining energy and nutrients	Population or community base or clinical populations (outpatient or hospital health service)
Exclusion	Animals, pregnant women, nursing mothers, children under six, adults and the elderly, as well as those developed only with specific groups of individuals, such as athletes, people with diabetes	Studies that investigated purgative or compulsive behaviour and other eating disorders Studies that assessed the pattern and location of meals, as well as professional-oriented dietary restrictions for specific diseases	

ICD, international statistical classification of diseases and health-related problems; DSM, diagnostic and statistics manual for mental disorders.

18 856 for reading the title and abstract. Subsequently, sixty-one publications remained in the selection process for full reading. Of these, thirty-five articles were excluded because they did not meet the eligibility criteria. No additional articles were identified by searching the reference lists. A total of twenty-four studies[24–49] and, for two primary studies, two publications were retained in each study[24,25,34,35] (Fig. 1). It should be noted that in the study by Bischoff-Seals[24], only the abstract was identified, and the author was asked for the dissertation, but without feedback, so only the characterisation of the study was described in this review.

Characteristics of the evidence sources

The selected studies were published from 1991 to 2020 and conducted in the USA (*n* 8)[24,25,28,29,39,42,44,45,48], Brazil (*n* 3)[31,34,35,37], Spain (*n* 3)[25–27], Canada (*n* 2)[28,29], Taiwan (*n* 2)[30,31], Australia (*n* 1)[32], Ireland (*n* 1)[33], Sweden (*n* 1)[34], Japan (*n* 1)[35], Germany (*n* 1)[36] and England (*n* 1)[37] (Fig. 2).

The sample size was 20–2·142 individuals aged between 9 and 20 years. Although the inclusion criterion had a maximum age of 19 years, we admitted three studies that had an age group between 12 and 20 years[24,25,44,45]. Thirteen studies involved female subjects[24–26,28,32,34,35,37,39,40,42–44,46,48] and eleven recruited participants of both sexes[24–29,33,34,36,38,39]. Few studies (*n* 4) reported the race/ethnicity of the participants[24,25,27,43,45]. Most studies (*n* 19) adopted a convenience sample without presenting the calculation of the sampling process[24–31,33–36,38–42,44–46,48] (Table 2).

Participants in nine studies had AN and were recruited in hospitals (*n* 5)[40–44], clinical centres (*n* 2)[24,25,45] and outpatient clinics (*n* 2)[32,35]. The REB was evaluated in fifteen studies that collected samples in schools (*n* 13)[27,29–36,38,43,46,47,49], clinical centres (*n* 1)[45] and communities (*n* 1)[36] (Fig. 3).

Characteristic of anorexia nervosa and restrained eating behaviour

Seven studies evaluated the diagnosis of AN using the classification system of the Diagnostic Statistical Manual of Mental Disorders Third Edition (*n* 1)[44], Diagnostic Statistical Manual of Mental Disorders Fourth Edition (*n* 4)[32,40,42,43] and Diagnostic Statistical Manual of Mental Disorders Fifth Edition (*n* 1)[39] and structured interviews based on the DMS-IV (Structured Clinical Interview for Axis I Disorders and the Eating Disorder Examination scale (*n* 1))[24,25]. The study by Allen *et al.*[32] conducted a two-phase study, first applying the Child Eating Disorder Examination and Eating Disorder Examination instruments – Questionnaire for screening and then the adolescents were evaluated for the presence of AN by the Diagnostic Statistical Manual of Mental Disorders Fourth Edition classification system. One study used diagnostic interviews[41] and another[35] reported that physicians experienced in the ED performed the diagnosis of AN (Table 3).

The following scales were used to evaluate the REB: Eating Attitudes Test-26 (*n* 4)[31,32,34,35,46]; Dutch Eating Behaviour Questionnaire (*n* 5)[28,33,34,36,37]; Eating Attitudes Test-40 (*n* 2)[25,27]; Modified Three-Factor Eating Questionnaire (*n* 1)[24]. Mulvihill *et al.*[37], in addition to using the DEBQ, also applied the Three-Factor Eating Questionnaire. One study used subscale food restriction of the Child-Eating Disorders Examination (*n* 1)[45]. Nevertheless, two other studies adopted questions that investigated the adoption of a restrictive diet[26,29]. It should be noted that the studies by Bisset *et al.*[28], Koch *et al.*[36] and Mulvihill *et al.*[37] stratified the sample by tertiles of food restriction into low, medium and high (Table 4).

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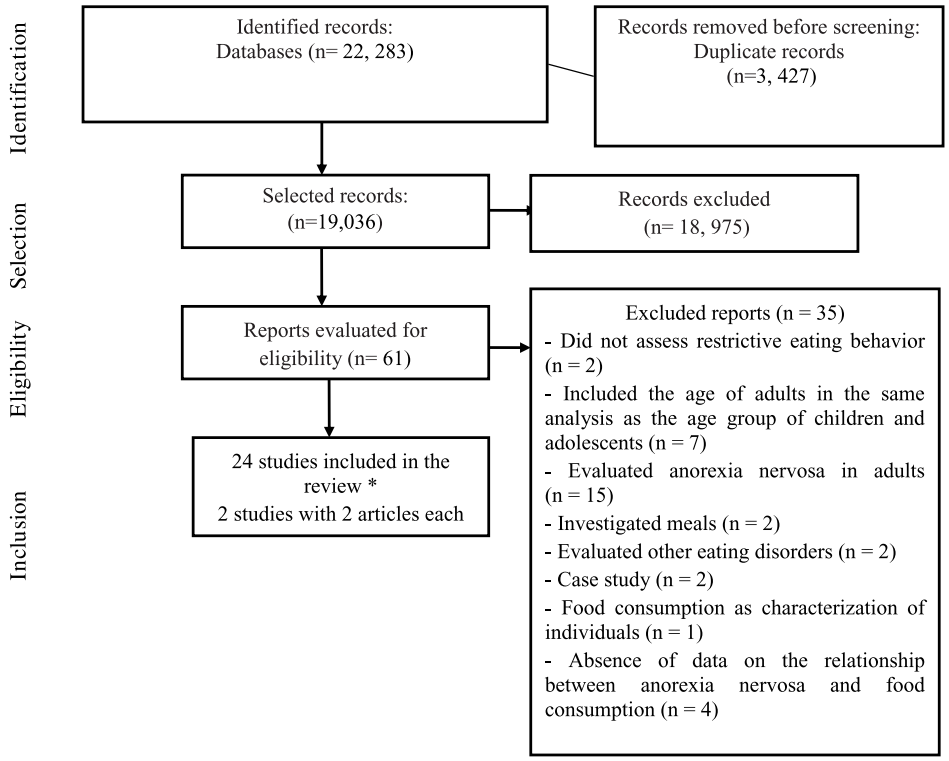

Fig. 1. Diagram of study selection.

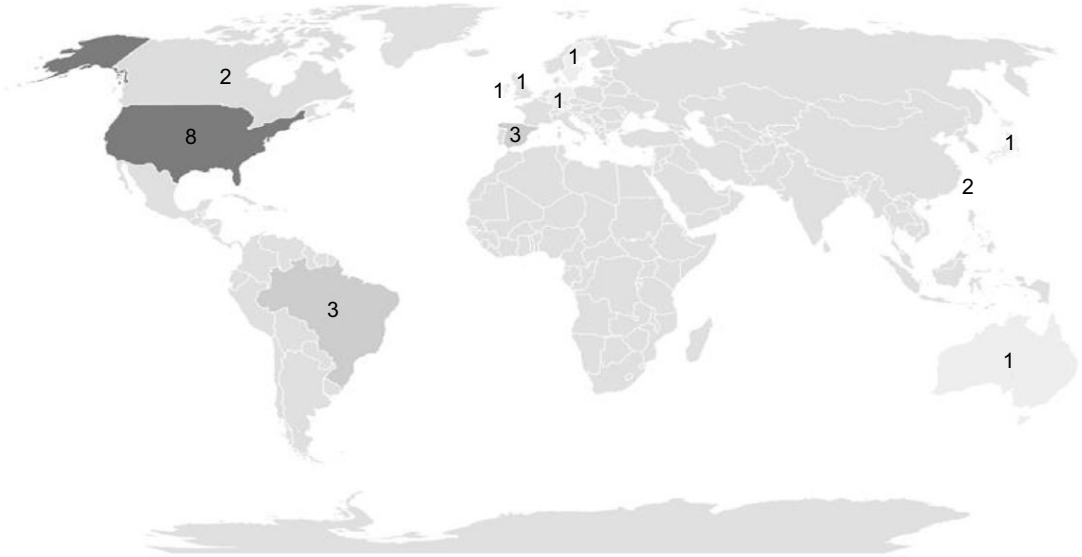

Fig. 2. Distribution of study by country.

Dietary evaluation

Different dietary survey methods were used to obtain data on the participants food intake. For people with AN and those with REB, the studies adopted the following instruments: 24-h recall (R-24 h) from 1 to 3 d (*n* 9)[27,29,32,34,35,39,44–46,49]; record or food diary (1–4 d) (*n* 5)[24,25,28,31,41,42]; FFQ (*n* 5)[28,32,34,41,45]; direct weighing (*n* 4)[28,33,37,44]. The self-administered diet history questionnaire was used by only one study in adolescents with AN[35]. Questions regarding the food consumption of the instruments Health Behaviour in School-Aged Children (*n* 1)[26] and Inventory of Health Behaviour in Scholars (*n* 1)[27] were used in participants with REB. Mulvihill *et al.*[37] and Nasserbakh *et al.*[43] also applied the daily record (Tables 3 and 4).

In studies with individuals with AN, the majority analysed dietary intake through the consumption of energy and macronutrients (*n* 9)[24,25,35,37,39,41–43,46], followed by six studies that

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Table 2. Main characteristics of the selected studies

Author/year	City/Country	Study objective	Study design	Sample size	Age – years (average)	Sex (ethnicity/race)	Setting
Anorexia nervosa and food intake							
Affenito *et al.*, 2002[46]	California (USA)	To compare the macronutrient intake of participants with a history of anorexia nervosa (AN) and matched healthy participants, at three times	Case control nested to a cohort	154 AN: 14 Healthy: 140	9–10 years at the beginning of the study	Female (White)	Clinical centres
Striegel-Moore *et al.*, 2006[47]	California (USA)	To test the hypothesis that caffeine intake in females with anorexia nervosa, or binge eating disorder is elevated compared with females who do not have an eating disorder	Case control nested to a cohort	2·054 AN:10; BN: 27; BED: 42 1·977 were sorted randomly into comparison groups of 659 each (one for each eating disorder)	9–10 years at the beginning of the study	Female (Blacks and whites)	Clinical centres
Allen *et al.*, 2013[32]	Raine (Western Australia)	Examine the dietary intake with eating disorders relative to controls	Cohort two stages	428 AN:6; BN: 38; BED:6; PD:15 Non-eating disorder controls: 363	15 7–18 2 years	Female (Not informed)	Outpatient
Baskaran *et al.*, 2017[40]	USA	Prospectively investigating macronutrient composition associated with weight gain over a 6–12 month follow-up period	Cohort	90 AN: 45 Healthy: 45	12–18 years	Female (Not informed)	Hospital and Community treatment centres and suppliers
Higgins *et al.*, 2013[41]	Colorado (USA)	To describe the changes in diet and physical activity that precede inpatient medical treatment for AN	Cohort Retrospective	20	11–19 years	Female (Not informed)	Hospital
Kanayama *et al.*, 2019[35]	Japan	To investigate detection of anorexia nervosa by comparing energy and nutrient intake between patients with anorexia nervosa and healthy thin persons	Cross-sectional	333 320 healthy girls; 13 with AN in the recovery phase	10–18 years	Female (Not informed)	Outpatient
Misra *et al.*, 2006[42]	USA	To compare the nutrient intakes of community-dwelling girls with AN with those of healthy adolescent	Cross-sectional	78 AN: 39 Healthy: 39	12 1–18 7 years	Female (not informed)	Hospital Communities centres
Nasserbakht *et al.*, 1996[43]	California (USA)	To investigate the energetic utilisation difference between eating disordered and normal adolescents	Cross-sectional	62 AN, BN: 32 Healthy: 30	Case: 12–20 years Control: 14–19 years	Female (not informed)	Hospital
Santiago *et al.*, 2017[39]	USA	To compare the nutritional intake of adolescents with eating disorders to recommended daily values of nutrients	Cross-sectional	46 AN: 19	12–20 years	Both sexes (Whites, Hispanics, Mixed, Asian)	Clinical

Table 2. (*Continued*)

Author/year	City/Country	Study objective	Study design	Sample size	Age – years (average)	Sex (ethnicity/race)	Setting
Weltzin *et al.*, 1991[44]	USA	To explore issues: (1) whether restricting and bulimic anorexic patients require different energetic intakes to maintain weight after weight restoration; and (2) whether normal-weight bulimic patients require same number of energy content to maintain stable weight as do previously anorexic bulimic patients	Cohort	53 AN: 13	13 years	Female (not informed)	Hospital
Restrained eating behaviour and food intake							
Aparicio *et al.*, 2014[25]	Tarragona (Spain)	To assess the relationship between the degree of severity of eating disorders and energy and nutrient intakes and nutritional risk in a mixed-sex adolescent population without clinical symptoms	Paired cross-section	495 EAT+: 146 Controls: 307 42 eating disorder not otherwise specified	Girls: Case: (14 3) Controls: (14 2) Boys: Case: (14 2) Controls: (13 9)	Both sexes (Caucasian)	School
Bischoff-Seals, 2007[24]	USA	Determine the effect of restricted eating behaviour on Ca food intake in adolescents	Cross-sectional	85	Adolescents	Both sexes (not informed)	Public school
Bisset *et al.*, 2007[28]	Quebec (Canada)	To describe patterns of dietary behaviours during the transition from childhood to adolescence	Cohort	1188 561 girls 627 boys	Childhood and early adolescence End of the study: 14–16 years	Both sexes (not informed)	School
Caran *et al.*, 2018[38]	Rio de Janeiro (Brazil)	To investigate the association between disordered eating behaviours and energy and nutrient intake	Cross-sectional	487 EAT+: 36	15–19 years (16·9)	Both sexes (not informed)	Public schools
Chang *et al.*, 2011[30]	Taiwan	To investigate how body image, weight satisfaction and weight loss experience related to a disturbed eating pattern	Cross-sectional	1543 EAT+: 264	15–18 years	Female (not informed)	Public and private schools
Daly *et al.*, 2020[33]	Ireland	To describe the eating behaviour styles and to explore the relationships between demographic factors, BMI and dietary intake and these eating behaviour styles	Cross-sectional nested to a cohort	441	13–17 years	Both sexes (not informed)	School

Table 2. (*Continued*)

Author/year	City/Country	Study objective	Study design	Sample size	Age – years (average)	Sex (ethnicity/race)	Setting
Dunker and Philippi, 2003[49]	São Paulo (Brazil)	To identify adolescents from female with symptoms of AN and describing its eating habits and behaviours	Cross-sectional	279 EAT+: 59	15–18 years	Female (not informed)	School private
Dunker and Philippi, 2005[48]	São Paulo (Brazil)	To identify adolescent girls with symptoms of AN and describe their diet	Cross-sectional	279 EAT+: 59	15–18 years	Female (not informed)	School
Elfhag *et al.*, 2008[34]	Sweden	We investigated associations between consumption of fruits, vegetables, sweets and soft drinks and the psychological dimensions of eating	Cross-sectional	1795 mothers, 1471 fathers and 1441 children's	(11·9)	Both sexes (not informed)	School
Grigolon *et al.*, 2019[45]	São Paulo (Brazil)	To investigate the association between dietary intake and increased risk of eating disorder	Paired cross-section	150 Case: 50 Control: 100	11–16 years	Female (not informed)	Clinic Schools
Guevara *et al.*, 2020[26]	Salamanca (Spain)	To analyse the range sex, age, weight loss diet, BMI and physical activity and their effect on the dietary habits	Cross-sectional	1318	11–18 years	Both sexes (not informed)	State and semi-private schools
Koch *et al.*, 2018[36]	Dortmund (Germany)	To determine the relevance of restrained eating for characteristics of circadian eating pattern	Cross-sectional nested to a cohort	209	11–18 years	Both sexes (not informed)	Community
Mulvihill *et al.*, 2002[37]	London (England)	To investigate the prevalence of dietary restraint and to examine the nutritional consequences of dietary restraint and its implications for Fe status	Cross-sectional	64	14–15 years	Female (White-Caucasian, Black-Chinese, Asiatic-other)	School
Tsai *et al.*, 2011[31]	Taichung City, (Taiwan)	To investigate the prevalence of disturbed eating attitudes and behaviours	Cross-sectional	835 EAT+:86	11–15 years	Female (not informed)	Public and private schools
Quiles-Marcos *et al.*, 2011[27]	Province of Alicante (Spain)	To study the differences between adolescents at high and low risk of developing an eating disorder in different behaviour related to health (eating habits, physical activity and the consumption of substances)	Cross-sectional	2142 EAT+:467	12–16 years	Both sexes (not informed)	School
Woodruff *et al.*, 2008[29]	Ontario (Canada)	To describe body weight concerns, dieting status and meal skipping of adolescents by sex, grade, and body weight status	Cross-sectional in two stages	1826	13–17 years	Both sexes (Not informed)	School

AN, anorexia nervosa; BN, bulimic nervosa; BED, binge eating disorder; PD, purging disorder.

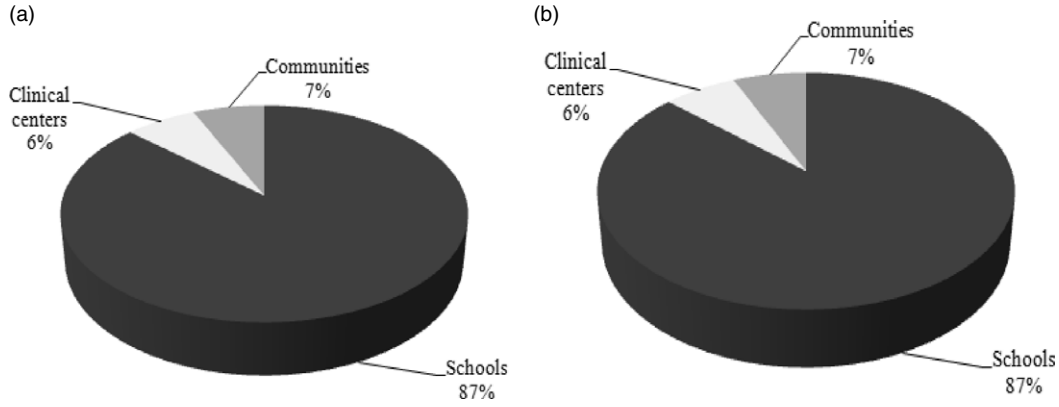

Fig. 3. Distribution of the study by location: (a) anorexia nervosa; (b) restrictive eating behaviour.

explored the intake of micronutrients[25,35,37,39,41,42] and two that recorded fibre intake[40,42]. Striegel-Moore *et al.*[47] analysed caffeine consumption, and Kanayama *et al.*[35] identified fourteen food groups. The *a priori* dietary pattern was investigated in the study by Santiago *et al.*[39], which used the Healthy Eating Index-2010 (HEI-2010). Four studies compared dietary intake with references to quantitative estimates of nutrient intake based on the Australian recommendation[32], in the *dietary recommended intake* (DRI)[35,41,42] and *average US dietary intake* for girls aged 12–19 years[41] in the recommendations of the 2010 Dietary Guidelines, which is based on the recommendations of the DRI[39]. Furthermore, Kanayama *et al.*[35] also used the *dietary goal for preventing lifestyle-related diseases* (DG) (Table 3).

In participants with REB, six studies evaluated energy intake[27,31,32,34,35,41,46], five analysed macronutrient intake[27,31,32,34,35,46] and seven evaluated the intake of micronutrients[24,25,30,31,37,38,48]. Koch *et al.*[36] evaluated the mean percentage of energetic intake; however, they considered the circadian, morning and evening dietary profiles. The study by Dunker and Philippi[48] calculated the mean values of the percentage of intake of macronutrients, Ca and Fe and compared them with the recommendations of the DRI and to evaluate the energy intake compared with the *National Research Council*. Two studies investigated the prevalence of inadequate energy intake[25] and nutrients[25,38] using the DRI probability created for the Spanish population[25] and Institute of Medicine[38], and a study compared nutrient intake with *reference nutrient intake*[37]. Two studies evaluated the fibre intake of individuals[30,31], four studies investigated the food group[28,37,45,48,49] and one identified dietary pattern *a priori* by the Healthy Eating Index – HEI-C[29] (Table 4).

Results and summary of evidence sources

Anorexia nervosa and food intake

Nine studies that evaluated the relationship between AN and food consumption were retained, including four cohort studies[32,40,41,44], a case–control study (two generated articles)[24,25] and four cross-sectional studies[35,39,42,43] (Fig. 4).

Energy content, macronutrients, fibres, micronutrients and caffeine. Initially, the results of the cohort studies[32,40,41,44] were obtained. Allen *et al.*[32] used Mann–Whitney *U* and Kruskal–Wallis tests and found that the median total and monounsaturated fat intake was significantly lower ($P < 0{\cdot}05$) among adolescents with AN. However, there was no significant difference in the intake of energy content, protein and carbohydrates between the groups. Baskaran *et al.*[40] evaluating the baseline data of the study with girls with AN, after applying the Wilcoxon, Kruskal–Wallis and Student's *t*-tests, did not observe differences in the mean energetic ($P = 0{\cdot}38$) and protein ($P = 0{\cdot}99$). However, girls with NA had higher energy intake obtained from carbohydrates ($P < 0{\cdot}001$) and lower energetic intake from fat ($P = 0{\cdot}0002$), SFA ($P < 0{\cdot}001$) and MUFA ($P < 0{\cdot}001$), compared with the controls. In addition, when comparing macronutrient intake in girls with AN who gained body weight (AN-1) *v.* those with AN and who maintained weight (AN-0) by means of Pearson's correlation analysis, it was found that in the AN group-0, there was a higher percentage contribution of energy content from protein intake ($P = 0{\cdot}046$). Throughout 6–12 months, ANCOVA was used and it was identified that adolescents with AN-1 consumed a lower percentage of energy content from protein ($P = 0{\cdot}001$) and a higher energetic percentage of fat and PUFA ($P = 0{\cdot}02$) when compared with the AN-0 group. ANOVA and Tukey Kramer test were also used for multiple comparisons between groups, observing lower mean intake of energy content from carbohydrates ($P = 0{\cdot}004$; AN-0 *v.* control), proteins ($P = 0{\cdot}03$; AN-0 *v.* AN-1) and fats ($P < 0{\cdot}001$; AN-0 *v.* control and AN-0 *v.* AN-1). Higgins *et al.*[41] did not observe significant differences in the mean intake of energy content ($P = 0{\cdot}312$), carbohydrates, proteins and fats between the period of 6 months and 1 week before hospitalisation among the participants using the paired *t* test.

When applying the ANOVA test, Affenito *et al.*[46] did not find significant differences in the mean energy intake ($P = 0{\cdot}20$) and in the percentage of energy obtained from carbohydrates ($P = 0{\cdot}71$), proteins ($P = 0{\cdot}34$) and fats ($P = 0{\cdot}76$) 2 years before the onset of symptoms of AN. However, there was a significant reduction in total energy intake ($P = 0{\cdot}03$) in the first year prior to diagnosis. Affenito *et al.* also found out that among girls with AN, there was a lower intake mean number of energy content ($P = 0{\cdot}03$) and the percentage of as well as higher percentage protein intake energy content in the first year of disease. After

Table 3. General results of articles that studied the relationship between anorexia nervosa and food intake in children and adolescents

Author/year	AN assessment	Food consumption instrument	Statistical analysis adjustment/confounders	Main results
Affenito *et al.*, 2002[46]	SCID and the Eating Disorder Examination	3-d food record	ANOVA	There were no significant group differences in intake of energy ($P = 0{\cdot}20$), carbohydrate ($P = 0{\cdot}71$), protein ($P = 0{\cdot}34$) and fat ($P = 0{\cdot}76$) at the assessment 2 years before the onset of AN. At the 1-year pre-onset assessment, the AN group consumed significantly less total energy ($P = 0{\cdot}03$) but otherwise did not differ significantly from the healthy comparison group At the assessment during the first year of AN, AN cases had significantly lower total energy ($P = 0{\cdot}03$) and fat ($P = 0{\cdot}04$) intakes and marginally higher protein ($P = 0{\cdot}07$) intake than matched healthy girls; the two groups did not differ in percentage of total energy from carbohydrate ($P = 0{\cdot}27$)
Striegel-Moore *et al.*, 2006[47]	Interview DSM-IV	Food record Caffeine Sources (coffee, tea, soda and chocolate-containing foods)	Generalised estimation equation (race and study centre)	The hypothesis of higher caffeine intake in individuals with AN was not statistically significant, although the results identified that caffeine intake increased more in the AN group when compared with peers, except for caffeine consumption obtained from coffee and tea (X^2 (2) = 3·88, $P > 0{\cdot}10$). Increased caffeine consumption over time between the ages of 9 and 19 years (X^2 (2) = 16·9–72·9, $P < 0{\cdot}0005$) Significantly higher proportional increase in caffeine intake from soda ($P < 0{\cdot}005$) and significantly higher corresponding decrease in caffeine intake from foods containing chocolate ($P < 0{\cdot}005$)
Allen *et al.*, 2012[32]	1[a] phase: Child Eating Disorder Examination and Eating Disorder Examination – Questionnaire	FFQ	Calculation of median and interquatile range for evaluation of energetic intake, nutrients	Group with anorexia nervosa had significantly lower intake of total fat and monounsaturated ocosapentaenoic acid, eicosadienoic acid, dihomo-gammalinolenic acid, arachidoni acid (AA) 20:4, adrenic acid 22:4 ($P < 0{\cdot}05$) compared with the control group There was no significant difference between the intake of energy, proteins and carbohydrates AN had a lower intake of total Na ($P < 0\ 05$) in the AN group compared with control participants
Allen *et al.*, 2012[32]	2[a] phase: DSM-IV		Mann–Whitney *U* and Kruskal–Wallis χ^2 test ANOVA	There were no significant differences between the groups in reported intake of fibre, Ca, Mg, hosphorus, Fe, Cu, Zn, carotene, K, thiamine, riboflavin, niacin, folic acid (total), biotin, vitamin B_6 or vitamin D, A, E A significantly greater proportion of eating disordered than control participants scored less than two-thirds the Australian RDI for Zn (8 % *v.* 1 % respectively, $P < 0{\cdot}001$), thiamine (14 % *v.* 4 %, $P < 0{\cdot}001$), vitamin B_6 (12 % *v.* 4 %, $P = 0{\cdot}012$) and phosphate (17 % *v.* 7 %, $P = 0{\cdot}008$)
Baskaran *et al.*, 2017[40]	Structured Clinical Interview for Diagnostic and Statistical Manual-IV	4-d food diary	Wilcoxon test Kruskal–Wallis test Tukey Kramer Student-*t* tests ANOVA ANCOVA (controlling for energy and nutrient intake) Pearson correlation	Baseline: Absolute energetic intake (1884 (kcal) cal; $P = 0{\cdot}38$) and proteins (71·3 g; $P = 0{\cdot}99$) reported by girls with AN was comparable with the control group (2001 kcal; 71·2 g, respectively). Energy content obtained from carbohydrates (293·4 g; $P = 0{\cdot}27$) and fibre was higher in the AN group when compared with the pairs. Girls with AN reported lower intake of energy content from total fat and fatty acid when compared with the control group Carbohydrate intake (293·8 g; $P = 0{\cdot}99$) and fat (52·2 g; $P = 0{\cdot}24$) in girls who gained weight (AN-1) *v.* those who did not increase body weight (AN-0) (293·1; 42·6 respectively) was not significant. It was identified that the highest percentage of total energy content was obtained from the protein (76·5 g) in the AN-0 Follow-up 6 to 12 months: AN-1 consumed lower percentage of total protein energy content (77·21 g; $P = 0{\cdot}14$) and higher percentage of total fat energy content (63·8 g; $P = 0{\cdot}10$) compared with AN-0 (89·30 g; 48·5 g respectively). AN-1 had a significant increase in the percentage of total energy content obtained from PUFA ($P = 0{\cdot}006$) compared with AN-0. Lowest mean intake of energy content from carbohydrates ($P = 0{\cdot}004$; AN-0 *v.* control), proteins ($P = 0{\cdot}03$; AN-0 *v.* AN-1) and fat ($P < 0{\cdot}001$; AN-0 *v.* control and AN-0 *v.* AN-1)

Table 3. (*Continued*)

Author/year	AN assessment	Food consumption instrument	Statistical analysis adjustment/confounders	Main results
Higgins *et al.*, 2013[41]	Interview	FFQ 24 h food recall	Paired *t*-tests Analysis of micronutrients adjustment Bonferroni method	There was no significant difference in energy consumption reported during 6 months and 1 week before admission (1404 *v.* 1272 kcal, $P = 0{\cdot}312$). The consumption of macronutrients in the diet has not changed over time. Significant changes in the intake of Cu ($P = 0{\cdot}0117$), Zn ($P = 0{\cdot}0031$), Fe ($P = 0{\cdot}0156$) and riboflavin ($P = 0{\cdot}007$), vitamin B_{12} ($P = 0{\cdot}0144$), retinol ($P < 0{\cdot}0001$), vitamin A ($P < 0{\cdot}0001$), vitamin D ($P < 0{\cdot}0001$) over 6 months. Lower intake of vitamin A, vitamin D, linoleic acid, retinol and pantothenic acid in 1 week before admission. Consumption of Ca and P in the diet did not change between 6 months and 1 week (798 and 748 mg/d for Ca, respectively; 994 and 874 mg/d for P.
Kanayama *et al.*, 2019[35]	Experienced outpatient physician	Self-administered Diet History Questionnaire (BDHQ)	Mann–Whitney test Kruskal–Wallis test Bonferroni multiple comparison test Macronutrients and energy compared with EAR	Food groups: cereals; potatoes; sugar and sweeteners; bean; green and yellow vegetables and greens; greens fruits; fish and shellfish; beef; egg; dairy products; fat and oil; confectionery; drinks; seasonings and spices and vegetables; Girls with AN had lower energy consumption (AN, 82·4 (23·7) *v.* lean, 119·3 (68·4 %) of EAR, $P < 0{\cdot}05$), fat (100·0 (29·4) *v.* 114·6 (24·9 %) of provisional DG, $P < 0{\cdot}01$), Zn (86·0 (128·8) *v.* 142·5 (82·6 %) of EAR, $P < 0{\cdot}01$),vitamin C (130·0 (58·2) *v.* 142·2 (100·8 %) AI, $P < 0{\cdot}01$), confectionery (7·6 *v.* 11·5% energy intake, $P < 0{\cdot}05$), higher consumption of vegetables (2·4 *v.* 1·2 % of energy intake, $P < 0{\cdot}01$) and sugars and sweeteners (0·7 *v.* 0·4 % of energy intake, $P < 0{\cdot}05$) when compared with lean girls In the AN group, individuals with lower Zn intake consumed less meat compared with individuals with higher Zn intake (3·8 *v.* 8·1 of energy intake, $P < 0{\cdot}05$) Girls with lower fat intake consumed fewer dairy products than girls with higher fat intake (6·1 *v.* 16·1 of energy intake, $P < 0{\cdot}01$). Thin girls with an above average desire for thinness seem to restrict their energy intake (119·3), carbohydrates (98·0), such as cereals (41·9), high fat intake (114·6) Of the 320 individuals evaluated, the energy intake was 99·8 (41·1 %) of the EAR and the protein intake was 173·2 (75·0 %) of the EAR, fat intake was 117·8 (22·2 %) of the DG and carbohydrate intake was 95·1 (12·2 %) of the DG
Misra *et al.*, 2006[42]	DSM-IV	4-d food record	Student's *t* test χ^2 test Fisher's exact test Wilcoxon test	Adolescents with AN consumed significantly fewer energy content (1649 *v.* 1970 kcal; $P = 0{\cdot}03$), saturated fat (14·3 *v.* 24·7; $P = 0{\cdot}0001$), monounsaturated fat (14·9 *v.* 24·7; $P < 0{\cdot}0001$). And polyunsaturated (9·3 *v.* 12·8; $P = 0{\cdot}001$), fatty acids *n*-3 (0·9 *v.* 1·3; $P = 0{\cdot}02$) and *n*-6 (8·3 *v.* 11·4; $P = 0{\cdot}02$) than healthy adolescents. Group AN had higher energy intake from proteins and carbohydrates than the control group, but the absolute intake of these macronutrients did not differ significantly between groups. Girls with AN did not differ from control individuals in the consumption of fructose (25·3 *v.* 30·4), galactose (1·02 *v.* 0·45), sucrose (48·9 *v.* 52·2), maltose (4·0 *v.* 3·3). However, glucose (26·1 *v.* 33·7; $P = 0{\cdot}07$) and starch (96·8 *v.* 116·4, $P = 0{\cdot}05$) intake decreased and lactose was higher in the AN group. Fibre intake was significantly higher in the AN group than in the group of healthy adolescents soluble Dietary fibre (g) (6·6 *v.* 5·3; $P = 0{\cdot}03$); insoluble dietary fibre (14·0 *v.* 9·4; $P = 0{\cdot}0003$) Intake of vitamin A (11521 *v.* 6359; $P \leq 0{\cdot}01$); thiamine (2·0 *v.* 1·8 0·1); riboflavin (2·7 *v.* 2·2; $P \leq 0{\cdot}05$); niacin (24·7 *v.* 21·0; $P \leq 0{\cdot}05$); pantothenic acid (6·4 *v.* 4·6; $P \leq 0{\cdot}05$); vitamin B_6 (2·2 *v.* 1·7; $P \leq 0{\cdot}05$); folate (447 *v.* 342, $P \leq 0{\cdot}01$); vitamin B_{12} (4·7 *v.* 4·3); vitamin C (159 *v.* 120; $P \leq 0{\cdot}05$); vitamin D ($6{\cdot}1 \pm 0{\cdot}7$ *v.* 5·0); vitamin E (10·4 *v.* 7·8); vitamin K $165{\cdot}9 \pm 47{\cdot}6$ *v.* $66{\cdot}9 \pm 7{\cdot}1$; $P \leq 0{\cdot}05$). However, the use of supplements favoured higher intake of vitamins A and D and

Table 3. (*Continued*)

Author/year	AN assessment	Food consumption instrument	Statistical analysis adjustment/confounders	Main results
				Most B vitamins in participants with AN when compared with peers. Ca food intake (1169 *v.* 981), P (1333 *v.* 216), Fe (17 *v.* 15), Zn (10·9 *v.* 9·3), Cu (1·2 *v.* 1·1), Se (92·7 ± 6·9 *v.* 101·9 ± 6·0) and Na (2879 ± 220 *v.* 2997 ± 137) did not differ significantly between girls with AN and control individuals. The intake of Ca, Fe and Zn supplements was higher in the AN group than in the control group A higher percentage of girls with AN met DRI for vitamin A (84·6 % *v.* 67·5 %), vitamin D (51·3 % *v.* 45 %), pantothenic acid (53·9 % *v.* 37·5 %) and folate (56·4 % *v.* 37·5 %) when compared with control. In addition to the proportion of girls with AN who meet the DRI for total Ca intake, but not for dietary Ca, it was significantly in relation to healthy adolescents ($P = 0·01$)
Nasserbakht *et al.*, 1996[43]	DSM-IV	24 h food recall Daily record annotated by hospital staff	ANCOVA	Anorectics (restrictive and bulimic anorectics) consumed more kcal/kg (61·42 kcal/kg; $P < 0·0001$) body weight to maintain weight than the control group. Non-bulimic anorectics consumed more energy content than bulimic anorectics (40·49 kcal/kg; $P < 0·0212$)
Santiago *et al.*, 2017[39]	DSM- 5	24 h dietary recall: USDA multiple pass method	Descriptive analyses	Mean energetic intake was lower than recommended values for the population studied. Atypical AN (1133·6 kcal); AN (1203·9 kcal). The distribution of macronutrients was within the limits recommended for older children and adolescents by the Dietary Guidelines for Americans, 2010. Carbohydrate (AN atypical 45·2 %; AN 48·5 %); fat (AN atypical 35·7 %; AN 34·5 %); protein (AN atypical 19·1 %; AN 17·1 %). Intake of vitamins A (AN atypical 103 %; AN 176 %), C (AN atypical 88 %; AN 110 %), Mn (AN atypical 119 %; AN 175 %) and Se (AN atypical 90 %; AN 99 %) was higher at the recommended daily values for those in the population studied. Intake of vitamins E (AN atypical 29 %; AN 47 %), D (AN atypical 21 %; AN 52 %) and B_{12} (AN atypical 36 %; AN 52 %), Zn (AN atypical 42 %; AN 46 %), Cu (AN atypical 44 %; AN 46 %), Fe (AN atypical 57 %; AN 51 %), K (AN atypical 47 %; AN 52 %) and Mg (AN atypical 50 %; AN 57 %) was lower than the daily values recommended for those in the population studied. Healthy Eating Index-2010 (HEI-2010) quality diet score > 80 is indicative of good diet quality; between 51 and 80 needing improvement on diet; < 50 low diet quality. Group AN had the highest score: 62·9 (needs to improve diet quality) of HEI-2010
Weltzin *et al.*, 1991[44]	DSM-III	Direct weighting	ANOVA MANOVA Linear regression and hierarchical analysis	AN-r with stable weight in the short time there was a higher consumption in the average of energy content ($P = 0·000$) per day when compared with AN-b in the short and long time and bulimia nervosa after the application of linear regression and hierarchical analysis. Girls with anorexia nervosa and who have reached the proper weight have abnormal energetic needs to maintain weight. After weight restoration, restrictive anorexic patients required significantly more energy content per day to maintain weight than bulimic anorexic patients. Bulimic anorexics with long-term weight maintenance, there was no relationship between current energy requirements and the time since the last low weight among bulimic anorexics with long-term weight maintenance'

DSM, diagnostic statistical manual of mental disorders; DG, dietary goal for preventing life-style related diseases; MANOVA, multivariate analysis of variance; SCID, Structured Clinical Interview for Axis I Disorders.

2 years of follow-up, there was no difference in the intake of energy content from carbohydrates ($P = 0{\cdot}27$) in both girls with AN and in pairs. Striegel-Moore *et al.*[47] applied the model of generalised estimation equations to investigate the relationship between caffeine consumption and NA. The investigators identified an increase in caffeine consumption over time in the AN group. Lower consumption of this food component by means of chocolate ($P < 0{\cdot}005$) and higher consumption of caffeine from soft drinks ($P < 0{\cdot}0005$) were also recorded, but no significant difference was identified in the intake of caffeine from coffee and tea ($P > 0{\cdot}10$).

Among the results of cross-sectional studies, Kanayama *et al.*[35] adopted the Mann–Whitney and Kruskal–Wallis tests and identified that, compared with lean individuals, the AN group had a significantly lower mean intake of energy content ($P < 0{\cdot}05$) and fat ($P < 0{\cdot}01$). A similar result was found in the study of Misra *et al.*[42]: adolescents with AN had lower mean energetic intake ($P = 0{\cdot}03$) and lower percentage of energy intake from total fat ($P < 0{\cdot}0001$), saturated fat ($P = 0{\cdot}0001$), monounsaturated fat ($P < 0{\cdot}0001$) and polyunsaturated fat ($P = 0{\cdot}001$). Misra *et al.*[42] also identified, higher intake of the percentage of energy content from protein ($P < 0{\cdot}0001$) and carbohydrates ($P = 0{\cdot}0009$); however, no difference was observed in the intake of animal or plant proteins, after using Student's *t*-test. Santiago *et al.*[39] determined the frequency of macronutrient intake and suggested that adolescents with AN in the complete (AN-c) and atypical (AN-a) forms have higher intake of the mean percentage of energy distribution than individuals with bulimic nervosa (BN) and lower intake than those with avoidant restrictive food intake disorder. In addition, the mean daily energetic intake was below the values recommended for the study population. Higher carbohydrate intake was also identified in adolescents with AN-c, followed by participants with BN and atypical AN and lower intake than participants with avoidant restrictive food intake disorder. Regarding fat and protein intake, individuals with AN-a had a higher percentage intake of these macronutrients than the other participants, except for protein intake in individuals with BN. Furthermore, the distribution of the percentage intake of macronutrients was in accordance with the *Dietary Guidelines for Americans*, 2010[50] (Table 3).

Nasserbakht *et al.*[43] applied the ANCOVA method and found that among the AN subtypes, adolescents with restrictive AN (AN-r) ingested more energy content than girls with bulimic AN (AN-b) ($P < 0{\cdot}0212$). However, both NA subtypes had higher energy intake ($P < 0{\cdot}0001$) than controls and BN. A similar result was identified in the study by Weltzin *et al.*[44], who observed that individuals with AN-r with short-term stable weight had higher average energy intake ($P = 0{\cdot}000$) per day when compared with short- and long-term AN-b and BN after applying linear regression And hierarchical analysis. Furthermore, after restoring weight, it was observed that r-AN individuals required greater energy intake per day for weight maintenance than those with AN-b.

When assessing fibre intake, two studies found higher intake in people with AN than in peers without this syndrome[40,42]. Misra *et al.*[42] identified that the intake of soluble and insoluble fibres was higher 24·0 and 49·6 %, respectively, in the AN group than in healthy adolescents.

Micronutrients. Allen *et al.*[32] identified a lower mean Na intake ($P < 0{\cdot}05$) among people with AN but not for the mean intake of the other micronutrients studied. After using the χ^2 test, they indicated that a higher percentage of participants with AN had less than two-thirds of the intake recommended by *Australian* RDI for Zn ($P < 0{\cdot}001$), thiamine ($P < 0{\cdot}001$), vitamin B_6 ($P = 0{\cdot}012$) and phosphate ($P = 0{\cdot}008$). Higgins *et al.*[41] observed lower average intakes of vitamins A and D, linoleic acid, pantothenic acid and retinol 1 week before hospitalisation among participants with AN. Over the course of 6 months, there was a reduction in the mean intake of Cu ($P = 0{\cdot}0117$), Zn ($P = 0{\cdot}0031$), Fe ($P = 0{\cdot}0156$) and most of the B vitamins intake of these nutrients remained within the limits recommended by the DRI. Additionally, the total intake of Ca and P remained unchanged throughout the study, with values below those recommended by the DRI (Table 3).

The results of two cross-sectional studies differed when evaluating the intake of vitamin C and Zn[35,42]. Kanayama *et al.*[35] reported lower mean vitamin C intake ($P < 0{\cdot}01$) and Zn ($P < 0{\cdot}01$), while Misra *et al.*[42] described higher mean vitamin C intake ($P \leq 0{\cdot}05$) among AN individuals, but there was no difference in Zn intake among the participants. Furthermore, Misra *et al.*[42] identified a higher mean intake of vitamins A ($P \leq 0{\cdot}01$), K ($P \leq 0{\cdot}05$) and B complex (except niacin). However, there was no difference in the intake of other vitamins and minerals evaluated by the study. In addition, the use of supplements favoured a greater intake of vitamins A and D and most of the B complex, Ca, Zn and Fe in the group with AN and a higher percentage of girls with NA met the recommendations of the DRI regarding the intake of vitamins A and D, pantothenic acid and folate and Ca (Table 3).

Santiago *et al.*[39] identified higher percentage intake of vitamin A and Mn in individuals with AN in complete form followed by participants with avoidant restrictive food intake disorder, atypical AN and BN, as well as lower intake of vitamin E, D, Se and K among individuals with AN-a. When comparing the daily values recommended by the 2010 Dietary Guidelines, higher intake of vitamins A and C and Mn and Se and lower intake of vitamins E, D and B_{12} were observed, as well as for Zn, Cu, Fe, K and Mg the participants.

Food groups and a priori dietary pattern. Kanayama *et al.*[35] reported a higher intake of vegetables ($P < 0{\cdot}01$) and lower consumption of confectionery foods ($P < 0{\cdot}05$) among adolescents with AN. In addition, thin girls without a diagnosis of AN but with a high desire for thinness usually restricted the intake of carbohydrate sources (e.g. cereals) but maintained the intake of high fat.

A study by Santiago *et al.*[39] reported that individuals with AN (full and partial AN) had the highest mean HEI-2010 score: 62·9, that is, it needs improvement when compared with participants with BN and avoidant restrictive food intake disorder after applying the Kruskal–Wallis test. However, the mean score of the HEI-2010 was below the value that indicates good diet quality in all groups.

Table 4. General results of articles that studied the relationship between restrictive eating behaviour and food intake in children and adolescents

Author/ year	REB assessment	Food consumption instrument	Statistical analysis (adjustment/confounders)	Main results
Aparicio *et al.*, 2014[25]	Eating Attitudes Test-40 (EAT-40)	24-h recall – 3 d	Test χ^2 Student's *t*-tests by Fisher ANOVA adjusted by Bonferroni Correction Multiple linear regression models Mean of the probability of intake inadequacy for all micronutrients and energy (Emotional symptoms Physical activity Socio-demographic status Puberty Body satisfaction BMI)	Among girls with REB media energy intake (1833·3 g *v.* 9644·5 g; $P<0·05$), protein 74·8 g *v.* 88·8 g; $P<0·05$), carbohydrate (198·0 g *v.* 249·6 ; $P<0·05$), fat (82·2 g *v.* 105·5 g; $P<0·05$) nutrients was significantly lower when compared with controls, except for vitamin D intake (1·5 mg *v.* 1·5 mg) As REB has become more severe female adolescents have lower consumption of energy, macronutrients and micronutrients: Ca (721·2 mg *v.* 847·4 mg; $P<0·05$), Fe (7·6 *v.* 9·1), Mg (234 mg *v.* 274·7 mg; $P<0·05$), K (2342·3 mg *v.* 2736·2 mg; $P<0·05$), P (1026·6 mg *v.* 1167·4 mg; $P<0·05$), Na (2487·1 mg *v.* 3049·5 mg; $P<0·05$), thiamine (0·5 mg *v.* 1·5 mg; $P<0·05$, vitamins E (10·9 mg *v.* 13·2 mg; $P<0·05$), C (61·5 mg *v.* 80·2 mg; $P<0·05$), B_6 (1·4 mg *v.* 1·7 mg; $P<0·05$), B_{12} (3·7 mg *v.* 3·9 mg; $P<0·05$), pantothenic acid (3·9 mg *v.* 4;6; $P<0·05$), folic acid (205·7 mg *v.* 253·2 mg; $P<0·05$) In contrast, for boys, significant differences were observed between the controls and the group only in the REB for PUFA (14·8 g *v.* 20·9g; $P<0·05$); Fe (9. 9 mg *v.* 12·0 mg; $P<0·05$),vitamin E (12·6 mg *v.* 17·1 mg; $P<0·05$) and vitamin C (105·7 mg *v.* 72·5 mg; $P<0·05$) Inadequate energy and nutrient intake Adolescent girls with REB had a higher prevalence of adequacy of energy intake than 2/3 of the recommended amount that 57·8 % of girls with REB had more than 50 % risk of inadequate micronutrient intake. For Ca, Fe, Mg, P, vitamins D and B_6, 60 % of girls with REB had inadequate intake
Bischoff-Seals, 2007[24]	Modified three-factor eating questionnaire	24-h recall	–	The average Ca intake for women and men was, respectively, 1121 and 1632 mg/d, which met Ca recommendations
Bisset *et al.*, 2007[28]	Dutch Eating Behaviour Questionnaire (DEBQ)	24-h recall and FFQ Food group: fruits, cooked vegetables and greens, green salad; low-quality snacks (donuts, cakes or pastries, chips, sweets, chocolate bars and fast food (fries or poutine, sauce and cheese curds, hamburgers, hot dogs, fried chicken))	Hierarchical linear modelling Sex and place of residence/ (Physical activity; Local (suburban, rural); Smoking, food restriction, overweight and obesity)/ (Smoking and physical activity)	Fruit and vegetable consumption decreased over the 5-year period ($P<0·025$) and was not associated with REB. Fruit and vegetable: Lower than average dietary restraint: −0·79 (0·46); $t=-1·67$; Higher than average dietary restraint: −0·60 (0·46); $t=1·22$ Linear change: Lower than average dietary restraint: −0·09 (0·12); $t=-0·77$; Higher than average dietary restraint: 0·03 (0·11); $t=0·24$ At baseline, high dietary restriction was associated with lower consumption of low-quality snacks than common limiters ($P=0·02$) Students with low dietary restriction reported lower fast food consumption than those with average dietary restriction at baseline ($P=0·001$). Dietary restriction was associated with frequency of low-quality snacks at baseline and over time. Adolescents who reported lower dietary restriction had higher consumption of low-quality snacks over time than those with medium or high levels of dietary restriction ($P=0·001$) Fast food consumption decreased over time, except for individuals who reported low dietary restriction ($P=0·019$)
Caran *et al.*, 2018[38]	Eating Attitudes Test-26 (EAT-26)	3-d food record	Pearson χ^2 test Linear regression modelling	There was no statistically significant difference in energy consumption (1910·02 kcal (155·6) *v.* 2027·61 kcal (57·7); $P=0·53$), carbohydrate (72·34 % (6·4) *v.* 63·26 (1·3); $P=0·21$), protein (16·58 % (1·5) *v.* 14·54 (0·4); $P=0·26$), fat (33·17 % (3·0) *v.* 29·70 (0·7); $P=0·32$) among girls with REB when micronutrients: Ca (mg/d) (547·62 *v.* 515·08 ; $P=0·26$); folate (μg/d) (199·30 *v.* 192·12; $P=0·42$); Zn (mg/d) (8·41 *v.* 8·22; $P=0·53$); vitamin A (μg/d) (555·10 *v.* 522·20; $P=0·48$); vitamin B_{12} (μg/d) (5·33 *v.* 4·14;

Table 4. (*Continued*)

Author/ year	REB assessment	Food consumption instrument	Statistical analysis (adjustment/confounders)	Main results
				$P = 0{\cdot}17$); Fe (mg/d) (10·31 *v.* 10·66; $P = 0{\cdot}36$; vitamin C intake (mg/d) (70·87 (4·1) *v.* 63·12 (2·3); $P = 0{\cdot}05$) was higher in girls with REB. Prevalence (%) of inadequate intake (girls): a prevalence of inadequate Ca intake (100%), folate (98·2%), Zn (46·5%), vitamin C (22·6 %), vitamin A RE (49·6 %, vitamin B_{12} (4 %), Fe (32·2%), Fe (32·2%), being only significant for vitamin C; $P = 0{\cdot}003$.
Chang *et al.*, 2011[30]	Eating Attitudes Test-26 (EAT-26)	24-h recall modified slightly to fit the food culture in Taiwan	Student's *t*-test	Participants with REB have lower intake of: energy (kcal/d) (1596·41 *v.* 1677·58; $P < 0{\cdot}01$); protein (g/d) (55·98; *v.* 60·08; $P < 0{\cdot}01$); carbohydrate (g/d) (217·71 *v.* 227·41; $P < 0{\cdot}05$); Zn (mg) (6·58 *v.* 6·99; $P < 0{\cdot}05$), vitamin B_6 (mg) (0·85 *v.* 0·92; $P < 0{\cdot}05$); vitamin B_{12} (μg) (3·04 *v.* 3·63; $P < 0{\cdot}05$); higher fibre consumption (g/d) (3·40 *v.* 3·0; $P < 0{\cdot}01$) feed when compared with REB participants There was no significant difference in fat intake (g/d) (56·46 *v.* 59·08) There was no significant difference in other vitamin and mineral doses between the EAT+ and EAT-
				Micronutrients: Ca (mg) (370·02 *v.* 351·95); Mg (mg) (165·65 *v.* 172·31); P (mg) (764·89 *v.* 788·64); Fe (mg) (8·47 *v.* 8·76); vitamin A (μg) RE) (1205·98 *v.* 1127·7); vitamin E (α-TE) (4·81 *v.* 5·08); vitamin B_1 (mg) (0·88 *v.* 0·91); vitamin B_2 (mg) (0·90 *v.* 0·94); niacin (mg NE) (12·67 *v.* 13·21)
Dunker and Philippi, 2003[49]	Eating Attitudes Test-26 (EAT-26)	24-h recall – 3 d	Distribution of food consumption	Food groups: cereals, breads, tubers and roots; vegetables; fruits; milk and dairy products; legumes; meat and eggs; oil and fat; sugar and candies Adolescents with EAT+ have a higher percentage of lettuce intake (42·8 % *v.* 26·7 %); tomato 41 % *v.* 22·2); beans (30·1 % *v.* 24·4 %); steak (23·5 % *v.* 18·5 %); chicken fillet (19·9 % *v.* 14·1 %); carrot (13·9 %); apple (13·3 %); papaya (12 %); mint drops bullet (12 %); mozzarella cheese (11·4 %); butter (11·4 %)
				Adolescents with EAT+ have a lower percentage of white rice intake (60·2 % *v.* 61·7), french bread (31·3 *v.* 36 %), type b milk (39·8 % *v.* 51·6 %); skimmed milk (28·9 % *v.*-); chocolate powder (23·5 % *v.* 32·6 %); curd (15·1 % *v.* 16·1 %); orange juice (15·1 % *v.* 17·8 %); bread (14·5 % *v.* 18 %); french fries (0 *v.* 17·1 %); pasta sugo (0 *v.* 12·1 %); sugar (0 *v.* 24·2 %); Coca Cola (0 *v.* 21 %); guarana (0 *v.* 14·3 %); chocolate bar (0 *v.* 13·8 %)
Dunker and Philippi, 2005[48]	Eating Attitudes Test-26 (EAT-26)	24-h recall	Student's *t*-tests χ^2 test	The EAT+ group had lower energy consumption (kcal) (1482·0 *v.* 1776·5 $P = 0{\cdot}00$), Fe (mg) (8·3 *v.* 9·5; $P = 0{\cdot}02$), Ca (mg) (538 *v.* 582·9; $P = 0{\cdot}25$) and higher protein intake (%) (16·4 *v.* 15·3; $P = 0{\cdot}02$) compared with EAT- Both groups have adequate carbohydrate intake (%) (46·7 *v.* 47·8; $P = 0{\cdot}25$), but closer to the recommended lower borderline (45–65 %), higher total fat intake (36·8 ± 6·6 *v.* 36·9 ± 5·7; $P = 0{\cdot}90$), but not significant differences were found. Lower Ca intake among participants REB (538 *v.* 582·9; $P = 0{\cdot}25$), but without statistically significant difference
Elfhag *et al.*, 2008[34]	Dutch Eating Behaviour Questionnaire	FFQ	Multivariate linear regression models (age and schooling of parents)	REB correlation and food intake Fruits: girls/boys(0·03/-0·03); Vegetables: girls/boys(0·07/-0·04) Sweets: girls/boys (−0·09; $P < 0.$ 05/−0. 21; $P < 0$ 001); Soft drinks: girls/boys (−0·02/−0·12; $P < 0{\cdot}01$)
Guevara *et al.*, 2020[26]	Questionnaire on diet adhering to weight loss	Health Behaviour in School-Aged Children	χ^2 test, ANOVA/Bonferroni (sex and age)	They classified foods as basic (fruits, vegetables and meat, fish and fish) and unhealthy (snacks, soft drinks or sodas and confectionery). Adherence to a weight loss diet reveals significant differences, With those who do not follow a weight loss diet consuming more vegetables

Table 4. (*Continued*)

Author/ year	REB assessment	Food consumption instrument	Statistical analysis (adjustment/confounders)	Main results
				($P < 0·05$; 4·7 *v.* 4·4), confectionery ($P < 0·001$; 3·9 *v.* 3·3) and nuts ($P < 0·001$; 3·6 *v.* 3·1)
Koch *et al.*, 2018[36]	Dutch Eating Behaviour Questionnaire for children (DEBQ-K)	3-d weighed dietary records Morning dietary intake between late evening until 11 AM and nocturnal energy intake was defined as all intake between 6 PM and early evening.	Regression models (age, sex, BMI, age of growth speed, puberty, breast-feeding, maternal overweight, maternal education and maternal employment, number of days of the week of 3-d food registration) Model A: adjusted for age. Model B: adjustment like in model A plus BMI, maternal educational status, maternal employment. Model C: only food records with energy intake in the morning or evening on all 3 d of food registration	Higher total energy intake was found in tertile 1 of ER and the lowest in tertile 3 for girls (1809 kcal (1561 kcal; 1982 kcal; 1604 kcal (1388 kcal; 1998 kcal, respectively) and boys 2270 kcal (1985 kcal; 2653 kcal); 2059 kcal (1748 kcal, 2688 kcal, respectively) Inverse association between the REB score and the total energy intake ($P < 0·0001$) Among girls, higher dietary restriction was associated with higher morning energy intake ($P = 0·03$). In boys, no association was observed between REB and morning energy intake. After excluding all food records without energy intake in the morning on at least 1 d of food registration, the association between REB and morning energy intake remained not statistically significant, either for girls ($P = 0·17$) or for boys ($P = 0·15$). Trend to lower energy intake at night with higher levels of food restriction ($P = 0·06$). Increased dietary restriction during adolescence was related to nocturnal energy intake ($\beta = -0·3$, $P = 0·06$) Tendency to decrease the frequency of snacks with increased dietary After excluding all food records without energy intake at night on at least 1 d of food registration, an increase in the RE score of 10 units was associated with a decrease in energy intake at night by 3·6 % ($P = 0·04$) Lack of association between changes in food restriction and simultaneous changes in energy intake in the morning
Mulvihill *et al.*, 2002[37]	Dutch Eating Behaviour Questionnaire (DEBQ) Three Factor Eating Questionnaire (TFEQ)	Direct weighing through food record −7 d of food and beverages Snacks consumed outside the home recorded in daily	ANOVA χ^2 test	Food groups: drinks, cereals and cereal products, eggs and egg dishes; fats and oils; fruits; meat and meat products; milk and milk products; nuts and seeds; soups and sauces; sugars and preserves and greens and vegetables Energy intake was inversely related to food restriction ($P < 0·05$) Differences were identified significant intake of fat ($P < 0·005$), monounsaturated fat ($P < 0·005$), polyunsaturated fat ($P < 0·01$) and sugar ($P < 0·05$). Intake of protein: low dietary restraint 70·7 ± 4·17; medium dietary restraint: 59·3 ± 2·48; high dietary restraint: 65·9 ± 3·77 Intake of carbohydrate: low dietary restraint 284 ± 18·1; medium dietary restraint: 249 ± 7·93; high dietary restraint: 244 ± 11·3 Participants with higher restrictive eating behaviour had higher energy consumption from bread, cereal products, fruits ($F = 3·83$, $P < 0·05$) and milk and dairy products (mainly cheese) ($F = 5·96$, $P < 0·005$) Consumption of beverages ($F = 3·52$, $P < 0·05$), meat and sugar and preserved products (i.e. confectionery) ($F = 6·48$, $P < 0·005$) was inversely related to food restriction No corresponding relationship was found between dietary restriction and reduced micronutrient intake Adequate micronutrient intake was found throughout the sample in addition to reference nutrient intake (RNI), except Ca, Fe and Zn
Tsai *et al.*, 2011[31]	Eating Attitudes Test-26 (EAT-26)	24-h recall	Student' *t*-test	Energy intake (kcal) (1403 *v.* 1617 ; $P < 0·0001$), protein (g) (52·4 *v.* 59·6; $P < 0·001$), fat (g) (47·7 *v.* 55·0; $P < 0·001$), carbohydrate (g) (193 *v.* 222; $P < 0·0001$), cholesterol (242 *v.* 289; $P < 0·05$), Zn (6·54 *v.* 7·59; $P < 0·001$) and vitamins B_6 (mg) (0·78 *v.* 0·88 ; $P < 0·05$), B_{12} (μg) (1·99 *v.* 3·79; $P < 0·001$) was significantly lower in participants with REB

Table 4. (*Continued*)

Author/ year	REB assessment	Food consumption instrument	Statistical analysis (adjustment/confounders)	Main results
				Participants with REB have higher fibre intake (10·2 *v.* 9·08; $P < 0·001$). Ca (mg) (375 *v.* 344); Mg (mg) (154 *v.* 160); P (mg) (733 *v.* 773); Fe (mg) (7·01 *v.* 7·96); vitamin A, RE (1150 *v.* 1111); vitamin E α-TE (5·30 *v.* 5·35); vitamin B_1 (mg) (0·72 *v.* 0·81); vitamin B_2 (mg) (0·95 *v.* 0·98); niacin (mg) NE (10·9 *v.* 12·3)
Quiles-Marcos *et al.*, 2011[27]	Eating Attitudes Test-40 (EAT-40)	Inventory of Health Behaviour in Scholars	Student's *t*-test Levene test	Girls at high risk of developing eating disorder consumed less unhealthy food sausages or other cold and sweet meats ($t = -4·90$, $P < 0·001$) Girls at high risk of AN symptoms had a full breakfast with cereals ($t = -3·92$, $P < 0·001$) and dined less frequently, which consists of a sandwich or baguette. Boys at high risk of developing an eating disorder consumed more healthy foods ($t = 4·43$, $P < 0·001$) than those at low risk
Woodruff *et al.*, 2008[49] Food consumption restrictive eating behaviour	Restrictive eating behaviour Questions concern about weight and dieting	24-h recall Diet quality: modified version of the Health Eating Index (HEI)	χ^2 test Ordinal logistic regression	Group 1 (individuals who were not concerned about weight and were not dieting). Group 2 (adolescents who were not concerned about weight but were dieting). Group 3 (participants who were concerned about weight but were not dieting). Group 4 (adolescents who were concerned about weight and dieting) HEI-C score ≤ 50, classified as 'poor'; a score of 50–80, 'needs improvement' and a score > 80 indicates 'good' quality of the diet. Participants obtained an average HEI-C score 69.0 (13 2) (need to improve diet) Average diet quality: scores were 70, 69 and 66 among groups 1–4, respectively, with higher scores being observed in group 1 compared with group 4 ($P < 0$ 001). Group 4 was more likely to have a worse quality of diet (OR = 0 59 (95 % CI 0 43, 0 81), $P = 0$ 001) when compared with group 1
Daly *et al.*, 2020[33]	Dutch Eating Behaviour Questionnaire (DEBQ)	Direct weighing through the 7-d food diary	Spearman and Pearson correlations	Energy intake through fat was negatively correlated (–0·113; $P = 0·02$) with the restriction scale The energy intake from CHO was positively correlated (0·100; $P = 0·04$) with the restriction scale Energy intake (kJ) was negatively correlated (–0·343; $P < 0·001$) with the restriction scale Protein intake without statistically significant difference (–0·020; $P = 0·683$)
Grigolon *et al.*, 2019[45]	Child-Eating Disorders Examination (EDE-Ch)	FFQ	Generalised linear models (age, BMI)	Food groups: bread, cereals, rice and pasta; fruits; vegetables); milk, yogurt and cheese; meat, poultry, fish and eggs; bean; fats and oils and sweets Consumption of meat, poultry, fish and eggs was significantly correlated ($P = 0·001$) to participants with REB Lower consumption of bread, cereals, rice and pasta was also identified, but with no statistically significant association between REB individuals Correlation coefficients between restraint scale: bread, cereal, rice and pasta group (%): –0·0135 (0·0158); fruit group (%): 0·0338 (0·0222); vegetable group (%): 0·0548 (0·0416); milk, yogurt and cheese group (%): 0·0122 (0·0261); meat, poultry, fish and eggs group (%): 0·0857 (0·0254/ $P = 0·001$); dry beans group (%): 0·00337 (0·0164); fat and oil group (%):0·06 (0·0366) ; fibre (g): –<0·001547 (0·0224)

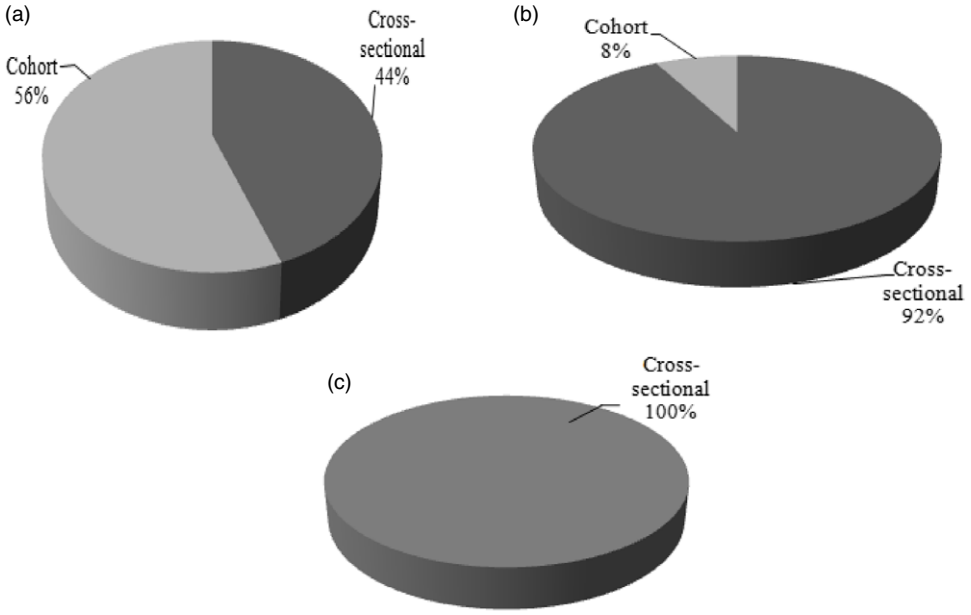

Fig. 4. Distribution by study design: (a) anorexia nervosa and food consumption; (b) restrictive eating behaviour and food consumption; (c) food consumption and restrictive eating behaviour.

Restrained eating behaviour and food intake

The relationship between REB and food consumption was investigated in thirteen studies[27,29–32,34–38,41,43,46,47,49], with twelve cross-sectional studies[27,29–32,34–38,41,43,46,47] and one cohort[36] (Fig. 4). The following statistical tests were identified to assess the relationship between dietary intake and REB: χ^2 test[27,34,35,43,49], Student's t[27,32,34,35,46,47], Levene's test[27], ANOVA[25,26,37], hierarchical linear modelling[28], linear regression[25,34,38], linear regression of mixed effects (fixed and random)[36] and multivariate logistic regression[31] (Table 4).

Energy content, macronutrients and fibres. When evaluating food intake, Aparicio *et al.*[25] identified a lower mean energy intake ($P < 0{\cdot}05$). After the linear regression analysis, a lower energy intake was associated with REB, especially in girls. Three studies[32,34,35,46] indicated lower mean energy intake among participants with REB; however, one study[38] did not observe a significant difference in the mean energy intake. In addition, Koch *et al.*[36] and Mulvihill *et al.*[37] suggested an inverse association between dietary restriction and energetic intake ($P < 0{\cdot}0001$; $P < 0{\cdot}05$, respectively). Koch *et al.*[36] also reported that among girls, greater dietary restriction was associated with higher morning energy intake ($P = 0{\cdot}03$). The study excluded food records that did not have all morning and evening intake data during the 3-d period, noting that there was no change in the association between food restriction and morning energy intake. However, reduced intake at night was found among individuals with high dietary restriction ($P = 0{\cdot}06$). Furthermore, over 4 years, the greatest dietary restriction was associated with lower nocturnal energy intake in both sexes and lower morning intake in girls. In addition, Aparicio *et al.*[25] reported that among girls, a higher prevalence of inadequate energy intake was observed, that is, below 2/3 of the recommended intake for both the DRI for the Spanish population and the Institute of Medicine (Table 4).

When evaluating macronutrients, the studies indicated lower mean carbohydrate intake[25,30,31], proteins[25,30,31] and fats[25,31] in individuals with REB. Furthermore, Aparicio *et al.*[25] found an association between lower carbohydrate, protein and fat intake and REB. Similar results were reported by Mulvihill *et al.*[37] who identified a lower mean intake of these macronutrients, with significance only for fat intake among participants with high restriction, when compared with individuals with medium and low dietary restriction. On the other hand, a study[34,35] reported a higher mean percentage of protein distribution in the REB group. Nevertheless, other studies did not observe differences in the mean carbohydrate intake[31,34,35], protein[38] and fat[31,32,34,35]. Dunker and Philippi[34,35] also reported that, among the participants, the carbohydrate intake was adequate (closer to the lower limit), while the fat intake was above the recommended percentage. Fibre intake was evaluated in two studies[30,31] that described higher mean intake among participants with REB compared with people without this condition (Table 4).

Micronutrients. Investigations involving micronutrient intake in adolescents with REB identified lower mean Fe intake[27,34,35], Zn[30,31], vitamins B_6 and B_{12}[25,30,31]. Aparicio *et al.*[25] suggested a lower intake of certain micronutrients (Ca, vitamins A, E, C, D, B_1, Na, K, hosphorus, pantothenic acid, folic acid) in both sexes and Mg only among girls[25]. The results of studies did not identify a significant difference in the mean intake of some micronutrients, namely vitamins A, B_1, B_2[30] and Ca[34,35]. Furthermore, Caran *et al.*[38] reported a higher mean intake of vitamin C, and Mulvihill *et al.*[37] did not find a reduction in the intake of the micronutrients studied among the food restriction groups; however, the intake of most vitamins and minerals (except for Ca, Fe

and Zn) was in accordance with that recommended by the reference nutrient intake (Table 4).

When assessing the prevalence of inadequate micronutrient intake (vitamins E, A and C, thiamine, riboflavin, niacin and folic acid), Aparicio *et al.*[25] reported that a higher percentage of girls with REB had more than 50 % risk of inadequate micronutrient intake. For Ca, Fe, Mg, hosphorus, vitamins D and B_6, 60 % of the girls with REB had inadequate intake. In continuity, Caran *et al.*[38] identified that the lowest percentage of participants with REB had inadequate intake of vitamins C and E (Table 4).

Food group and a priori *dietary pattern.* Bisset *et al.*[28] performed hierarchical linear modelling and identified that, at the baseline of the study, high dietary restriction was associated with lower consumption of snacks of low nutritional quality ($P < 0{\cdot}02$) than the group with moderate dietary restriction. After 5 years, having low food restriction was associated with a higher frequency of low-quality snacks ($P < 0{\cdot}001$). The consumption of fast food decreased over time, except for individuals who reported low dietary restriction ($P < 0{\cdot}019$). A reduction in the intake of fruits and vegetables at baseline and over time was also identified, but without association with dietary restriction ($P < 0{\cdot}025$).

Dunker and Philippi[34,35] reported that adolescents with symptoms of AN have higher intake of fruits, vegetables, skimmed milk and peppermint drops and lower intake of bread, rice, type B milk, curd, orange juice, sugar, soft drinks, chocolate, pasta and potato chips when compared with pairs. Elfhag *et al.*[34] described that restrictive behaviour was correlated with lower consumption of sweets (both sexes) and soft drinks (only in boys). Mulvihill *et al.*[37] reported that beverage consumption ($P < 0{\cdot}05$), sugars, meat and meat products and confectionery ($P < 0{\cdot}005$) were inversely related to REB. In addition, energy consumption from bread, cereal products, fruits ($P < 0{\cdot}05$) and milk and milk products ($P < 0{\cdot}005$) was directly related to REB. In addition, other researchers reported a lower intake of sausages, other sausages and sweets ($P < 0{\cdot}001$)[27] and higher consumption of legumes ($P < 0{\cdot}005$), nuts ($P < 0{\cdot}001$)[26] and confectionery ($P < 0{\cdot}001$)[26] in adolescents with REB. In a study[27], girls with a high risk of AN symptoms had a lower consumption of unhealthy foods ($P < 0{\cdot}001$) than those with a low risk; however, boys with a high risk of developing symptoms of AN had a higher consumption of healthy foods ($P < 0{\cdot}001$) than boys with a low risk (Table 4).

Woodruff *et al.*[29] applied the χ^2 test and observed that the mean HEI-C score in all groups was 69·0, that is, the quality of the diet of the participants *'needs improvement'*. Nevertheless, it was identified that adolescents who were concerned about weight and dieting (group 4) were more likely to have a lower HEI-C score ($P = 0{\cdot}001$) than participants who were not concerned with weight and were not dieting (group 1) after ordinal logistic regression analysis (Table 4).

Food consumption and feeding restriction behaviour

Only two studies had as an outcome the behaviour of food restriction and adopted a cross-sectional design[33,45] (Fig. 4).

Energy and macronutrients. Daly *et al.*[33] calculated Pearson's and Spearman's correlation and showed that the mean total energy intake and mean fat intake in energy content were negatively correlated with the REB (−0·343; $P < 0{\cdot}001$; −0·113; $P = 0{\cdot}02$, respectively), while the energy intake from carbohydrates was positively correlated (0·100; $P = 0{\cdot}04$) with the restriction behaviour. There was no significant difference in mean protein intake (−0·020; $P = 0{\cdot}683$) between groups.

Food group. Grigolon *et al.*[45] using generalised linear models reported that the consumption of meat, poultry, fish and eggs was significantly correlated ($P = 0{\cdot}001$) with the participants with the food restriction subscale. Lower consumption was also identified in the group of bread, cereals, rice and pasta and in the group of oils and fats, but there was no statistically significant association between individuals and the food restriction subscale (Table 4).

Discussion

This review identified twenty-four primary studies published from 1991 to 2020 that provided important information on the characteristics of food intake in children and adolescents with AN/REB. The results suggest a lower mean intake of energy content, macronutrients, especially, fat, and certain micronutrients (Na, K, Cu, Zn, Fe, Se, B complex, vitamins D and E) and a higher prevalence of inadequate energy intake and micronutrients. Additionally, the consumption of *snacks, fast food*, sweets, beverages, meat and meat-based products, carbohydrate and fat source foods and higher intake of caffeine, fibre, fruits, vegetables, legumes and nuts was identified. In addition, the intake of meat, poultry, fish and eggs groups was related to the participants with REB. When evaluating the dietary pattern by the HEC, the study participants had a 'need to improve' their diet.

There is consistent evidence that energy restriction is considered an essential factor related to AN/REB[1,11], mainly due to insufficient consumption of carbohydrates and fats[51–53] and by the preference of intake of foods considered to have low energetic value, for example, fruits, vegetables and legumes, which have more fibre. It is also considered a common practice in individuals with AN/REB and higher caffeine intake due to the appetite inhibiting effect and for promoting weight reduction[54]. In addition, the lower micronutrient intake and higher prevalence of nutrient inadequacy among adolescents identified in the studies may influence the development and satisfactory growth inherent to this phase, causing damage to health over time, which requires the adoption of specific nutritional intervention measures[12]. Another important point is the need to improve the quality of the diet found in two studies. It is noteworthy that the study participants did not have sufficient energetic intake for adequate application of HEI. However, it favours the reflection of the risk gradient for the development of chronic diseases related to food among adolescents with AN/REB, which can be continued into adulthood[55].

Researchers suggest that biological, psychological and sociocultural factors may influence the food intake of individuals with AN/REB[56–58]. In biological lines, studies show that nutrient

deficiency for a prolonged period of time increases opioid activity in the brain, triggering feelings of pleasure that allow adherence to a restrictive diet[59–61]. Another hypothesis explored is the participation of brain-derived neurotrophic factor. Researchers note that individuals with AN have lower brain-derived neurotrophic factor plasma concentrations than individuals without AN[62,63]. Brain-derived neurotrophic factor regulates a series of physiological processes, including food intake and decreased serum concentration of this neuropeptide, favouring the restriction of food intake[56]. Furthermore, it has been reported that an increase in the level of the 5-hydroxytryptamine or serotonin receptor (5-HT2A) is associated with decreased energy metabolism, resulting in lower food intake, especially in the restrictive subtype[64]. Continuously, individuals with AN have low plasma levels of leptin related to low weight, and this hormone may be causing an erroneous signal of satiety to the brain, even when the body weight is not yet fully restored[65], promoting reduced food intake and increased energy expenditure[10,66], suggesting the participation of leptin in AN maintenance.

Among the psychological factors, studies suggest that individuals with AN/REB have dysfunctional beliefs and attitudes about food or nutrients, favouring energy restriction, mainly by reducing the consumption of foods with high fat content and inadequate intake of certain micronutrients. These dysfunctional beliefs and attitudes can become habitual behaviour driven by neural mechanisms related to the formation of habits that favour the maintenance of food restriction[57,67,68]. In addition, individuals with AN have greater pre-meal anxiety and reduced pleasure related to eating when compared with controls, especially when the meal has a higher energetic value[57].

Additionally, the pressures and social stigmas for an ideal body may favour adolescents to be confronted with such images and experience dissatisfaction with body image and exaggerated concern with weight. This involves both the fear of gaining weight and frustration with the body, as well as disappointment for not achieving the ideal of beauty to which they do not belong[58,69–71], adopting disordered eating behaviours involving inadequate methods for weight control, such as restrictive diet and exclusion of foods with high energetic density[5,72].

This review also identified different types of food survey instruments (food records, R-24 h, FFQ, food diaries, self-administered diet history questionnaires, direct weighing and specific questions about food consumption) to assess dietary intake. The choice of the food survey instrument to assess food consumption depends on the objective of the study. The use of R-24 h, daily or food record instruments is recommended to quantitatively investigate nutrient intake because they provide details regarding the types and amount of food consumed. The FFQ estimates the usual diet and can be used to investigate dietary patterns, food intake or specific nutrients and is widely used in epidemiological studies to verify the diet–disease relationship. Dietary history is suggested to obtain data on current and past eating habits. It should be added that the methods of investigation of food consumption have limitations that involve the time and memory of the interviewee, interference of sex, age, environment, passing through the educational level, cognitive skills and behavioural change of the interviewee (the individual knows that he/she is being evaluated) until the interviewer's ability to establish good communication and avoid inducing responses. The main measurement errors of the food surveys reduce the accuracy of the results, which can lead to under- or overestimation of intake [18]. However, these errors can be minimised with the adoption of more than one R-24 h or food record to allow obtaining information on the daily variability in intraindividual food intake[73].

In addition, most studies did not perform analysis of dietary data by adjusting intrapersonal variability or by energy. These approaches are important to reduce the total variance of distribution, which can influence the number of people with inadequate intake and the removal of intrapersonal variability, favouring that the results of the studies report only interpersonal variability[74]. Only two studies[25,38] estimated the prevalence of nutrient inadequacy, and this analysis is important to provide information on the proportion of individuals who have intake above or below a certain recommendation, which is essential for monitoring or interventions of health actions[74].

Only two studies evaluated the dietary pattern *a priori*[29,39] from more robust statistical methods that take into account the interrelationships (correlations) between foods. Evaluating dietary patterns, rather than their individual components (such as macro- and micronutrients), has become increasingly important in epidemiological studies to identify the relationship between diet and diseases, especially due to the complex interaction and correlation between nutrients and other nutrients, Food components[75,76]. The assessment of dietary pattern is more comprehensive than the assessment of nutrients or isolated foods.

In addition, many studies used only bivariate statistical methods between exposure and outcome to identify the relationship between food consumption and AN/REB, and Student's *t*-test and χ^2 test were used squares most frequently. The ANOVA test was also applied, which allows identifying if there is a difference and where is the difference between the groups but does not quantify it and is therefore considered an initial step in the analysis of factors that affect a given dataset[77] and should be followed by regression models. In addition, of the longitudinal studies identified in this review (n 5), only two[36,47] used appropriate statistical models that take into account temporal variation and inter- and intra-individual variability, such as generalised estimation equation and mixed-effects modelling.

This review has some limitations. First, the quality of the studies was not evaluated, although it was not considered a mandatory step in a scope review. Second, most of the studies included in this review have a cross-sectional design and do not suggest causality. Third, it refers to the instruments for evaluating food consumption that have diversified among the publications, which could explain, at least partially, the divergence between the results. Finally, the various statistical techniques to evaluate the associations between food consumption and AN/REB may have affected the quality of the results identified by the different authors, as well as their interpretations of this binomial.

Strengths were identified in this review. To our knowledge, this is the first review to assess food intake in children and adolescents with AN/REB. A review methodology was used according to Preferred Reporting Items for Systematic Review and Meta-

Analysis Extension for Scoping Reviews, and the protocol was registered to obtain greater scientific rigor. In addition, large databases were used, including grey literature and a list of references of the selected studies, which allowed for greater selection of studies according to the objective of this review. Additionally, a wide diversity of studies was identified in different populations that included European, Asian, American and Australian countries.

Conclusion

In conclusion, most studies identified that adolescents with AN/REB have a lower intake of energy content, fat and certain micronutrients and a higher prevalence of inadequate energy intake and micronutrients. A lower intake of foods or a group of foods with a high content of carbohydrates and fats, sweets, low-quality *snacks, fast food* and *a* higher intake of caffeine, fruits, legumes, nuts and fibre was also found. The 'need for improvement' of the diet was observed according to quality assessment indices. The correlation between food intake and REB was recorded for meat, poultry, fish and egg intake. Thus, it is important to consider the general set of scientific evidence to make dietary recommendations for individuals, since food consumption is influenced by several biopsychosocial factors and is reflected in health over time. The identification of restrictive dietary characteristics is expected to be recognised early and to assist in the prevention of diseases, thus promoting higher life expectancy of future adults. It is noteworthy that healthy eating not only contributes to an adequate body weight but also brings psychosocial benefits by favouring the consumption of different foods from different cultures, origins and various food preparations[78].

Thus, the future development of a systematic review on the subject will be beneficial for the increase of knowledge in this field of research to enable understanding, counselling and deeper nutritional treatment of the AN/REB relationship and food consumption.

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