Review Article

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Diet and special educational needs (SENs) among children and adolescents: a systematic review

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Abstract Special educational needs (SENs) refer to children and adolescents needing additional educational support. Diet during pregnancy and pediatric age can influence the prevalence/severity of symptoms in SEN-related conditions/disabilities. This review aims to summarize associations between (i) pregnant women's diet and the prevalence of SEN-related conditions/disabilities among children/adolescents and (ii) the diet of children/adolescents with SEN-related conditions/disabilities and their symptomatology/well-being. A literature search was performed on Medline and Scopus, according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The following inclusion criteria were considered, for each aim: (i) children/adolescents aged 19 years and younger, pregnant women's diet/nutrition, and diagnosis of SEN-related conditions/disabilities in children/adolescents; (ii) children/adolescents aged 19 years and younger, children/adolescents' diet/nutrition, and symptomatology/well-being of children/adolescents with SEN-related conditions/disabilities. 87 articles were included, referring to 10 different SEN-related conditions/disabilities, from which attention-deficit/hyperactivity disorder (ADHD) (41 articles) and autism spectrum disorder (ASD) (34 articles) stand out. Noteworthy results were seen regarding maternal caffeine consumption; pregnant woman multivitamin supplementation, high-sugar foods, and beverage intake during childhood/adolescence; maternal breastfeeding; and vitamin D supplementation. Despite the notable associations, further research using more standardized and homogeneous methodologies is needed to strengthen these findings. PROSPERO registration number: CRD42022313235.

Key words: special educational needs, systematic review, diet, pediatric age, pregnancy, children, adolescents

Introduction

Special educational need (SEN) is a legal term used in many countries around the world, referring to children and adolescents with some type of disability that makes them need additional support throughout their education.[1] The definition of SEN is widely variable between countries, reflecting the complexity and diversity of disabilities covered by this concept, which includes mental or physical disabilities and cognitive or educational impairments.[1,2] For example, in the Individuals with Disabilities Education Act (IDEA), from the US Department of Education, 14 disability categories are covered: (1) autism, (2) deaf blindness, (3) deafness, (4) emotional disturbance, (5) hearing impairment, (6) intellectual disability, (7) multiple disabilities, (8) orthopaedic impairment, (9) other health impairments, (10) specific learning disability, (11) speech or language impairment, (12) traumatic brain injury, (13) visual impairment, and (14) developmental delay.[3] The Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-V) is a commonly used tool to diagnose SEN-related conditions or disabilities, as the mental disorders included in this manual fit into the SEN categories of most of the countries.[4]

In the past few years, an upward trend in the prevalence of SENs among children and adolescents has been observed.[5] The risk of SEN-related conditions or disabilities can be influenced by pregnant women's dietary habits. For example, a higher maternal dietary quality index score has been associated with a 13% decrease in the risk of attention-deficit/hyperactivity disorder (ADHD) in children.[6] In addition, the intake of folic acid and multivitamin supplements during pregnancy has been associated with a lower risk of autism spectrum disorders (ASDs) in children.[7] In addition, even after a confirmed diagnosis, there is evidence showing that dietary habits of children and adolescents have an impact on symptoms' manifestation. For instance, higher intake of sweet desserts, fried food, fast food, and sugar-sweetened beverages has been related to more severe ADHD symptoms.[8-10]

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The influence of diet on children and adolescents (19 years and younger)[11] with SEN-related conditions or disabilities has been an increasingly studied issue in recent decades.[12] However, to our best knowledge, there is still no systematic review that summarizes this information, considering, at the same time, the data available in the literature regarding dietary habits of pregnant women and children/adolescents related to the diagnosis and symptomatology of SEN-related conditions or disabilities, respectively. However, such systematization is crucial to the establishment of dietary guidelines that can not only help to reduce the incidence of these conditions or disabilities but also help to control the symptoms associated when a diagnosis is already established, aiming for a better life quality during pediatric age.

Objectives

The main goal of this review was to study the influence of diet on diagnosis, symptomatology, and well-being of children and adolescents with SEN-related conditions or disabilities. The specific objectives were as follows:

(i) To study the associations between pregnant women's diet and the diagnosis of SEN-related conditions or disabilities among children and adolescents

(ii) To study the associations between the diet of children and adolescents with SEN-related conditions or disabilities and their symptomatology and well-being

These objectives were transformed in a population, indicator, comparator, outcomes, and study (PICOS) design, as presented in Table 1.

Methods

Study design

This systematic review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[13] and its respective guidelines.[14] It was also registered prospectively in the International Prospective Register of Systematic Reviews (PROSPERO, registration number: CRD42022313235; Available at: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42022313235).

Search strategy

The search strategy was made and used from March to June of 2022, in 2 databases: *Medline* (*PubMed*) and *Scopus*. The search strategy was built by 1 reviewer while the rest of the team confirmed the process. For PubMed, the following search strategy was built: ("food consumption" OR diet* OR (eating[MeSH Terms]) OR ingestion OR food* OR (feeding behavior[MeSH Terms]) OR (meal[MeSH Terms])) AND ((child[MeSH Terms]) OR (adolescent[MeSH Terms])) AND ((child[MeSH Terms]) OR (adolescent[MeSH Terms]) OR pregnan* OR gestational*) AND ("mental well-being" OR "mental health" OR "well-being" OR (quality of life[MeSH Terms]) OR symptom* OR (neurobehavioral manifestations[MeSH Terms]) OR "neurologic dysfunction" OR depression OR anxiety OR stress OR agressive OR emotion*) AND ((dyslexia[MeSH Terms]) OR (Attention Deficit Disorders with Hyperactivity[MeSH Terms]) OR (autism spectrum disorder[MeSH Terms]) OR (Autistic disorder[MeSH Terms]) OR (dyscalculia[MeSH Terms]) OR dyspraxia OR

Table 1

Eligibility criteria of the studies included in this review according to the population, indicator, comparator, outcomes, and study (PICOS) design format.

PICOS format	Inclusion criteria	Exclusion criteria
Population*	i) and ii) Children and/or adolescents aged 19 years and younger	i) and ii) Previous diagnosis needing special dietary requirement
Indicator*	i) Pregnant women's diet or nutrition (considering every form of dietary exposure, including nutrition supplementation, evaluation of dietary patterns, or food group consumption) ii) Children and/or adolescents' diet or nutrition (considering every form of dietary exposure, starting from breastfeeding duration, nutrition supplementation, dietary pattern evaluation, or food group consumption evaluation)	i) and ii) Previous diagnosis needing special dietary requirement i) and ii) Diet not related to a special educational need at pediatric age
Comparator	i) Pregnant women not consuming/exposed to the food groups or nutrition supplementation in study ii) Children and adolescents without SEN or children and adolescents with SEN but not consuming/exposed to the food groups or nutrition supplementation in study	Not applicable
Outcomes*	i) Diagnosis of special educational needs in children and/or adolescents ii) Symptomatology and/or well-being of children and/or adolescents with special educational needs	i) A diagnosis of special educational needs in children and/or adolescents presented in the article but the relation with pregnant women's diet and/or nutrition not studied ii) Symptomatology or well-being of children and/or adolescents with special educational needs presented in the article but the relation with children and adolescents' diet not studied
Study design	Original studies	Reviews, only abstracts, case studies of 1 individual, books, paper conferences

* Indicators and outcomes are different for each objective (i and ii, respectively).

dysphasia OR dysgraphia OR dyslalia OR "special educational needs" OR "special education" OR "TIC disorder" OR "Tourette" OR "trisomy 21" OR "down syndrome" OR "trisomy of the autosomes" OR "cerebral palsy" OR (neurodevelopmental disorders[MeSH Terms]) OR (intellectual disability[MeSH Terms]) OR "high intellectual potential" OR "learning disabilities" OR "learning disability" OR "communication disorder" OR (motor disorders[MeSH Terms])). Regarding the *Scopus* database, a similar search strategy was used. Keywords related to SEN-related conditions or disabilities and SENs were chosen based on terms related to neurodevelopmental disorders found in DSM-V and considering the SEN categories in the IDEA program, regarding the distribution of the prevalence of students who received special educational services under this program.[3-5]

Eligibility criteria

The eligibility criteria considered for the study selection were selected based on PICOS design and are provided in Table 1. For both databases, filters such as language (English and Portuguese) and age (19 years and younger) were used. In addition, for *Medline* (*Pubmed*), only studies in humans and studies with abstract available were considered.

Study selection and data extraction

First, 2 reviewers applied the eligibility criteria and selected the studies for inclusion, by reading the titles and respective abstracts independently of one another. Second, the same 2 reviewers analyzed the full-text studies to decide which ones met the inclusion criteria to enter this systematic review, independently of one another. In case of doubt, when reading both the abstracts and the full texts, a third reviewer assisted the decision, based on the support of evidence present in the literature. The number of studies excluded and respective reasons are reported in the PRISMA fluxogram presented in Figure 1.

No contact with the study authors was needed, once all the required data to answer the objectives had already been published.

There was no minimum number of studies considered to include in this review. A study was included if it could answer, at least, 1 of the 2 specific objectives. The eligible studies are summarized in Table 2, according to the name of the SEN-related condition or disability studied. This table consists of the following information: type of study, country, children/adolescents' sample size, age and sex, method of diagnosis and/or symptomatology, diet element studied, prevalence of SEN-related condition or disability, risk of diagnosis, and/or symptomatology/well-being.

Duplicate articles were identified and eliminated using *Endnote*.[15] Starting from screening of 4062 abstracts, this review included 220 studies for eligibility and, of these, 87 were included in the qualitative synthesis (Figure 1).

Quality assessment

The quality of cohort and case-control studies was evaluated with the Newcastle–Ottawa Quality Assessment Scale (NOS), with a range of an overall quality score from 0 to 9 stars.[16] To assess the quality of cross-sectional studies, an adapted version of the NOS (ranging from 0 to 8 stars) was used.[17] In addition, for the assessment of quality and bias of experimental studies, the Cochrane tool for assessing risk of bias in randomized trials (RoB 2) was applied.[18]

Results

Regarding the 87 articles included, 13 were cohort studies, 54 experimental studies (40 randomized controlled trials (RCTs), 6 clinical trials, and 8 open trials), 8 case-control studies, and 12 cross-sectional studies. This review included, in total, 544,682 children and adolescents, from birth to 18.7 years. Of these, 19,541 (3.6%) had a confirmed SEN-related condition or disability. 85 studies included children, and 51 included adolescents. 46 studies were published between 2015 and 2022, and 41 were published between 1975 and 2014. Considering the geographical distribution, 32 studies were conducted in Europe, 23 studies in America (18 being in the United States), 24 studies in Asia, 7 studies in Oceania, and 1 study in Africa.

Regarding quality assessment, for cross-sectional studies, the mean ± SD quality score was 4.92 ± 0.90 (min: 4; max: 7); for case-control studies, the mean ± SD quality score was 5.38 ± 1.41 (min: 3; max: 7); and for the cohort studies, it was 6.46 ± 1.20 (min: 4; max: 8). Regarding experimental studies, 3 studies presented a low risk of bias, 1 study presented some concerns, and 50 articles presented a high risk of bias.

Regarding SEN-related conditions or disabilities, 41 articles studied ADHD, where the ADHD diagnosis proportion ranged from 2.2%[19] to 100%,[20-40] and 34 studied ASD, where the ASD diagnosis proportion ranged from 1.3%[7] to 100%.[41-64] The remaining SEN-related conditions or disabilities included in this review were learning disabilities,[10,65-69] dyslexia,[70,71] epilepsy,[72,73] Tourette syndrome (TS),[74] autosomal trisomy,[75] pediatric bipolar disorder (PBD),[76] intellectual disability,[77] and Smith–Lemli–Opitz syndrome.[78]

Concerning the study methods, the most frequently used measurement tools to assess ADHD diagnosis were the

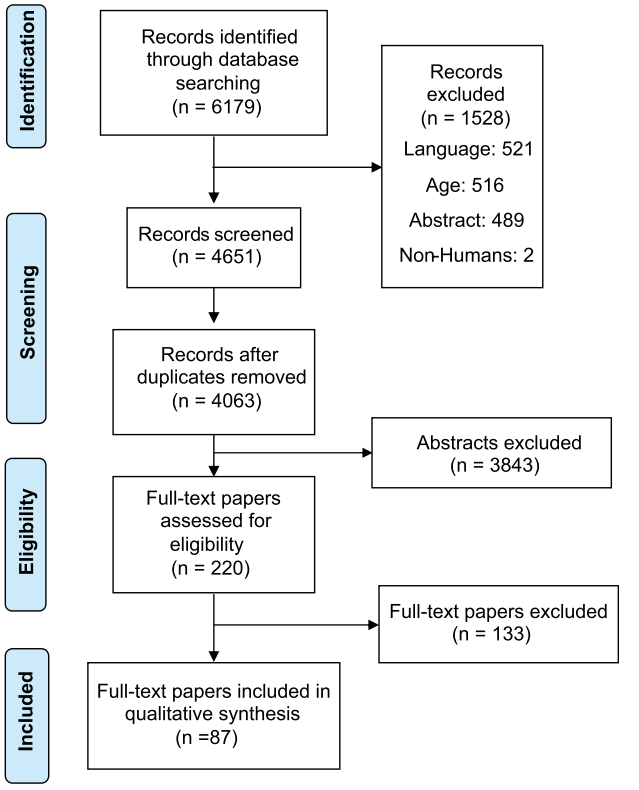

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) fluxogram.

Table 2

Characteristics of the studies included, related to the influence of diet on children and adolescents with SEN.

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
ADHD	Abel et al, 2017[19]	Cohort study (8 years of follow-up)	Norway	n = 77164 0–8 years 48.8% female	Diagnostic: previously obtained	IN PREGNANCY: iodine intake from food vs supplementation based on the Food Frequency Questionnaire	n = 1725 (2.2%)	Nonusers of supplemental iodine (n = 53360): no association between iodine intake from food and risk of child diagnosis ($P = .89$); iodine supplementation (≥160 μg/day) in 0–12 gestational weeks associated with an increased risk of child diagnosis (HR = 1.50, 95% CIs = 1.07–2.10)	—	7
ADHD	Bélanger et al, 2009[20]	RCT (16 weeks)	Canada	n = 26 6.9–11.9 years 30.8% female	Diagnostic: DSM-IV Symptomatology: Strengths and Weaknesses of ADHD Symptoms and Normal Behavior Scale (SWAN); Conners Rating Scales	IN PEDIATRIC AGE: intervention group (A): n-3 polyunsaturated fatty acid (PUFA) supplementation (20–25 mg/kg/day of EPA +8.5–10.5 mg/kg/day of DHA) for 16 weeks; placebo group (B): placebo for 8 weeks (phase 1) + n-3 (PUFA) supplementation for 8 weeks (phase 2)	n = 37 (100%)	—	For both groups (A, n = 13, and B, n = 13), there was a significant decrease in ADHD symptoms (Conners subscales of cognitive problems/inattention, hyperactivity and ADHD index), between baseline and the end of phase 2 ($P < .05$)	High risk of bias
ADHD	Barling et al, 1985[109]	Case-control study	South Africa	n = 27 9.15 years (mean) No information about gender	Diagnostic: Teacher Rating Scale (TRS) Symptomatology: Behavior Problem Checklist	IN PEDIATRIC AGE: sucrose consumption by the 7-day dietary record reported by the mother	n = 13 (48%)	—	No significant relationships emerged between sucrose consumption and hyperactivity or aggression symptoms ($P > .05$)	5
ADHD	Arnold et al, 2005[21]	Cross-sectional study	United States	n = 48 5–10 years 22.9% female	Diagnostic: DSM-IV Symptomatology: Conners Rating Scales–Revised (severity)	IN PEDIATRIC AGE: serum zinc levels were determined regarding the Food Frequency Questionnaire reported by parents	n = 48 (100%)	—	Lower zinc levels associated with more ADHD inattention symptoms ($P = .002$); zinc levels were not significantly associated with hyperactive-	5

(*continued on next page*)

Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
									impulsive symptoms ($P = .35$)	
ADHD	Barry et al, 2012[110]	RCT (1 week)	Australia	n = 36 8–13 years 27.8% female	Diagnostic: DSM-IV Symptomatology: Conners Rating Scales–Revised (severity)	IN PEDIATRIC AGE: Caffeine levels by administration of 2 identical gelatin capsules, containing either 80 mg/capsule of caffeine or placebo in 2 sessions	n = 18 (50%)	—	Increase in caffeine-induced arousal in the ADHD group was positively associated with their hyperactivity/ impulsivity levels (r = 0.41, $P = .044$, partial 2 = 0.171)	High risk of bias
ADHD	Borge et al, 2021[6]	Cohort study (ongoing—findings at the 8th year of follow-up)	Norway	n = 77768 0–8 years 48.9% female	Diagnostic: previously obtained according to ICD-10 codes Symptomatology: Parent Rating Scale for Disruptive Behavior Disorders (severity)	IN PREGNANCY: diet quality reported on the Food Frequency Questionnaire (FFQ) and assessed with Prenatal Diet Quality Index (PDQI) and Ultra-Processed Food Index (UPFI) IN PEDIATRIC AGE: diet assessed by parent-reported food intake questions and evaluated using Diet Quality Index (DQI)	n = 2255 (2.9%)	1 standard deviation increase in the PDQI score was associated with a 13% decrease in the risk of ADHD diagnosis (RR = 0.87, CI: 0.79, 0.97)	Child diet (DQI) was not associated with the ADHD symptom score at 8 years of age ($P >$ .05)	8
ADHD	Borlase et al, 2020[22]	RCT (10 weeks)	New Zealand	n = 27 8.1–13.2 years 0% female	Diagnostic: DSM-V and Kiddie Schedule for Affective Disorders and Schizophrenia Lifetime Version (K-SADS-PL) Symptomatology: Clinical Global Impressions–Improvement (CGI-I) scale; Children's Global Assessment Scale (CGAS); ADHD Rating Scale IV (ADHD-RS-IV); Conners Parents and Teacher Rating Scale (CPRS and CTRS)	IN PEDIATRIC AGE: micronutrient supplementation (daily essential nutrients (DENs)) or placebo	n = 27 (100%)	—	The micronutrient group showed a significant clinical benefit on the CGI-I global score (ADHD measure of symptoms) ($P = .01$) compared with the placebo group	High risk of bias
ADHD	Bos et al, 2015[85]	RCT (16 weeks)	The Netherlands	n = 79 8–15 years 0% female	Diagnostic: DSM-IV; Diagnostic Interview Schedule for Children–Parent Version (DISC-P) Symptomatology: Child Behavior Checklist (CBCL);	IN PEDIATRIC AGE: 10g of omega-3 (either normal or fortified with margarine) supplementation containing 650 mg of	n = 40 (50.6%)	—	After supplementation with omega-3 PUFAs, the ADHD investigation group had significantly reduced scores on CBCL attention problems, compared	Low risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
					Strengths and Weaknesses of ADHD Symptoms and Normal Behavior Scale (SWAN)	DHA and 650 mg of EPA, or placebo			with the placebo group ($P < .001$)	
ADHD	Crippa et al, 2019[23]	RCT (6 months)	Italy	n = 50 7–14 years 8% female	Diagnostic: DSM-IV; Development and Well-Being Assessment (DAWBA) Symptomatology: ADHD Rating Scale (ADHD-RS); Conners Parent Rating Scale–Revised (CPRS-R); Clinical Global Impressions–Improvement and Severity (CGI-I and CGI-S) scales	IN PEDIATRIC AGE: an active supplement, namely 2 soft gelatin pearls per day providing a dose of 500 mg of algal DHA or a placebo	n = 50 (100%)	—	There were no significant differences in ADHD Rating Scale scores (primary outcome) in the DHA group, compared with the placebo group ($P > .05$), indicating no significant benefit of supplementation	Low risk of bias
ADHD	Del-Ponte et al, 2016[79]	Cohort study (11 years of follow-up)	Brazil	n = 3485 0–11 years 48.1% female	Diagnostic: Development and Well-Being Assessment (DAWBA)	IN PREGNANCY: caffeine intake from coffee and yerba mate evaluated with a daily frequency questionnaire	n = 143 (4.1%)	There was no association between maternal caffeine consumption and incidence of ADHD at 11 years in children, during the 3 pregnancy trimesters and the entire pregnancy ($P > .05$)	—	8
ADHD	Hemamy et al, 2021[24]	RCT (8 weeks)	Iran	n = 66 9.11 ± 1.61 years 30.3% female	Diagnostic: DSM IV Symptomatology: Strengths and Difficulties Questionnaire (SDQ) (mental health status)	IN PEDIATRIC AGE: vitamin D (50,000 IU/ week) plus magnesium (6 mg/kg/day) supplementation or placebo	n = 66 (100%)	—	Children receiving vitamin D plus magnesium (n = 33) showed a significant reduction in emotional problems, conduct problems, peer problems, prosocial scores, total difficulties, externalizing scores, and internalizing scores ($P < .05$) of SDQ, compared with children treated with the placebo (n = 33)	High risk of bias
ADHD	Hariri et al, 2012[25]	RCT (8 weeks)	Iran	n = 103 6–12 years 35% female	Diagnostic: Conners Abbreviated Symptom Questionnaire (ASQ-P) scores for hyperactivity greater than 14	IN PEDIATRIC AGE: supplementation with a total daily dose of 900 mg of n-3 fatty acids (635 mg of EPA,	n = 103 (100%)	—	A significant improvement was observed in hyperactive behaviors rated by ASQ-P scores in the n-	High risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
					Symptomatology: ASQ-P	165 mg of DHA, and 100 mg of other n-3 fatty acids) or placebo			3 group ($P<.01$) compared with the placebo group after 8-week intervention compared with baseline	
ADHD	Julvez et al, 2007[92]	Cohort study (4 years of follow-up)	Spain	n = 500 0–4 years 49.8% female	Diagnostic: DSM-IV Symptomatology: McCarthy Scales of Children's Abilities (MCSA) (cognitive and motor capabilities); ADHD-DSM-IV; Social Competence (CPSCS)	IN PEDITRIC AGE: duration of breastfeeding, assessed through interviewer-administered questionnaires	No information about the prevalence of diagnosis, only about symptomatology	—	Long-term breastfeeding (>28 weeks, n = 98) was associated with low attention-deficit hyperactivity symptom scores (RR = 0.56; CI: 0.37 – 0.85, after >12 weeks) ($P<$ .05), compared with the group that was breastfed for less than 2 weeks (n = 101)	7
ADHD	Hirayama et al, 2014[26]	RCT (2 months)	Japan	n = 36 4–14 years 5.6% female	Diagnostic: previously obtained Symptomatology: DSM-IV-TR; (severity); Wechsler Intelligence Scale for Children (WISC-III) (memory); GO/NO-GO task (mental performance)	IN PEDIATRIC AGE: placebo or supplementation with cocoa-flavored chews containing 100 mg of soy-derived phosphatidylserine (PS) per chewable tablet (2 chews per day)	n = 36 (100%)	—	PS supplementation (n = 19) resulted in significant improvements in ADHD ($P<$ .01), short-term auditory memory ($P<$ .05), and inattention and impulsivity ($P<$ .05) between baseline and after intervention, compared with the placebo group (n = 17)	High risk of bias
ADHD	Hontelez et al, 2021[27]	RCT (8 weeks)	The Netherlands	n = 79 8–10 years 0% female	Diagnostic: DSM-IV criteria Symptomatology: ADHD Rating Scale (ADHD-RS)	IN PEDIATRIC AGE: Free food diet (FFD) during 32–33 days of rice, turkey, vegetables, pears, olive oil, ghee, salt, and rice drink with added calcium and water. During the first 2 weeks, this diet was extended with some other foods, allowing lamb; butter; and small portions of wheat, corn, potatoes, some fruits, and honey	n = 79 (100%)	—	At the end of the FFD period, the mean of the ADHD-RS score was significantly lower than the mean before the FFD period, indicating a significant improvement in symptoms ($P<$ .0001)	High risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
ADHD	Hsu et al, 2021[28]	RCT (8 weeks)	Taiwan	n = 20 10.0 ± 2.1 years 15% female	Diagnostic: DSM-IV-TR Symptomatology: Swanson, Nolan, and Pelham (SNAP-IV) Questionnaire	IN PEDIATRIC AGE: placebo: maltodextrin (75%) and magnesium stearate (25%) supplement: 1 capsule (if BW < 50 kg) or 2 (if BW > 50 kg) of pine bark extract (PE)/day containing/capsule 25 mg (Oligopin) for 4 weeks +2 weeks of washout +4 weeks of placebo or PE	n = 20 (100%)	—	PE supplementation caused a significant reduction in the SNAP-IV inattention items and in teacher's hyperactivity-impulsivity item ($P <$ .05) compared with baseline	High risk of bias
ADHD	Hirayama et al, 2004[88]	RCT (2 months)	Japan	n = 40 6.8–11.3 years (mean age = 9 years) 20% female	Diagnostic: DSM-IV Symptomatology: DSM-IV; Development Test of Visual Perception; questions to evaluate aggression and impulsivity	IN PEDIATRIC AGE: placebo or DHA supplementation (fermented soybean milk with 600 mg of DHA/ 125 ml, 3x a week, bread rolls with 300 mg of DHA/45 g, 2x a week, and steamed bread with 600 mg of DHA/60 g, 2x a week)	n = 31 (80%)	—	Considering children with ADHD, visual short-term memory and errors of commission (continuous performance) significantly improved in the control group (n = 16) compared with the changes over time in the DHA group (n = 16) ($P <$ .05). DHA supplementation did not improve ADHD-related symptoms	High risk of bias
ADHD	Joshi et al, 2006[87]	Clinical trial (pilot study) (3 months)	India	n = 60 7.5 years (control) and 8.0 years (ADHD group) 26.7% female	Diagnostic: DSM-IV Symptoms: Parent Rating Scale	IN PEDITRIC AGE: flax oil supplementation (200 mg of ALA content +25 mg of vitamin C twice a day)	n = 30 (50%)	—	In the ADHD group (n = 30), there was a highly significant decrease in individual scores for total hyperactivity, self-control, psychosomatic condition, restlessness, inattention, and impulsivity ($P <$ .001) and a significant decrease in scores of social and learning problems ($P <$ .05) in the postsupplementation period, compared with	High risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
									the presupplementation period	
ADHD	Cremonte et al, 2017[29]	Clinical trial (pilot study) (6 months)	Italy	n = 30 6–15 years 7% female	Diagnostic: DSM-IV Symptomatology: Children's Global Assessment Scale (CGAS); Swanson, Nolan, and Pelham (SNAP-IV) Questionnaire; Conners Parent Rating Scale (CPRS); Bell test and Tower of London test (executive functioning); Wechsler Intelligence Scale for Children III (WISC-III)	IN PEDIATRIC AGE: Klamin (phenylethylamine (PEA), naturally contained in the Klamath Lake microalgae) supplementation	n = 30 (100%)	—	After 6 months of therapy for all patients, there was a significant improvement in their overall functioning, behavioral aspects related to inattention and hyperactivity impulsivity, attention functions in both the selective and sustained component and executive functions (CGAS score; SNAP-IV inattention, hyperactivity, and total scores; Tower of London test; and Bell test) ($P < .005$)	High risk of bias
ADHD	Dölp et al, 2020[30]	Uncontrolled open-label dietary intervention study (22 weeks)	Germany	n = 10 8–14 years 20% female	Diagnostic: ICD-10 Symptomatology: ADHD Rating Scale IV (ADHD-RS-IV); Childhood Behavior Checklist (CBCL); Abbreviated Connors Scale (ACS); DISYPS-II FBB-ADHD.	IN PEDIATRIC AGE: phase T0-T1 (2 weeks): regular diet; phase T1-T2 (4 weeks): diet only with limited selection of hypoallergenic foods; reintroduction phase T2-T4: different food groups were successively tested (16 weeks)	n = 10 (100%)	—	There was a significant mean improvement in the ADHD-RS scores and in DISYPS-II FBB-ADHD scale scores, in every subscale, and in CBCL in "Externalizing," "Internalizing," "Withdrawn," "Anxious/depressed," "Delinquent behavior," and "Aggressive behavior" after diet (T2 vs T1) ($P \leq .036$)	High risk of bias
ADHD	Kim et al, 2018[8]	Cross-sectional study	Korea	n = 16831 9.29 years ±1.71 50.2% female	Symptomatology: ADHD Rating Scale (ADHD-RS)	IN PEDIATRIC AGE: evaluation of dietary habits assessed with a parent-reported food frequency questionnaire (to have data regarding fast-food, soft drinks, instant noodles, fruit and vegetables, and milk)	No information about the diagnostic prevalence, only about symptomatology	—	Children who consumed fast food, instant noodles, and soft drinks more frequently had higher K-ADHD-RS scores and higher odds ratios for ADHD risk than the children who never	5

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
									consumed these foods ($P < .05$). Children who consumed fruit and vegetables more frequently had significantly lower K-ADHD-RS scores and lower odds ratios for ADHD risk than those children who consumed these foods less frequently ($P < .05$)	
ADHD	Ng et al, 2009[31]	Cross-sectional study	Australia	n = 79 9.3 ± 1.7 years 27.8% female	Diagnostic: Conners Parent Rating Scale (CPRS) scores >90th percentile Symptomatology: CPRS-ADHD Index	IN PEDIATRIC AGE: evaluation of diet with a weighted food record during 3 nonconsecutive days to assess PUFA intake	n = 79 (100%)	—	There were no significant correlations found between PUFA intake and ADHD symptoms ($P > .05$). Likewise, no significant correlations were found between the amount of fish/seafood and meat/egg consumption and ADHD symptoms ($P > .05$)	5
ADHD	Raz et al, 2009[32]	RCT (7 weeks)	Israel	n = 63 7–13 years No information about gender	Diagnostic: previously obtained Symptomatology: Conners Rating Scale; Continuous Performance Test	IN PEDIATRIC AGE: supplements contained 480 mg of linoleic acid and 120 mg of a-linolenic acid, and the placebo contained 1000 mg of vitamin C	n = 63 (100%)	—	No significant differences in ADHD symptoms were found between the 2 groups after the treatment ($P > .05$)	High risk of bias
ADHD	Lien et al, 2006[95]	Cross-sectional study	Norway	n = 5498 15–16 years 49.4% female	Diagnostic: Strengths and Difficulties Questionnaire (SDQ)-Hyperactivity subscore >90th percentile Symptomatology: SDQ-Hyperactivity	IN PEDIATRIC AGE: the following question was asked: "How much do you normally drink cola or 'fizzy' drinks with sugar?"	n = 508 (9.1%)	—	For boys, drinking 1 or more glasses of soft drinks a day (n = 1221) was associated with more hyperactivity symptoms compared with drinking no soda at all (example: >4 glasses/d: OR = 4.15, 95% CI: 2.80, 6.16))	5
ADHD		Case-control study	Taiwan	n = 332	Diagnostic: DSM-IV		n = 173 (52.1%)	—		6

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
	Yu et al, 2016[9]			4–15 years 28.1% female	Symptomatology: Swanson, Nolan and Pelham (SNAP-IV) Questionnaire; SNAP-IV Teacher and Parent Rating Scale	IN PEDIATRIC AGE: sugar-sweetened beverage consumption and dietary habits evaluated with a questionnaire administered by a trained interviewer to the caretaker			Children who consumed 1-6 servings of SSBs/week and children who consumed 7 or more servings of SSBs/week (n = 82) had a higher risk of having ADHD symptoms, compared with those who did not consume SSBs (n = 19) (OR = 1.36, CI95%: 0.61, 3.05 for 1-6 servings; OR = 3.69, CI 95%: 1.291, 10.60 for 7 or more servings)	
ADHD	Iv et al, 2022[111]	Cohort study (6 years of follow-up)	France	n = 1432 2–8 years 47.9% female	Symptomatology: Strengths and Difficulties Questionnaire (SDQ)-Hyperactivity and Inattention	IN PEDIATRIC AGE: dietary intake at the age of 2 years collected using a Food Frequency Questionnaire (FFQ)—3 dietary patterns were identified: processed and fast foods; labeled guidelines; baby foods	No information about the prevalence of diagnosis, only about symptomatology	—	The score on the labeled guideline dietary pattern was negatively associated with the risk of having hyperactivity-inattention symptoms (OR: 0.75; 95% CI: 0.60–0.94) between 3 and 8 years of age, contrary to adherence to the baby food dietary pattern (OR: 1.41; 95% CI: 1.16–1.71)	6
ADHD	Loomans et al, 2012[80]	Cohort study (6 years of follow-up)	The Netherlands	n = 3439 0–6 years 50.2% female	Diagnostic: Strengths and Difficulties Questionnaire (SDQ) with a score >17th percentile Symptomatology: SDQ	IN PREGNANCY: dietary caffeine (tea, cola, coffee) intake evaluated with a questionnaire at the 16th week of gestation	n = 257 (7.5%)	Caffeine intake was not associated with a higher risk of behavior problems or with suboptimal prosocial behavior ($P > .05$)	—	6
ADHD	Milte et al, 2012[86]	RCT (4 months)	Australia	n = 87 7–12 years 20.7% female	Diagnostic: medical diagnostic or Conners Parent Rating Scale (CPRS) > 90th percentile Symptomatology: Wechsler Individual Achievement Test III (literacy); Wechsler Scale	IN PEDIATRIC AGE: supplementation with 500 mg of fish-oil capsules per day containing 1109 mg of EPA and 108 mg of DHA (EPA-rich oil); a fish-oil providing 264 mg of	n = 87 (100%)	—	There were no significant differences between the supplemented groups (n = 30; n = 28) in relation to the control group (n = 29), concerning the ADHD	High risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
					of Children's Intelligence III (vocabulary)	EPA and 1032 mg of DHA (DHA-rich oil), or a safflower oil (control) providing 1467 mg/d of u-6 PUFA linoleic acid (LA)			index ($P > .05$). An increased proportion of DHA was associated with improved word reading (r = 0.394)	
ADHD	Perera et al, 2012[33]	RCT (6 months)	Sri Lanka	n = 94 6–12 years 27% female	Diagnostic: DSM-IV Symptomatology: checklist to parents and teachers' application	IN PEDIATRIC AGE: the intervention group supplemented with a combined omega3 and omega6 preparation or the control group supplemented with placebo	n = 94 (100%)	—	After 6 months, the intervention group (n = 48) had a significant improvement in all symptoms evaluated ($P < .05$), except for distractibility ($P = .55$), compared with the placebo group (n = 46)	Some concerns
ADHD	Pelsser et al, 2010[34]	RCT (7 weeks)	The Netherlands	n = 24 3–8 years 20.8% female	Diagnostic: DSM-IV Symptomatology: Physical Complaints Questionnaire (behavior, physical, and sleep complaints)	IN PEDIATRIC AGE: a 2-week baseline diet (normal diet), followed by an elimination diet for 5 weeks (diet of few foods consisting of a limited number of hypoallergenic foods, such as rice, turkey, lamb, a range of vegetables, pears, and water). Diet assessed with an extended diary filled by parents	n = 24 (100%)	—	After intervention, there was a significant decrease in the total number of complaints, including sleep complaints ($P = .001$) in the diet group (n = 13), compared with the control group (n = 11)	High risk of bias
ADHD	Pelsser et al, 2011[35]	RCT (13 weeks)	The Netherlands	n = 100 4–8 years 14% female	Diagnostic: Structured Psychiatric Interview (SPI) Symptomatology: ADHD Rating Scale (ADHD-RS); Abbreviated Conners Scale (ACS); Strengths and Difficulties Questionnaire (SDQ)	IN PEDIATRIC AGE: 5 weeks of a restricted elimination diet (diet group) or a healthy diet (control group). Then, those with an improvement of at least 40% on the ADHD Rating Scale [ADHD-RS] from the diet group proceeded with a 4-week diet, with high-IgG or low-IgG foods added to the diet	n = 100 (100%)	—	Between baseline and the first phase, those who were in the diet group (n = 50) had significantly low ADHD-RS and ACS scores than those who were in the control group (n = 50) ($P < .0001$). At the second phase, reintroducing foods led to a significant behavioral relapse in 63.3% of the clinical responders ($P < .001$)	High risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
ADHD	Widenhorn-Müller et al, 2014[36]	RCT (16 weeks)	Germany	n = 95 8.91 ± 1.35 years 22.1% female	Diagnostic: DSM-IV Symptomatology: FBB ADHS parent-rated and teacher-rated questionnaires (DISYPS-II); Child Behavior Checklist (CBCL); Teacher's Report Form (TRF) (academic performance, social problems, depression, anxiety, and aggressive behavior)	IN PEDIATRIC AGE: intervention group: 2 soft gelatin capsules with a daily dose of 720 mg of omega-3 fatty acids (600 mg of EPA, 120 mg of DHA) and 15 mg of vitamin E; placebo group: 2 olive oil–containing capsules per day	n = 95 (100%)	—	At the end of intervention, there were no significant differences in scores of the DISYPS-II questionnaire, CBCL scores, and TRF, between both groups ($P > .05$). However, there was a significant improvement in working memory function (index score) in the intervention group (n = 46) after 16 weeks, compared with placebo (n = 49)	High risk of bias
ADHD	Stevens et al, 2003[37]	RCT (4 months)	United States	n = 47 6 – 13 years 11% female	Diagnostic: previously obtained Symptomatology: Conners Abbreviated Symptom Questionnaire (ASQ); Disruptive Behavior Disorders (DBD) Rating Scale; Conners Continuous Performance Test (CPT); and Woodcock–Johnson Psycho-Educational Battery Revised (WJ-R) (cognitive function)	IN PEDIATRIC AGE: supplementation group received 8 capsules of PUFA (60 mg of DHA, 10 mg of EPA, 5 mg of AA, 12 mg of GLA, and 3 mg of vitamin E per capsule) and placebo group received 8 capsules (0.8 g of olive oil per capsule) per day		—-	At the end of the intervention, a clear significant benefit from PUFA supplementation for all behaviors characteristic of ADHD was not observed ($P >$ .05). However, attention symptoms were significantly improved according to teacher ($P = .03$), compared with placebo	Low risk of bias
ADHD	Yorgidis et al, 2021[38]	Open trial (22 weeks)	Germany	n = 16 7–13 years 18.8% female	Diagnostic: ICD-10, Kiddie-SADS-Present and Lifetime Version (K-SADS-PL) Symptomatology: ADHD Rating Scale IV (ADHD-RS-IV); Abbreviated Conners Scale (ACS)	IN PEDIATRIC AGE: (T0-T1): daily 24-h recalls, 2 weeks; (T1-T2): administration of an oligoantigenic diet, 4 weeks; (T2-T4): reintroduction of usually consumed foods, 16 weeks	n = 16 (100%)	—	After 4 weeks of oligoantigenic diet, a significant reduction in the ADHD-RS total score ($P < .0001$) was observed, compared with baseline. This effect was more significative when diet included milk products, corn, and wheat	High risk of bias
ADHD	Stadler et al, 2016[93]	Case-control study	United States	n = 474 7 – 13 years 36% female	Diagnostic: DSM-V criteria Symptomatology: ADHD Rating Scale (ADHD-RS)	IN PEDIATRIC AGE: assessment of breastfeeding duration retrospectively by a	n = 291 (61.4%)	—	An association between shorter breastfeeding duration and more child	7

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
						single item on the developmental history form			total ADHD symptoms was found ($P < .05$)	
ADHD	van Egmond-Fröhlich et al, 2012[96]	Cross-sectional study	Germany	n = 9428 6–17 years No information about gender	Diagnostic: parent-rated Strengths and Difficulties Questionnaire (SDQ); Symptomatology: SDQ	IN PEDIATRIC AGE: dietary assessment with a semiquantitative Food Frequency Questionnaire (FFQ); diet quality assessed with Healthy Nutrition Score for Kids and Youth (HuSKY)	n = 1272 (13.5%)	—	SDQ-HI scores were significantly and positively associated with average energy density of food, volume of beverages, and total energy intake ($P <$ .001) and negatively associated with the HuSKY Diet Quality Index ($P <$ .001)	7
ADHD	Rucklidge et al, 2019[39]	RCT (10 weeks)	New Zealand	n = 71 9.7 ± 1.5 years 33% female	Diagnostic: Kiddie Schedule for Affective Disorders and Schizophrenia Lifetime Version (K-SADS-PL); Parent and Teacher Conners Rating Scales Symptomatology: ADHD Rating Scale IV (ADHD-RS-IV); Clinical Global Impressions—Improvement (CGI-I) ratings (response to treatment); Children's Global Assessment Scale (CGAS) (functioning)	IN PEDIATRIC AGE: supplementation with micronutrient formula (daily essential nutrients—DENs) of 3 capsules per day, with a gradual increase up to 12 capsules a day on the 7th day	n = 71 (100%)	—	There were no significant improvements in ADHD outcomes after the 10-week treatment, compared with baseline	High risk of bias
ADHD	Schmidt et al, 1997[40]	RCT (9 days)	Germany	n = 49 6–12 years 4% female	Diagnostic: DSM-III and ICD-10 Symptomatology: Paired Associate Learning Task (PAT) and Continuous Performance Task (CPT) (performance evaluation); Conners Abbreviated Parent-Teacher Questionnaire (behavior evaluation)	IN PEDIATRIC AGE: oligoantigenic diet during 9 days with assessment at days 3 and 8	n = 49 (100%)	—	12 children (24%) showed significant behavioral rating improvement (>25%) in standardized play situations and test situations during intervention diet, relative to control diet conditions ($P <$ .05)	High risk of bias
ADHD and learning disabilities	Park et al, 2012[10]	Cross-sectional study	Korea	n = 986 9.1 ± 0.7 years 48.6% female	Diagnostic: DSM-IV and Learning Disability Evaluation Scale (LDES) Symptomatology: Child Behavior Checklist (CBCL); Korean Educational	IN PEDIATRIC AGE: children's diet assessed with the mini-dietary assessment for Koreans	n = 45 (4.6%)	—	A high intake of sweetened desserts, fried food, and salt is significantly associated with more learning, attention, and	6

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					Development Institute's Wechsler Intelligence Scales for Children (KEDI-WISC) (cognitive function)				behavioral problems, whereas a balanced diet, regular meals, and a high intake of dairy products and vegetables are significantly associated with less learning, attention, and behavioral problems ($P < .01$)	
ADHD and ASD	Boucher et al, 2016[94]	Cohort study (4 years of follow-up)	Spain	n = 1346 0–6.9 years 50% female	ADHD symptomatology: DSM-IV ASD diagnostic: Childhood Autism Spectrum Test (CAST)	IN PEDIATRIC AGE: diet report using interviewer-administered questionnaires when children were 6 months, 14 months, and 4 years of age	ADHD: n = 69 (5%) ASD: n = 70 (5%)	—	Longer duration of breastfeeding was independently associated with fewer autistic traits (β = -0.08, 95% CI: −0.16, −0.00). Breastfeeding was not related to ADHD symptoms (β = -0.02, 95% CI: −0.04, 0.01)	7
ASD	Kerley et al, 2017[41]	RCT (20 weeks)	Ireland	n = 38 6.9 ± 3.8 years (placebo); 7.9 ± 2.3 years (intervention) 13% female	Symptomatology: Developmental Disabilities—Children's Global Assessment Scale (DD-CGAS) (self-care, communication, social behavior, and school/ academic subscales)	IN PEDIATRIC AGE: 2000 IU vitamin D3 supplementation or placebo daily	n = 38 (100%)	—	No significant differences were observed in behavior scores ($P > .05$). However, a significant improvement was observed in the self-care score on DD-CGAS in the vitamin D3 group (n = 18), compared with the placebo group (n = 20) ($P = .02$)	High risk of bias
ASD	Alessandria et al, 2019[42]	Cohort study (6 months of follow-up)	Italy	n = 130 10.4 ± 6.6 years 17% female	Diagnostic: DSM-IV Symptomatology: medical history and physical examination	IN PEDIATRIC AGE: gluten/casein-free diet (GCFD) reported by a 3-day dietary recall	n = 151 (100%)	—	Symptoms improvement was not significantly associated with GCFD ($P > .05$), namely constipation, diarrhea, abdominal pain, dysphagia, macroscopic malabsorption, food	5

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
									selectivity, vomiting, and flatulence	
ASD	Alomar et al, 2021[90]	Case-control study	Saudi Arabia	n = 200 3–10 years 35.5% female	Diagnostic: DSM-V Symptoms: Childhood Autism Rating Scale (CARS) (severity)	IN PEDIATRIC AGE: vitamin D diet intake reported using a specially designed questionnaire	n = 100 (50%)	—	74.19% (n = 23) of severely autistic children, 60.87% (n = 42) of mild-to-moderate autistic children, and 34% (n = 34) of normal children had a deficient vitamin D intake. A negative association was found between a vitamin D–rich diet and mild-to-moderate degree of autism (symptom level) (OR = 0.27, 95% CI = 0.12–0.57)	4
ASD	Afzal et al, 2003[89]	Case-control study	United Kingdom	n = 132 2.2–18.7 years 21.2% female	Diagnostic: DSM-IV Symptomatology: constipation symptoms using a validated index (≥9 points in a score)	IN PEDIATRIC AGE: dietary history extracted from clinical records: combined diary-free and gluten-free diets; dairy-free diet; gluten-free diet	n = 103 (78%)	—	Consumption of milk was the strongest predictor of constipation in the autistic group (n = 103) ($P < .01$). Gluten consumption was not associated with constipation in this group ($P > .05$)	3
ASD	Raghavan et al, 2018[81]	Cohort study (12 years of follow-up)	United States	n = 1257 5–17 years 53% female	Diagnostic: previously obtained	IN PREGNANCY: multivitamin supplementation was assessed by a questionnaire interview	n = 86 (7%)	Low (≤2 times/week) and high (>5 times/week) supplementation was associated with increased risk of having ASD compared with moderate (3–5 times/week) self-reported supplementation during pregnancy	—	7
ASD	Piwowarczyk et al, 2020[43]	RCT (6 months)	Poland	n = 66 36–69 months 15.2% female	Diagnostic: DSM-V Symptomatology: Social Communication Questionnaire; Autism Spectrum Rating Scale	IN PEDIATRIC AGE: intervention group: 6 months of run-in period on a gluten-free diet (GFD); control group: gluten-containing diet	n = 66 (100%)	—	There were no differences in autistic symptoms, maladaptive behaviors, or intellectual abilities after the intervention ($P > .05$), between the	High risk of bias

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									GFD group (n = 28) and control group (n = 30)	
ASD	Levine et al, 2018[7]	Cohort study (8–12 years of follow-up)	Israel	n = 45300 0–12 years 48.8% female	Diagnostic: ICD-9	IN PREGNANCY: consumption of folic acid (vitamin B9) and multivitamin supplements (Anatomical Therapeutic Chemical A11 codes vitamins A, B, C, and D) before and during pregnancy	n = 572 (1.3%)	Maternal exposure to folic acid and multivitamin supplements was significantly associated with a lower likelihood of having ASD, compared with no exposure, before and during pregnancy ((RR, 0.39; 95% CI, 0.30–0.50), (RR, 0.27; 95% CI, 0.22–0.33), respectively)	—	7
ASD	Navarro et al, 2015[44]	RCT (4 weeks)	United States	n = 12 4–7 years No information about gender	Diagnostic: DSM-IV Symptomatology: lactulose: mannitol (L/M) sugar permeability test (intestinal permeability); Aberrant Behavior Checklist (ABC); Conners Parent Rating Scale (CPRS) (behavior)	IN PEDIATRIC AGE: gluten–dairy-free diet vs placebo	n = 12 (100%)	—	Neither the L/M ratio nor behavioral scores were different between groups exposed to gluten/dairy (n = 6) or placebo (n = 6) (P = .307 and P = .292, respectively)	High risk of bias
ASD	Levy et al, 2007[45]	Cross-sectional study	United States	n = 62 3–8 years 10.4% female	Diagnostic: DSM-IV Symptoms: parental self-report (gastrointestinal symptoms)	IN PEDIATRIC AGE: 3-day diet reported by parents (further calculation of total calories, protein, carbohydrate, and fat intake)	n = 62 (100%)	—	No statistically significant relationships between stool consistency (gastrointestinal symptoms) and total calories, protein, carbohydrate, and fat intake were observed (P > .05)	5
ASD	Li et al, 2018[82]	Case-control study	China	n = 708 3–6 years 52.5% female	Diagnostic: DSM-IV	IN PREGNANCY: questionnaire by interview about diet, obtaining information about 3 dietary patterns: mostly meat, mostly vegetables, or both	n = 354 (50%)	Dietary patterns of mostly meat and mostly vegetables during pregnancy were associated with a significant increased risk of ASD in offspring (OR: 3.975; 95% CI: 1.202, 13.148), (OR:	—	6

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Table 2 (*continued*)

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								2.134; 95% CI: 1.138, 4.001), respectively)		
ASD	Chan et al, 2012[112]	RCT (1 month)	China	n = 24 7–17 years 16.7% female	Diagnostic: DSM-IV Symptomatology: Autism Diagnostic Interview Revised (ADI-R)	IN PEDIATRIC AGE: placebo or dietary modifications including reduced intake of ginger, garlic, green onion, spicy foods, eggs, meat, and fish	n = 13 (54.2%)	—	After 1 month of modification in diet, the experimental group (n = 12) showed significantly improved performance in mental flexibility, response inhibition, and planning ($P < .05$), compared with baseline. Parents of the children from the experimental group also reported a significant reduction in social communication problems and repetitive, inflexible, and hyperactive behaviors ($P < .05$), compared with baseline	High risk of bias
ASD	DeVilbiss et al, 2017[83]	Cohort study (4–15 years of follow-up)	Sweden	n = 273,107 0–15 years 48.7% female	Diagnostic: DSM-IV	IN PREGNANCY: multivitamin, iron, and folic acid supplementation during pregnancy, self-reported at the first antenatal visit	n = 6115 (2.3%)	Maternal multivitamin use with or without additional iron or folic acid, or both were associated with lower odds of ASD with intellectual disability in children, compared with mothers who did not use multivitamins, iron, and folic acid (OR = 0.69, 95% CI = 0.57–0.84). There was no consistent evidence that either iron or folic acid use was inversely associated with ASD prevalence	—	7
ASD	Elder et al, 2006[46]	RCT (12 weeks)	United States	n = 15 2–16 years 20% female	Diagnostic: DSM-IV Symptomatology: Childhood Autism Rating Scale (CARS); Ecological Communication	IN PEDIATRIC AGE: regular diet vs gluten- and casein-free diet (GFCF)	n = 15 (100%)	—	Group analysis results indicated no significant differences between regular diet and GFCF diet in CARS ($P = .85$),	High risk of bias

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					Orientation Scale (ECOS); direct behavioral observation				ECOS ($P = .29$), or behavioral frequencies ($0.32 < P < .45$) although several parents reported improvement in child language, decreased hyperactivity, and decreased tantrums in their children	
ASD	Ghalichi et al, 2016[47]	RCT (6 weeks)	Iran	n = 76 7.92 ± 3.37 years 26.3% female	Diagnostic: Autism Diagnostic Interview-Revised (ADI-R) Symptomatology: ROME III questionnaire; Gilliam Autism Rating Scale 2 (GARS-2) questionnaire	IN PEDIATRIC AGE: regular diet vs gluten-free diet (GFD), consisting of gluten-free pasta, biscuits, and breads, according to age requirements	n = 76 (100%)	—	In the GFD group (n = 38), the prevalence of gastrointestinal symptoms including stomach ache, bloating, and constipation (according to Rome III) and behavioral outcomes including stereotyped behaviors, communication, and social interaction (according to GARS-2), decreased significantly after 6 weeks of intervention, compared with baseline ($P < .05$)	High risk of bias
ASD	González-Domenech et al, 2020[48]	RCT (1 year)	Spain	n = 37 8.9 ± 4.0 years 46% female	Diagnostic: ICD-10 Symptomatology: Autism Treatment Evaluation Checklist (ATEC) Scale; Behavioral Summarized Evaluation (ERC-III) Scale	IN PEDIATRIC AGE: normal diet vs gluten-free and casein-free (GFCF)	n = 37 (100%)	—	When both groups were analyzed, a nonsignificant decrease was found in the scores of ATEC Scale and ERC-III Scale, after 6 months of intervention ($P > .05$). The GFCF diet did not induce significant changes in behavioral symptoms of autism ($P > .05$)	High risk of bias
ASD	Hyman et al, 2016[49]	RCT (30 weeks)	United States	n = 14 3–5 years 14.3% female	Diagnostic: Autism Diagnostic Interview (ADI-R); Autism Diagnostic	IN PEDIATRIC AGE: implementation phase: gluten-free/casein-free (GFCF) diet consumption	n = 14 (100%)	—	Dietary challenges did not have statistically significant effects on measures of	High risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
					Observation Schedule (ADOS) Symptomatology: Bristol Stool Scale (Physiologic Functioning); Conners Abbreviated Rating Scale (attention), Ritvo–Freeman Real Life Rating Scales (ASD behavior)	for 4–6 weeks; challenge phase: (foods that contained gluten only, casein only, both gluten and casein, or neither (placebo)) once per week for 12 weeks; maintenance phase: families were free to maintain, modify, or abandon the GFCF diet for 12 more weeks			physiological functioning, behavior problems, or autism symptoms, between the day before the challenge, the day of the challenge, and the day after the challenge, compared with placebo ($P > .05$)	
ASD	Feng et al, 2017[91]	RCT (6 months)	China	n = 500 4.76 ± 0.95 years (ASD group); 5.12 ± 1.15 years (control group) 20.4% female	Diagnostic: DSM-IV Symptoms: Autism Behavior Checklist (ABC); Childhood Autism Rating Scale (CARS)	IN PEDIATRIC AGE: vitamin D3 supplementation intramuscularly administered at a dosage of 150 000 IU per month (for 3 months) and orally administered at a dosage of 400 IU per day (for 3 months)	n = 215 (43%)	—	In the ASD group (n = 215), ABC subscales (social skills, body and object use, language, and social or self-help) and total CARS scores were reduced significantly, compared with the situation before treatment ($P <$ .05)	High risk of bias
ASD	Harris et al, 2012[50]	Cross-sectional study	United States	n = 13 9 ± 1.9 years 30.8% female	Diagnostic: previously obtained Symptomatology: Gastrointestinal Symptoms Rating Scale (GSRS); Childhood Autism Rating Scale (CARS)	IN PEDIATRIC AGE: gluten-free and casein-free (GFCF) diet, evaluated with a Food Frequency Questionnaire	n = 13 (100%)	—	GSRS and CARS scores did not differ significantly according to diet ($P > .05$) between the GFCF diet group (n = 7) and non–GFCF diet group (n = 6). Parents of all the children on a GFCF diet (n = 7) reported improved GI symptoms and behavior patterns	4
ASD	Inoue et al, 2019[51]	Clinical trial (15 months)	Japan	n = 13 5.9 ± 2.2 years 7.7% female	Diagnostic: DSM-V; Pervasive Developmental Disorders Autism Society Japan Rating Scale (PARS); Modified Checklist for Autism in Toddlers (M-HAT) Symptomatology: feces and serum collection; Aberrant Behavior Checklist–Japanese Version	IN PEDIATRIC AGE: supplementation with partially hydrolyzed guar gum (PHGG) (guar gum with b-endogalactomannase produced by a strain of *Aspergillus niger*)	n = 13 (100%)	—	Supplementation with partially hydrolyzed guar gum significantly increased the frequency of defecation per week ($P <$ .01) and significantly improved behavioral irritability as per the ABC-J ($P <$	High risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
					(ABC-J) (behavioral irritability)				.01), compared with presupplementation	
ASD	Javadfar et al, 2020[52]	RCT (15 weeks)	Iran	n = 43 3–13 years 16.3% female	Diagnostic: DSM-V Symptoms: Autism Rating Scale (CARS); Autism Treatment Evaluation Checklist (ATEC); Aberrant Behavior Checklist Community (ABC-C)	IN PEDIATRIC AGE: placebo or vitamin D supplementation (300 IU/kg daily up to a maximum of 6000 IU/d vitamin D syrup)	n = 43 (100%)	—	In vitamin D group (n = 22), the clinical symptoms of autism measured by CARS and ATEC scales were alleviated significantly ($P = .021$ and $P = .020$, respectively), compared with the placebo group (n = 21), after 15 weeks. At the end of the study, no significant difference was detected in the ABC-C score between the 2 groups ($P > .05$)	High risk of bias
ASD	Mazahery et al, 2019[53]	RCT (12 months)	New Zealand	n = 73 2.5–8 years 17.8% female	Diagnostic: DSM-V Symptomatology: Aberrant Behavior Checklist (ABC)	IN PEDIATRIC AGE: placebo or consumption of vitamin D3 (2000 IU/day) and omega-3 LCPUFA (722 mg DHA/day)	n = 73 (100%)	—	After 12 months, children receiving omega-3 (n = 23) and vitamin D (n = 19) had greater reduction in irritability than placebo ($P = .001$ and $P = .01$, respectively). Compared with placebo, children in the vitamin D group also had greater reduction in hyperactivity ($P = .047$)	High risk of bias
ASD	Mazahery et al, 2019[54]	RCT (12 months)	New Zealand	n = 73 2.5–8 years 17.8% female	Diagnostic: DSM-V Symptomatology: Social Responsiveness Scale (SRS); Sensory Processing Measure (SPM)	IN PEDIATRIC AGE: placebo or consumption of vitamin D3 (2000 IU/day) and omega-3 LCPUFA (722 mg DHA/day)	n = 73 (100%)	—	Compared with placebo (n = 29), children who received omega-3 (n = 23) and vitamin D + omega-3 (n = 15) showed significant improvements in SRS-social awareness ($P = .03$) and a trend for improvements in SRS-social communicative functioning and SPM-taste/smell ($P < .1$). A	High risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
									trend was also found for improvements in children who received omega-3 for SRS-total score and SPM-balance/motion score ($P < .1$)	
ASD	Mehrazad-Saber et al, 2018[55]	RCT (2 months)	Iran	n = 43 4–16 years 27.9% female	Diagnostic: DSM-IV Symptomatology: Gilliam Autism Rating Scale 2 (GARS-2); Children's Sleep Habits Questionnaires (sleep disorders)	IN PEDIATRIC AGE: 500 mg of carnosine supplementation or 500 mg of placebo per day	n = 43 (100%)	—	After 2 months of carnosine supplementation (n = 21), there was no significant effect on autism severity ($P > .05$), whereas it significantly reduced sleep duration ($P = .04$), parasomnias ($P = .02$), and total sleep disorder scores ($P = .006$) when compared with the control group (n = 22)	High risk of bias
ASD	Nogay et al, 2021[56]	RCT (2 weeks)	United States	n = 15 11.7 ± 3.3 years 33.3% female	Diagnostic: previously obtained Symptomatology: Aberrant Behavior Checklist–Community (ABC-C); Pediatric Quality of Life Inventory (PedsQL) (gastrointestinal)	IN PEDIATRIC AGE: placebo or low FODMAP diet, evaluated with a 3-day dietary record	n = 15 (100%)	—	The low FODMAP diet group (n = 7) had significantly less GI symptoms, compared with the control group (n = 8) at follow-up ($P < .05$). However, there were no significant differences in behavioral problems between these groups ($P > .05$), after intervention	High risk of bias
ASD	Ooi et al, 2015[57]	Open-label trial (12 weeks)	Singapore	n = 41 11.66 ± 3.05 years 12.2% female	Diagnostic: DSM-IV Symptomatology: Social Responsiveness Scale Parent (SRS-P); Child Behavior Checklist (CBCL)	IN PEDIATRIC AGE: 15 ml of liquid (Efamol Efalex) twice daily, which consists of 1 g/day of omega-3 fatty acids (840 mg of DHA, 192 mg of EPA, 1278 mg of pure evening primrose oil with 66 mg of	n = 41 (100%)	—	After treatment, participants showed significant improvements in all subscales of the SRS ($P < .01$) and in Social and Attention Problems syndrome scales of the CBCL	High risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
						arachidonic acid (AA) and 144 mg of gamma linolenic acid, 60 mg of vitamin E, and 3 mg of thyme oil)			($P < .05$), compared with the baseline period	
ASD	Pennesi et al, 2012[58]	Cross-sectional study	United States	n = 387 Children, no information about age 18% female	Diagnostic: previously obtained Symptomatology: online questionnaire (ASD behaviors, physiological symptoms, and social behaviors	IN PEDIATRIC AGE: assessment of gluten-free, casein-free diet (GFCF) diet implementation using a 90-item online questionnaire given to parents	n = 387 (100%)	—	Parental report of GFCF diet implementation showed a significant improvement in ASD behaviors, physiological symptoms, and social behaviors ($P < .05$) with dietary treatment	4
ASD	Silva et al, 2020[59]	Cross-sectional study	Brazil	n = 39 3–10 years 15.4% female	previous diagnostic of ASD gastrointestinal symptoms assessed with a questionnaire concerning the occurrence of diarrhea, constipation, bloating, gas, nausea, vomiting, and gastroesophageal reflux in the previous 30 days before the survey	IN PEDIATRIC AGE: evaluation of food intake in the past 24 hours of the interview, categorized into gluten sources, casein sources, and ultraprocessed foods	n = 39 (100%)	—	In this sample (n = 3), only gluten consumption was associated with gastrointestinal manifestations (β = 0.38; 95% CI 0.07–0.75; $P = .02$). Casein and ultraprocessed foods were not associated with gastrointestinal symptoms ($P > .05$)	4
ASD	Whiteley et al, 2010[60]	RCT (8–24 months)	Denmark	n = 55 4–10.9 years 10.9% female	Diagnostic: ICD-10 Symptomatology: Autism Diagnostic Observation Schedule (ADOS); Gilliam Autism Rating Scale (GARS); Attention-Deficit Hyperactivity Disorder Rating Scale IV (ADHD-RS-IV) (Inattention and hyperactivity)	IN PEDIATRIC AGE: placebo or gluten-free and casein-free diet during 8, 12, 20, or 24 months	n = 55 (100%)	—	Children in the diet group (n = 27) showed a significant improvement at 12 months, in social interaction ($P = .0001$), inattention ($P = .0007$), and hyperactivity ($P = .0188$), compared with baseline	High risk of bias
ASD	Şengüzel et al, 2021[61]	Cross-sectional study	Turkey	n = 46 2–10 years 17.4% female	Diagnostic: previously obtained Symptomatology: Autism Behavior Checklist (ABC); Brief Autism Mealtime Behavior Inventory (BAMBI)	IN PEDIATRIC AGE: food consumption assessed with a Food Frequency Questionnaire	n = 46 (100%)	—	Consumption of milk was associated with higher BAMBI autism scores (r= -0.388, $P = .008$); consumption of oily seeds was associated	4

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SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
									with a higher ABC sensorial score (r = -0.338, P = .022); not consuming fresh fruits was associated with higher ABC relating scores (r=0.317, P = .032); no yoghurt consumption was associated with higher ABC language scores (r=0.302, P = .042)	
ASD	Sun et al, 2016[62]	Open-label trial (3 months)	China	n = 66 57.23 ± 15.06 months 18.2% female	Diagnostic: DSM-IV Symptomatology: Autism Behavior Checklist (ABC), Childhood Autism Rating Scale (CARS); Autism Treatment Evaluation Checklist (ATEC); Psychoeducational Profile-3 (PEP-3)	IN PEDIATRIC AGE: 400 μg of folic acid supplementation twice a day (a total of 800 μg/ day)	n = 66 (100%)	—	Folic acid supplementation in the intervention group (n = 44) improved autism symptoms toward sociability, cognitive verbal/preverbal ability, receptive language, affective expression, and communication, compared with baseline (P < .05)	High risk of bias
ASD	Taliou et al, 2013[63]	Open-label pilot study (26 weeks)	Greece	n = 40 79.94 ± 20.08 months 12.5% female	Diagnostic: DSM-IV Symptomatology: Vineland Adaptive Behavior Scales (VABS); Aberrant Behavior Checklist (ABC); Autism Treatment Evaluation Checklist (ATEC); Clinical Global Impressions–Improvement (CGI-I) scale	IN PEDIATRIC AGE: 1 soft gel capsule/10 kg (22 lb.) weight/day with food for 26 weeks, each capsule containing: 2 flavonoids (>95% pure), 100 mg of luteolin from chamomile, 70 mg of quercetin, and 30 mg of quercetin glycoside rutin from the *Sophora japonica* leaf	n = 40 (100%)	—	In this sample (n = 40), there was a significant improvement in adaptive functioning as measured by the VABS scores (P < .005), as well as in overall behavior as indicated by the reduction in ABC subscale scores (P < .05), after 26 weeks of supplementation, compared with baseline	High risk of bias
ASD	Tan et al, 2020[84]	Clinical trial (24 weeks)	China	n = 617 4.68 ± 1.94 years (ASD group); 4.47 ± 1.06 years (control group) 22% female	Diagnostic: DSM-V Symptomatology: Autism Behavior Checklist (ABC); Childhood Autism Rating Scale (CARS); Social Responsiveness Scale (SRS)	IN PREGNANCY: supplementation with folic acid or micronutrients during 2–4 weeks	n = 416 (67.4%)	Compared with the children whose mothers used FA supplementation during pregnancy, the children whose mothers did not use FA supplementation had	—	High risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
								an increased risk of ASD (OR) = 1.905, 95% CI: 1.238–2.933, $P = .003$), as well as children born to a mother who did not use micronutrient supplements during pregnancy, compared with children whose mother did (OR = 1.718, 95% CI: 1.196–2.468, $P = .003$)		
ASD	Voigt et al, 2014[64]	RCT (6 months)	United States	n = 48 6.1 ± 2.0 years 17% female	Diagnostic: DSM-IV Symptomatology: Child Development Inventory (CDI); Aberrant Behavior Checklist (ABC); Behavior Assessment Scale for Children (BASC)	IN PEDIATRIC AGE: daily supplementation during 6 months with triglyceride oil capsule containing 200 mg of DHA from algal oil +300 mg of oleic acid from sunflower oil; placebo capsule: 250 mg of corn oil +250 mg of soybean oil	n = 48 (100%)	—	The DHA group (n = 24) did not significantly improve in core symptoms of autism on the CGI-I, CDI, or ABC compared with the placebo group (n = 24) after 3 or 6 months of treatment ($P > .05$). Significant improvements were found in only 2 items (parent-social skills and teacher-functional communication) of the BASC ($P < .05$) after 6 months of treatment, compared with the placebo group	High risk of bias
Tourette Syndrome (TS)	Rizzo et al, 2022[74]	Open label trial (pilot study) (2 months)	Italy	n = 34 4–17 years 11.8% female	Diagnostic: DSM-V Symptomatology: Yale Global Tic Severity Scale (YGTSS); Children's Yale-Brown Obsessive-Compulsive Scale for Children (CY-BOCS); Anxiety Scale for Children (MASC) (anxiety)	IN PEDIATRIC AGE: nutritional supplementation with L-theanine (200 mg/day) and vitamin B6 (2.8 mg/day) vs placebo (psychoeducation)	n = 34 (100%)	--	After 2 months, supplementation with L-theanine and vitamin B6 was significantly more effective than psychoeducation in reducing severity of tics, anxiety, and co-occurring disorders in the supplementation group (n = 17), compared with the	High risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
									placebo group (n = 17) as measured by neuropsychological findings ($P < .05$)	
Autosomal trisomy	Botto et al, 2004[75]	Case-control study	United States	n =2976 2–16 years No information about gender	Diagnostic: Down syndrome (trisomy 21), trisomy 18, and trisomy 13 previously diagnosed	IN PREGNANCY: multivitamin use 3 months before and 3 months into pregnancy was asked through a structured questionnaire	n = 197 (0.1%)	Multivitamin use was not associated with a major reduction in the risk of common autosomal trisomy (OR = 0.9, 95% C I= 0.6–1.3), compared with no such use	—	7
Bipolar disorder (PBD) and ADHD	Rucklidge et al, 2010[76]	Clinical trial (6 months)	Canada	n = 161 7–18 years 40.8% female	Diagnostic: previously obtained Symptomatology: Self-Monitoring Form (DSM-specified mood symptoms and ADHD index)	IN PEDIATRIC AGE: supplementation with a 36-ingredient micronutrient formula (EMPowerplus) for 3–6 months	Children with only PBD = 91 (56.5%); children with PBD and ADHD = 29 (18%); children with only ADHD = 41 (25.5%)	—	At follow-up, the mean of bipolar symptom severity was 44% lower than baseline ($P < .001$) in children with only PBD. In children with both PBD and ADHD, there was a 43% decline in bipolar symptoms and 40% decline in ADHD symptoms, compared with baseline ($P < .002$). Children with only ADHD showed a 47% reduction in symptoms from baseline to follow-up ($P < .001$)	High risk of bias
Dyslexia	Lindmark et al, 2007[70]	Open pilot study (5 months)	Sweden	n = 17 9–17 years 33% female	Diagnostic: previously obtained Symptomatology: objective word-chain test	IN PEDIATRIC AGE: 8 capsules per day of a long-chain polyunsaturated fatty acid (LC-PUFA) supplement containing high-DHA fish oil and evening primrose oil	n = 17 (100%)	—	13 of 17 children (76.4%) had a significant improvement on the word-chain test ($P = .04$). Reading speed improved by 60% after supplementation, compared with baseline ($P = .01$)	High risk of bias
Dyslexia	Kairaluoma et al, 2009[71]	RCT (90 days)	Finland	n = 61 10.6 ± 1.1 years 42.6% female	Diagnostic: standardized reading test—Lukilasse (≥4 standard points below age	IN PEDIATRIC AGE: Ethyl-EPA (500 mg/day) and carnosine (400 mg/	n = 61 (100%)	—	There were no statistical differences between the EPA group (n = 30) and placebo	High risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
					level) + intelligence quotient (IQ) >80 Symptoms: word and pseudo-word reading tasks; text-reading task; spelling subtest of Lukilasse; standardized test for decoding fluency; Rapid serial naming test; Wechsler Intelligence Scale for Children-III	day) supplementation vs placebo			(n = 31) in reading accuracy, speed measured on any of the four reading tests, spelling, decoding fluency, arithmetical skills, language skills, and teacher and parental assessments of attention and behavior problems ($P > .05$)	
Epilepsy	Ijff et al, 2016[72]	RCT (19 weeks)	The Netherlands	n = 50 1.1–16.5 years 42% female	Diagnostic: previously obtained Symptomatology: Profile of Mood States (POMS) questionnaire; Peabody Picture Vocabulary test (PPVT-III-NL); Hague Restrictions in Childhood Epilepsy Scale (HARCES); Personal Adjustment and Role Skills Scale III (PARS-III) questionnaire	IN PEDIATRIC AGE: ketogenic diet (KD) vs control diet	n = 50 (100%)	—	At the 4-month follow-up, the KD group (n = 28) had a higher score on the subscale "vigor" (energy') in POMS, a significant seizure reduction according to the HARCES rating, a higher score on the subscale 'productivity' in PARS-III, and less anxious and mood-disturbed behavior on the SEV subscale, compared with the control group (n = 22) ($P < .05$)	High risk of bias
Epilepsy	Hallböök et al, 2015[73]	Cohort study (2 years of follow-up)	Denmark, Norway, and Sweden	n = 290 5.3 years (median age at diet introduction) 49.3% female	Diagnostic: International League Against Epilepsy (ILAE); Symptomatology: seizure frequency	IN PEDIATRIC AGE: ketogenic diet at a 3:1 or 4:1 ratio calculated on an individual basis by a dietitian and fully supplemented with vitamins and minerals (follow-ups at 3, 6, 12, and 24 months)	n = 290 (100%)	—	The association between the ketogenic diet and seizure reduction was statistically significant at 3, 6, and 12 months ($P < .05$) (n = 290), compared with number of seizures at the start of treatment	4
Intellectual Disability	Gore et al, 2015[77]	Cross-sectional study (integrated into a cohort Study)	United Kingdom	n = 18504 7 years No information about gender	Diagnostic and Symptomatology: Bracken School Readiness Assessment (≥2 standard deviations below the mean for a confirmed diagnosis);	IN PEDIATRIC AGE: maternal self-reported breastfeeding habits when the child was 9 months old	n = 539 (3%)	—	Those who were ever breastfed (n = 13085), breastfed at 3 months (n = 7155), exclusively breastfed at 3 months (n = 4701), and	5

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Table 2 (*continued*)

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					British Ability Scales (BAS) Naming Subscale				breastfed at 6 months (n = 4353) have less intellectual disability symptoms at 9 months ($P < .001$), compared with children without breast-feeding (OR: 0.56, CI: 0.47–0.67; OR: 0.50, CI: 0.41–0.61; OR: 0.53, CI:0.42–0.68, OR: 0.53, CI:0.42–0.68, respectively)	
Learning disabilities	Carlton et al, 2000[65]	RCT (1 year)	United States	n =19 7–14 years 30% female	Diagnostic: New York State criteria; previous records; psychoeducational tests (Wechsler Intelligence Scale for Children; Wide Range Achievement Test, Detroit Test of Learning Aptitude, Test of Written Language, Woodstock Reading Mastery, Coopersmith Self-Esteem Inventory, Standford Achievement Test, Bender-Gestalt Test) Symptomatology: parent-reported behavior and psychoeducational tests	IN PEDIATRIC AGE: placebo vs bottle containing 1 of the 3 nutrients: magnesium, pyridoxine, and ascorbic acid according to the recommended daily allowance	n = 19 (100%)	—	Some children gained 3–5 years in reading comprehension within the first year of treatment. All children in special education classes had their grades grown significantly ($P < .01$)	High risk of bias
Learning disabilities (ADD/ ADHD, tutoring for reading and math, attending summer school, special class placement, Individualized Education Plan, repeating a grade, and low educational attainment)	Carwile et al, 2016[66]	Cohort study	United States	n =1689 7–13 years 73% female	Diagnostic and symptomatology: self-administered questionnaires	IN PEDIATRIC AGE: fish consumption reported in self-administered questionnaires	n = 451 (27%)	—	Participants who ate fish several times a week had an elevated odds of ADD/ADHD (odds ratio: 5.2; 95% confidence interval: 1.5–18) compared with participants who did not eat fish	5
Learning disabilities	Thiessen et al, 1975[68]	Clinical trial (12 weeks)	United States	n = 33 7.5–14.9 years	Diagnostic: extreme difficulty in reading and spelling, with	IN PEDIATRIC AGE: administration of mega	n = 24 (72.7%)	—	No significant changes were observed in	High risk of bias

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
(extreme difficulty in reading and spelling, dyslexia, and other behavioral problems)				24.2% female	or without other behavioral problems Symptomatology: Illinois Test of Psycholinguistic Ability (sensory function); The Glen Green Perceptual Dysfunction Questionnaire (behavior)	doses of vitamins, daily: 3 g of ascorbic acid, 3 g of niacinamide, 250 mg of pyridoxine, and 250 mg of pantothenic acid for 12 weeks			reading and spelling levels in the experimental group (n = 24) after intervention, compared with control (n = 9) ($P > .05$). However, there was an improvement in the reduction in hyperkinesis, sleep disturbance, and nystagmus in experimental children receiving mega doses of vitamin C, vitamin B-sub-3, pantothenic acid, and vitamin B-sub-6 (plus a high-protein low-carbohydrate diet), compared with the control group ($P < .05$)	
Specific learning difficulties (weak working memory and phonological processing, specific reading difficulties, dyslexia)	Richardson et al, 2002[67]	RCT (2 weeks)	United Kingdom	n = 41 10.25 ± 0.74 years 14.6% female	Diagnostic: DSM Inattention, DSM Hyperactive–Impulsive and DSM Combined-type scores above age; Conners Parent Rating Scale (CPRS-L) Symptomatology: CPRS-L (behavior and learning problems)	IN PEDIATRIC AGE: intervention group: n-3 and n-6 PUFA supplementation for 2 weeks, daily: 186 mg of EPA, 480 mg of DHA, 96 mg of γ-linolenic acid, 60 IU of vitamin E, 864 cis-linoleic acid, 42 mg of AA, and 8 mg of thyme oil; placebo group: olive oil	n = 41 (100%)	—	After 12 weeks, mean scores for cognitive problems and general behavior problems were significantly lower for the group treated with PUFA (n = 15), compared with the placebo group (n = 14) ($P < .05$)	High risk of bias
Learning and ehavioural disabilities (hyperactivity, slow learning, emotional disturbance, emotional deficit)	Colgan et al, 1984[69]	Case-control study	United States	n = 32 3–15 years 31.2% female	Diagnostic: previously obtained Symptomatology: Stanford–Binet IQ Test (cognitive function); behavior and reading scales (unspecified)	IN PEDIATRIC AGE: individually designed vitamin and mineral supplements + modified diet to reduce sugars, refined foods, and toxic metal contamination	n = 32 (100%)	—	There was a significant difference in IQ scores in the follow-up at 19 weeks and in reading improvement in the follow-up at 20 weeks, between supplemented group (n = 16) and control	5

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Table 2 (*continued*)

SEN-related condition or disability	Author, year (reference)	Type of study	Country	Child/adolescent sample size, age, and sex	Method for diagnostic/ symptomatology assessment	Diet element study (in pregnancy or during pediatric age)	Prevalence of SEN-related condition or disability	Risk of diagnosis	Symptomatology/ well-being	Quality assessment score
									group (n = 16) ($P < .05$)	
Smith–Lemli–Opitz syndrome	Sikora et al, 2004[78]	Open trial (6 years of follow-up)	United States	n = 14 1 month–13 years, 4 months 64.3% female	Diagnostic: previously obtained Symptomatology: Bayley Scales of Infant Development; Vineland Adaptive Behavior Scales; Peabody Developmental Motor Scales	IN PEDIATRIC AGE: cholesterol supplementation with egg yolks (approximately 18–60 mg/kg/ d cholesterol, depending on age)	n = 14 (100%)	—	There were no statistically significant differences between cholesterol supplementation and these syndrome symptoms, at the end of the follow-up ($P > .05$)	High risk of bias

ADD, attention-deficit disorder; ADHD, attention-deficit/hyperactivity disorder; CI, confidence interval; DSM, Diagnostic and Statistical Manual of Mental Disorders; HR, hazard ratio; ICD-10, International Classification of Diseases, 10th revision; OR, odds ratio; RCT, randomized controlled trial; RR, relative risk; SEN, special educational need.

Diagnostic and Statistical Manual of Mental Disorders, fourth and fifth editions (DSM-IV/DSM-IV-TR and DSM-V), presented in 20 of 41 articles. For ADHD symptomatology, the tools included Conners Rating Scales (CRS) and subscales used in 14 of 41 articles, the ADHD Rating Scale (ADHD-RS) used in 10 of 41 articles, and the Strengths and Difficulties Questionnaire (SDQ) used in 6 of 41 articles. For ASD diagnosis, the most frequently used assessment tools were also DSM-IV and DSM-V, presented in 13 and 7 of 34 studies, respectively. Regarding ASD symptomatology evaluation, the Childhood Autism Rating Scale (CARS), the Aberrant Behavior Checklist, and the Autism Behavior Checklist were the ones most used, presented in 8, 6, and 5 of 34 articles, respectively. For the other 8 SEN-related conditions or disabilities listed, 5 were already previously diagnosed in the beginning of the study, and considering symptomatology, 17 different scales were used to assess it http://links.lww.com/PBJ/A39.

10 articles had information regarding the association between pregnant women's diet and the diagnosis of SEN-related conditions or disabilities in pediatric age, with 4 being related to ADHD,[6,19,79,80] 5 to ASD,[7,81-84] and 1 to autosomal trisomy diagnosis.[75] 78 articles studied the association between the diet of children and/or adolescents and the symptomatology and well-being of children and/or adolescents with ADHD (38 articles), ASD (29 articles), learning disabilities,[10,65-69] dyslexia,[70,71] epilepsy,[72,73] TS,[74] PBD,[76] intellectual disability,[77] and Smith–Lemli–Opitz syndrome.[78]

Regarding pregnant women's diet, the most studied dietary elements were multivitamin supplementation,[7,75,81,83] folic acid supplementation,[7,83,84] diet quality evaluation,[6] and caffeine intake.[79,80]

Considering ADHD, 1 study found that a low maternal diet quality score during pregnancy was associated with an increased risk of an ADHD diagnosis in children, compared with a higher maternal diet quality score during pregnancy.[6] 2 studies did not find any significant relationship between caffeine intake during pregnancy (for categories of consumption up until more than 425 mg per day) and the incidence of ADHD in children, considering coffee, yerba mate, tea, or cola, compared with children of mothers who consumed <100 mg/day of caffeine during pregnancy.[79,80] Regarding ASD, 2 studies found a negative association between multivitamin supplementation during pregnancy and the risk of ASD diagnosis, compared with mothers who did not use multivitamins, iron, and folic acid during pregnancy,[7,83] while 1 study found a positive association (with a damaging effect) between both high (>5 times/week) and low (≤2 times/week) multivitamin supplementation doses and the risk of ASD, compared with the intake of moderate multivitamin supplementation doses (3–5 times/week) during pregnancy.[81] In one of these studies, when folic acid or iron supplementation was added to the multivitamin treatment, no significant changes were observed.[83] However, in the other study, a protective effect of folic acid supplementation during pregnancy, considering ASD diagnosis, was found, independently of its use being isolated or combined with multivitamin supplementation.[7]

Considering children and adolescents' diet, the most studied dietary elements were polyunsaturated fatty acid (PUFA) supplementation,[20,23,25,31-33,36,37,53,54,57,64,67,70,71,85-88] gluten-free diet/casein-free diet/gluten–casein-free diet,[42-44,46-50,58-60,89] vitamin D supplementation,[24,41,52-54,90,91] micronutrient supplementation,[22,39,65,68,76] breastfeeding,[77,92-94] magnesium supplementation,[24] and folic acid[62] supplementation.

Considering ADHD, PUFA supplementation was associated with symptomatology improvements in 6 studies, namely regarding ADHD behavioral symptoms,[20,25,33,85] working memory function,[36] and word reading improvement,[86] compared with placebo groups. However, in 3 studies, none of those associations were found,[23,37,88] compared with placebo groups. 5 studies found associations between the intake of processed food and food with high fat, sugar, and salt (fast food, instant noodles, sugar-sweetened beverages, fried food, sweet desserts, and high energy intake) and higher ADHD behavioral symptomatology manifestation,[8-10,95,96] compared with children who did not consume these type of foods. Finally, 2 studies found a protective association between breastfeeding (>28 weeks) and ADHD behavioral symptoms,[92,93] compared with children who were breastfed for a short time.

Regarding ASD, 5 studies found an association between vitamin D3 supplementation and ASD behavioral symptom improvement,[52-54,90,91] compared with the placebo group/absence of supplementation. However, 1 study did not find such association.[41] PUFA supplementation was associated with symptom improvement in 3 studies,[53,54,57] compared with the placebo group or baseline period, although there was no association in another different one.[64] However, in one of these studies, combined vitamin D3 and PUFA supplementation showed a protective effect over ASD behavioral symptomatology,[54] compared with the placebo group. In 2 studies, a gluten-free and casein-free diet showed a significant effect on improving ASD behaviors, physiological symptoms, and social behaviors,[58,60] compared with children with ASD on the experimental diet, but without gastrointestinal symptoms,[58] or compared with children with ASD in the placebo group.[60] In 2 other studies, a gluten-free diet showed a significant effect on improving behavioral symptoms[47] and/or gastrointestinal symptoms,[47,59] compared with the consumption of a regular diet with gluten. On the contrary, 5 articles about the gluten-free and casein-free diet[42,46,48-50] and 3 articles about the gluten-free diet[43,44,89] did not found a significant relationship between the respective diets and ASD symptomatology improvement.

Considering epilepsy, 2 studies showed significant improvements considering the disease severity, including seizure reduction, during a ketogenic diet treatment,[72,73] compared with the control diet[72] or the number of seizures at the baseline period.[73] For intellectual disabilities, children who were breastfed had less symptoms compared with children who were not ever breastfed, in 1 study.[77] Regarding dyslexia, PUFA supplementation had a protective association with symptomatology in one study[70] while another did not find any association,[71] compared with the baseline period[70] or placebo group.[71] Regarding learning disabilities, significant improvements in cognitive function with multivitamin and PUFA supplementation were found in 3 studies[65,68,69] and 1 study,[67] respectively, compared with the placebo group.

Discussion

In this systematic review, the following SEN-related conditions or disabilities were considered according to the definition of each study included: ADHD, ASD, learning disabilities, dyslexia, epilepsy, TS, autosomal trisomy, PBD, intellectual disability, and Smith–Lemli–Opitz syndrome. A SEN can include a wide range of different disabilities and spectra, being sometimes difficult to isolate each one from another. which needs to be taken into consideration when analyzing the results of this review. In that

case, the child would be considered in the "multiple disabilities" category of the IDEA program.[3] Considering the articles included in this review, a child could be, for example, diagnosed not only with ADHD but also with learning disabilities.[10] This needs to be taken into consideration when analyzing the results of this review. As so, in this review, when an article includes more than one SEN-related condition or disability, the results are specified for each condition mentioned.[10,76,94]

In general, the studies included in this review are widely distributed across the different continents of the world, corroborating that this theme is a global theme studied around the world, which has gained importance over the years.[12]

Regarding the diagnostic tests used in the different articles included in this review, the main tool found was the DSM (mainly 4th and 5th editions), appearing in 44 of 88 articles. Apart from the DSM, other additional 20 tests were identified. For symptomatology assessment, 66 different methods were found in the different studies, in total. This fact helps to explain some differences in these review results. For example, there are studies related to the use of gluten-free and/or casein-free diet in ASD included that do not show any clinically significant improvement in the disorder when using the Childhood Autism Rating Scale (CARS) and the Ecological Communication Orientation Scale (ECOS). However, considering parents' reporting, an improvement in the outcome was detected.[46,50] In addition, for the same dietary element studied in this review, the symptomatology type studied was very diverse for the same SEN-related condition or disability, making the comparison between study results difficult. For example, regarding the association between PUFA supplementation and ADHD symptomatology in children and adolescents, 1 article studies ADHD general symptoms with the Child Behavior Checklist (CBCL) and Strengths and Weaknesses of ADHD Symptoms and Normal Behavior Scale (SWAN)[20] while the other article studies only hyperactivity symptoms with the Conners Abbreviated Symptom Questionnaire (ASQ-P).[25]

Considering the relationships between pregnant women's diet and diagnosis of SEN-related conditions or disabilities, there does not seem to exist any association between caffeine consumption and the risk of ADHD during childhood.[79,80] In a previously review published in 2015 assessing this subject, also no association was found.[97] It is important to mention that the 2 studies included are cohort studies, with a quality assessment score of 8 and 6, respectively. Therefore, supporting evidence seems to exist to restrict caffeine consumption in pregnant women when it comes to ADHD, but further research should be conducted to reach more consistent results.

Considering a previous meta-analysis, folic acid or multivitamin supplementation during pregnancy showed to be protective against children's risk of ASD (relative risk (RR) = 0.64, 95% CI = [0.46; 0.90]),[98] which is consistent with the results obtained in this review, in 3 cohort studies included.[7,81,83] These 2 studies had a quality assessment score of 7.[7,81,83] It needs to be taken into consideration that the only study included in this review showed damaging effects of multivitamin supplementation during pregnancy on ASD risk in offspring, referred to high (>5 times/week) or low (≤2 times/week) frequency, supporting that moderate supplementation should be recommended.[81]

Regarding the relationships between children and adolescents' diet and symptomatology of SEN-related conditions or disabilities, according to a critical review made in 2020, there are many inconsistent results about the effect of PUFA supplementation on children and adolescents with ADHD, concluding that further research is necessary.[99] In this review, 5 of 9 studies showed a protective effect,[20,25,33,36,85] with 3 of them having a high risk of bias, 1 of them having some concerns, and 1 having low risk of bias. However, 4 studies did not find any association,[23,37,86,88] 2 having a high risk of bias and 2 having a low risk, also revealing this inconsistency.

Considering different foods and beverages, our results include 5 studies that found an association between the intake of processed food and beverages with high sugar, fat, and salt content and the increase in ADHD severity[8-10,95,96] while fruits, vegetables, and milk products were associated with symptomatology improvement.[8,10] Within these 5 studies, 2 had an overall quality assessment score of 5 points,[8,95] 2 studies had 6 points,[9,10] and 1 study had 7 points.[96] It needs to be taken into consideration that 4 of these studies are cross-sectional,[8,10,95,96] meaning that reverse causality can affect the results—whether these eating habits resulted in the outcome or whether the severity of the condition resulted in these eating habits. Indeed, an association between sugar and sugar-sweetened beverage intake and ADHD symptoms had been already shown in a 2020 meta-analysis, which corroborates these results.[100] Despite the meta-analysis findings, more research regarding dietary patterns in only children and/or adolescents with ADHD should be conducted, considering that the previously referred study included both children with ADHD and without ADHD.

Considering breastfeeding, 2 meta-analyses had concluded that it seems to be associated with a lower risk of ADHD in children.[101,102] It needs to be taken into consideration that these 2 meta-analyses studied the relationship between breastfeeding and risk of ADHD while this review studied the relationship between breastfeeding and ADHD symptoms, as 2 of 3 studies, with an overall quality assessment score of 7 points, found a protective association between breastfeeding and the severity of symptoms in children with ADHD.[92-94] Further studies that distinguish the risk of ADHD diagnosis vs the severity of symptoms of children with an established diagnosis, regarding their association with breastfeeding, should be conducted.

Regarding ASD symptoms and their association with vitamin D supplementation, most studies included seem to show that this supplementation leads to an improvement. In 2017, a narrative review concluded that vitamin D supplementation seemed to be beneficial in improving symptomatology.[103] It needs to be considered that the articles included in this review involve different dosage levels of supplementation and different proportions of individuals with vitamin D deficiency, considering that children with autism tend to naturally have a higher risk of vitamin D deficiency, which can influence these results.[103,104] In addition, although they were mostly randomized controlled trials, they had a high risk of bias, supporting that further research should be conducted.

Regarding the relationship between PUFA supplementation and ASD symptoms, overall, there seems to be an association between the 2 factors, with only 1 in 4 studies included showing no association.[64] A previous meta-analysis described some inconsistent results and a lack of studies focusing on this topic.[105] It is important to notice that all 4 studies included in this systematic review present a high risk of bias. For this reason, further research is also recommended.

Considering gluten-free and casein-free diet, 5 of 7 studies included in this review did not support the use of this diet to reduce ASD behavioral severity.[42,46,48,50] Interestingly, despite the statistically insignificant results, considering the information resource, parents tend to report an improvement in ASD symptoms of their children.[46,50] Besides this, it needs to be taken

into consideration that 2 of the 7 studies are cross-sectional,[50,58] meaning that reverse causality can affect the results—whether these selective eating patterns resulted in the outcome or whether the severity of the condition resulted in these selective eating habits. However, a systematic review published in 2018 supports our results, showing no evidence for the use of these diets in ASD, regarding the improvement of symptom severity, referring that some differences found in their study results were related to the use of parent-report tools.[106]

Considering the relationships between children and adolescents' diet and epilepsy, the 2 studies included, 1 RCT with a high risk of bias and 1 cohort study with a quality assessment score of 4 points, support the protective effect of ketogenic diet on seizure reduction.[72,73] These results are supported by the existing evidence presented in the literature, namely a 2020 review that studied the efficacy and tolerability of the ketogenic diet from randomized controlled trials (RCTs) in children and adolescents with refractory epilepsy.[107] This review concluded that the Atkins diet (a modified ketogenic diet) should be considered for children and adolescents with refractory epilepsy who are not eligible for epilepsy surgery, considering the beneficial results.[107]

Finally, relative to the studies included in this review about learning disabilities, an association between symptom improvement and multivitamin supplementation has been found,[65,68,69] with 2 studies having a high risk of bias.[65,68] Although there are no systematic reviews addressing this specific subject, a review published in 2012 suggested cognitive and behavioral benefits after vitamin and mineral supplementation with or without n-3 PUFA supplementation.[108]

Regarding the other SEN-related conditions or disabilities studies included in this review (dyslexia, TS, autosomal trisomy, PBD, intellectual disability, and Smith–Lemli–Opitz syndrome), because of the small number of studies included for each condition/disability, and considering, at the same time, the different dietary elements, it is not possible to extrapolate results and discuss them more broadly. For this reason, the main conclusion is that further studies about these SEN-related conditions or disabilities should be conducted.

The studies included in this systematic review also present some limitations. The sample size of each study included is widely variable, as well as the methods used in each study for diagnostic and/or symptomatology assessment of one same disorder (for example, different scales and report methods). These different methodologies make it difficult to compare and discuss results. Moreover, the significant heterogeneity observed across the data precluded the possibility of conducting a meta-analysis or other forms of aggregated statistical analysis. As a result, a purely descriptive approach was used to summarize the findings. This limitation not only affects the robustness of the conclusions but also restricts the ability to generalize the results across different contexts. Future studies should aim to standardize data collection methods and reduce variability to allow for more rigorous quantitative analysis and stronger, more conclusive insights. In addition, the fact that there are still SEN-related conditions or disabilities with few studies covering pediatric age on this theme makes it hard to extrapolate results. Finally, for this systematic review, only 2 databases were used to conduct the research, which means that there may be relevant studies on the subject that were not included. Therefore, a third database should be used in further studies.

Apart from these limitations, there are strengths associated with this systematic review. It is the first one to assess the different disabilities eligible for a SEN classification and to study the relationships between the diet of pregnant women and children/adolescents and the diagnosis and symptomatology of SEN-related conditions or disabilities, respectively. This review included 87 articles, with a high proportion of experimental studies, including RCTs, allowing the establishment of causal relationships, essential to respond to our concrete objectives. In addition, the quality of the studies included was assessed, allowing a greater care in the interpretation of the results.

This study can contribute to the field of clinical nutrition by helping to establish guidelines for pregnant women and children and adolescents with SENs that can help not only to reduce the incidence of these diagnosis but also to control the symptoms associated when a diagnosis is already established, aiming for a better life quality supporting this group.

Conclusions

This systematic review includes studies referring to the following SEN-related conditions or disabilities: attention-deficit/hyperactivity disorder, autism spectrum disorder, learning disabilities, dyslexia, epilepsy, Tourette syndrome, autosomal trisomy, pediatric bipolar disorder, intellectual disability, and Smith–Lemli–Opitz syndrome.

Regarding the effect of pregnant women's diet and the diagnosis of SEN-related conditions or disabilities among children and adolescents, it stands out the fact that it does not seem to exist an association between caffeine consumption from diet and the risk of ADHD in children and adolescents. A protective effect stands out, considering pregnant woman multivitamin supplementation, in moderate doses, on the risk of ASD diagnosis.

Regarding the relation between the diet of children and adolescents with SEN, we highlight the fact that the consumption of fast food and sugar-sweetened beverages is associated with an increase in ADHD symptom's severity. In addition, no association was found between gluten-free and casein-free diet and ASD symptomatology. Maternal breastfeeding and vitamin D supplementation seem to have a protective effect on ASD symptoms. PUFA supplementation presented inconsistent results regarding their effect on ASD symptomatology.

More studies are needed to support the results of this review, namely regarding the associations between each dietary element studied for pregnant women/children/adolescents and diagnosis and symptomatology of SEN-related conditions or disabilities. Until then, the results of this review may prove to be highly relevant to develop guidelines for specific dietary recommendations for this population.

References

[1] Organisation for Economic Co-operation and Development (OECD). Special Educational Needs (SEN); 2012. Available at: https://www.oecd.org/els/family/50325299.pdf. Accessed May 10, 2022
[2] International Institute for Educational Planning (IIEP-UNESCO). Special Educational Needs—Definition; 2017. Available at: https://policytoolbox.iiep.unesco.org/glossary/special-educational-needs/. Accessed May 10, 2022
[3] Congressional Research Service. The Individuals with Disabilities Education Act (IDEA): A Comparison of State Eligibility Criteria; 2020. Available at: https://crsreports.congress.gov/product/pdf/R/R46566. Accessed May 10, 2022
[4] American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-V). Arlington, VA: American Psychiatric Association; 2013.
[5] National Center for Education Statistics. Students With Disabilities. U.S. Department of Education—Institute of Education Sciences; 2022.

Available at: https://nces.ed.gov/programs/coe/indicator/cgg. Accessed May 16, 2022
[6] Borge TC, Biele G, Papadopoulou E, et al. The associations between maternal and child diet quality and child ADHD—findings from a large Norwegian pregnancy cohort study. BMC Psychiatry. 2021;21:139.
[7] Levine SZ, Kodesh A, Viktorin A, et al. Association of maternal use of folic acid and multivitamin supplements in the periods before and during pregnancy with the risk of autism spectrum disorder in offspring. JAMA Psychiatry. 2018;75:176–84.
[8] Kim KM, Lim MH, Kwon HJ, et al. Associations between attention-deficit/hyperactivity disorder symptoms and dietary habits in elementary school children. Appetite. 2018;127:274–9.
[9] Yu CJ, Du JC, Chiou HC, et al. Sugar-sweetened beverage consumption is adversely associated with childhood attention deficit/hyperactivity disorder. Int J Environ Res Public Health. 2016;13:678.
[10] Park S, Cho SC, Hong YC, et al. Association between dietary behaviors and attention-deficit/hyperactivity disorder and learning disabilities in school-aged children. Psychiatry Res. 2012;198:468–76.
[11] World Health Organization. Adolescent Health. 2019. World Health Organization. Available at: https://www.who.int/health-topics/adolescent-health#tab=tab_1. Accessed May 18, 2022
[12] PubMed. Special Educational Needs—Results by Years. PubMed; 2022. Available at: https://pubmed.ncbi.nlm.nih.gov/?term=special+educational+needs&filter=age.allchild&filter=age.newborn&filter=age.allinfant&filter=age.infant&filter=age.child&filter=age.adolescent&filter=age.preschoolchild. Accessed May 18, 2022
[13] Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. BMJ. 2009;339:b2700.
[14] Shamseer L, Moher D, Clarke M et al, PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ. 2015;350:g7647.
[15] Clarivate Analytics. Endnote. Boston, MA: Clarivate Analytics; 2019.
[16] Wells G, Shea B, O'Connell D, et al. The Newcastle–Ottawa Scale (NOS) for Assessing the Quality of Non-Randomized Studies in Meta-Analysis. Ottawa, Canada: The Ottawa Hospital Research Institute; 2000. Available at: https://www.ohri.ca/programs/clinical_epidemiology/oxford.asp. (2000). Accessed August 8, 2022
[17] Moskalewicz A, Oremus M. No clear choice between Newcastle-Ottawa Scale and Appraisal Tool for Cross-Sectional Studies to assess methodological quality in cross-sectional studies of health-related quality of life and breast cancer. J Clin Epidemiol. 2020;120:94–103.
[18] Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ. 2019;366:l4898.
[19] Abel MH, Ystrom E, Caspersen IH, et al. Maternal iodine intake and offspring attention-deficit/hyperactivity disorder: results from a large prospective cohort study. Nutrients. 2017;9:1239.
[20] Bélanger SA, Vanasse M, Spahis S, et al. Omega-3 fatty acid treatment of children with attention-deficit hyperactivity disorder: a randomized, double-blind, placebo-controlled study. Paediatr Child Health. 2009;14:89–98. [Article].
[21] Arnold LE, Bozzolo H, Hollway J, et al. Serum zinc correlates with parent- and teacher- rated inattention in children with attention-deficit/hyperactivity disorder. J Child Adolesc Psychopharmacol. 2005;15:628–36.
[22] Borlase N, Melzer TR, Eggleston MJF, Darling KA, Rucklidge JJ. Resting-state networks and neurometabolites in children with ADHD after 10 weeks of treatment with micronutrients: results of a randomised placebo-controlled trial. Nutr Neurosci. 2020;23:876–86.
[23] Crippa A, Tesei A, Sangiorgio F, et al. Behavioral and cognitive effects of docosahexaenoic acid in drug-naïve children with attention-deficit/hyperactivity disorder: a randomized, placebo-controlled clinical trial. Eur Child Adolesc Psychiatry. 2019;28:571–83.
[24] Hemamy M, Pahlavani N, Amanollahi A, et al. The effect of vitamin D and magnesium supplementation on the mental health status of attention-deficit hyperactive children: a randomized controlled trial. BMC Pediatr. 2021;21:178.
[25] Hariri M, Djazayery A, Djalali M, Saedisomeolia A, Rahimi A, Abdolahian E. Effect of n-3 supplementation on hyperactivity, oxidative stress and inflammatory mediators in children with attention-deficit-hyperactivity disorder. Malays J Nutr. 2012;18:329–35.
[26] Hirayama S, Terasawa K, Rabeler R, et al. The effect of phosphatidylserine administration on memory and symptoms of attention-deficit hyperactivity disorder: a randomised, double-blind, placebo-controlled clinical trial. J Hum Nutr Diet. 2014;27(Suppl 2):284–91.
[27] Hontelez S, Stobernack T, Pelsser LM, et al. Correlation between brain function and ADHD symptom changes in children with ADHD following a few-foods diet: an open-label intervention trial. Sci Rep. 2021;11:22205.
[28] Hsu CD, Hsieh LH, Chen YL, et al. Complementary effects of pine bark extract supplementation on inattention, impulsivity, and antioxidative status in children with attention-deficit hyperactivity disorder: a double-blinded randomized placebo-controlled cross-over study. Phytother Res. 2021;35:3226–35.
[29] Cremonte M, Sisti D, Maraucci I, et al. The effect of experimental supplementation with the Klamath Algae extract klamin on attention-deficit/hyperactivity disorder. J Med Food. 2017;20:1233–9.
[30] Dölp A, Schneider-Momm K, Heiser P, et al. Oligoantigenic diet improves children's ADHD rating scale scores reliably in added video-rating. Front Psychiatry. 2020;11:730.
[31] Ng KH, Meyer BJ, Reece L, Sinn N. Dietary PUFA intakes in children with attention-deficit/hyperactivity disorder symptoms. Br J Nutr. 2009;102:1635–41.
[32] Raz R, Carasso RL, Yehuda S. The influence of short-chain essential fatty acids on children with attention-deficit/hyperactivity disorder: a double-blind placebo-controlled study. J Child Adolesc Psychopharmacol. 2009;19:167–77. [Article].
[33] Perera H, Jeewandara KC, Seneviratne S, Guruge C. Combined ω3 and ω6 supplementation in children with attention-deficit hyperactivity disorder (ADHD) refractory to methylphenidate treatment: a double-blind, placebo-controlled study. J Child Neurol. 2012;27:747–53.
[34] Pelsser LM, Frankena K, Buitelaar JK, Rommelse NN. Effects of food on physical and sleep complaints in children with ADHD: a randomised controlled pilot study. Eur J Pediatr. 2010;169:1129–38.
[35] Pelsser LM, Frankena K, Toorman J, et al. Effects of a restricted elimination diet on the behaviour of children with attention-deficit hyperactivity disorder (INCA study): a randomised controlled trial. Lancet. 2011;377:494–503.
[36] Widenhorn-Müller K, Schwanda S, Scholz E, Spitzer M, Bode H. Effect of supplementation with long-chain ω-3 polyunsaturated fatty acids on behavior and cognition in children with attention deficit/hyperactivity disorder (ADHD): a randomized placebo-controlled intervention trial. Prostaglandins Leukot Essent Fatty Acids. 2014;91:49–60.
[37] Stevens L, Zhang W, Peck L, et al. EFA supplementation in children with inattention, hyperactivity, and other disruptive behaviors. Lipids. 2003;38:1007–21.
[38] Yorgidis E, Beiner L, Blazynski N, et al. Individual behavioral reactions in the context of food sensitivities in children with attention-deficit/hyperactivity disorder before and after an oligoantigenic diet. Nutrients. 2021;13:2598.
[39] Rucklidge JJ, Eggleston MJF, Darling KA, Stevens AJ, Kennedy MA, Frampton CM. Can we predict treatment response in children with ADHD to a vitamin-mineral supplement? An investigation into pre-treatment nutrient serum levels, MTHFR status, clinical correlates and demographic variables. Prog Neuropsychopharmacol Biol Psychiatry. 2019;89:181–92.
[40] Schmidt MH, Möcks P, Lay B, et al. Does oligoantigenic diet influence hyperactive/conduct-disordered children--a controlled trial. Eur Child Adolesc Psychiatry. 1997;6:88–95.
[41] Kerley CP, Power C, Gallagher L, Coghlan D. Lack of effect of vitamin D(3) supplementation in autism: a 20-week, placebo-controlled RCT. Arch Dis Child. 2017;102:1030–6.
[42] Alessandria C, Caviglia GP, Campion D, et al. HLA-DQ genotyping, duodenal histology, and response to exclusion diet in autistic children with gastrointestinal symptoms. J Pediatr Gastroenterol Nutr. 2019;69:39–44.
[43] Piwowarczyk A, Horvath A, Pisula E, Kawa R, Szajewska H. Gluten-free diet in children with autism spectrum disorders: a randomized, controlled, single-blinded trial. J Autism Dev Disord. 2020;50:482–90.
[44] Navarro F, Pearson DA, Fatheree N, Mansour R, Hashmi SS, Rhoads JM. Are 'leaky gut' and behavior associated with gluten and dairy containing diet in children with autism spectrum disorders? Nutr Neurosci. 2015;18:177–85.
[45] Levy SE, Souders MC, Ittenbach RF, Giarelli E, Mulberg AE, Pinto-Martin JA. Relationship of dietary intake to gastrointestinal symptoms

in children with autistic spectrum disorders. Biol Psychiatry. 2007;61: 492–7.
[46] Elder JH, Shankar M, Shuster J, Theriaque D, Burns S, Sherrill L. The gluten-free, casein-free diet in autism: results of a preliminary double blind clinical trial. J Autism Dev Disord. 2006;36:413–20.
[47] Ghalichi F, Ghaemmaghami J, Malek A, Ostadrahimi A. Effect of gluten free diet on gastrointestinal and behavioral indices for children with autism spectrum disorders: a randomized clinical trial. World J Pediatr. 2016;12:436–42.
[48] González-Domenech PJ, Díaz Atienza F, García Pablos C, Fernández Soto ML, Martínez-Ortega JM, Gutiérrez-Rojas L. Influence of a combined gluten-free and casein-free diet on behavior disorders in children and adolescents diagnosed with autism spectrum disorder: a 12-month follow-up clinical trial. J Autism Develop Disord. 2020;50: 935–48.
[49] Hyman SL, Stewart PA, Foley J, et al. The gluten-free/casein-free diet: a double-blind challenge trial in children with autism. J Autism Dev Disord. 2016;46:205–20.
[50] Harris C, Card B. A pilot study to evaluate nutritional influences on gastrointestinal symptoms and behavior patterns in children with Autism Spectrum Disorder. Complement Ther Med. 2012;20: 437–40.
[51] Inoue R, Sakaue Y, Kawada Y, et al. Dietary supplementation with partially hydrolyzed guar gum helps improve constipation and gut dysbiosis symptoms and behavioral irritability in children with autism spectrum disorder. J Clin Biochem Nutr. 2019;64:217–23. [Article].
[52] Javadfar Z, Abdollahzad H, Moludi J, et al. Effects of vitamin D supplementation on core symptoms, serum serotonin, and interleukin-6 in children with autism spectrum disorders: a randomized clinical trial. Nutrition. 2020;79-80:110986.
[53] Mazahery H, Conlon CA, Beck KL, et al. A randomised controlled trial of vitamin D and omega-3 long chain polyunsaturated fatty acids in the treatment of irritability and hyperactivity among children with autism spectrum disorder. J Steroid Biochem Mol Biol. 2019;187:9–16.
[54] Mazahery H, Conlon CA, Beck KL, et al. A randomised-controlled trial of vitamin D and omega-3 long chain polyunsaturated fatty acids in the treatment of core symptoms of autism spectrum disorder in children. J Autism Dev Disord. 2019;49:1778–94.
[55] Mehrazad-Saber Z, Kheirouri S, Noorazar SG. Effects of l-carnosine supplementation on sleep disorders and disease severity in autistic children: a randomized, controlled clinical trial. Basic Clin Pharmacol Toxicol. 2018;123:72–7.
[56] Nogay NH, Walton J, Roberts KM, Nahikian-Nelms M, Witwer AN. The effect of the low fodmap diet on gastrointestinal symptoms, behavioral problems and nutrient intake in children with autism spectrum disorder: a randomized controlled pilot trial. J Autism Dev Disord. 2021;51:2800–11.
[57] Ooi YP, Weng SJ, Jang LY, et al. Omega-3 fatty acids in the management of autism spectrum disorders: findings from an open-label pilot study in Singapore. Eur J Clin Nutr. 2015;69:969–71.
[58] Pennesi CM, Klein LC. Effectiveness of the gluten-free, casein-free diet for children diagnosed with autism spectrum disorder: based on parental report. Nutr Neurosci. 2012;15:85–91.
[59] Silva DVD, Santos PNM, Silva D. Excess weight and gastrointestinal symptoms in a group of autistic children. Rev Paul Pediatr. 2020;38: e2019080.
[60] Whiteley P, Haracopos D, Knivsberg AM, et al. The ScanBrit randomised, controlled, single-blind study of a gluten- and casein-free dietary intervention for children with autism spectrum disorders. Nutr Neurosci. 2010;13:87–100.
[61] Şengüzel S, Cebeci AN, Ekici B, Gönen İ, Tatlı B. Impact of eating habits and nutritional status on children with autism spectrum disorder. J Taibah Univ Med Sci. 2021;16:413–21. [Article].
[62] Sun C, Zou M, Zhao D, Xia W, Wu L. Efficacy of folic acid supplementation in autistic children participating in structured teaching: an open-label trial. Nutrients. 2016;8:337.
[63] Taliou A, Zintzaras E, Lykouras L, Francis K. An open-label pilot study of a formulation containing the anti-inflammatory flavonoid luteolin and its effects on behavior in children with autism spectrum disorders. Clin Ther. 2013;35:592–602.
[64] Voigt RG, Mellon MW, Katusic SK, et al. Dietary docosahexaenoic acid supplementation in children with autism. J Pediatr Gastroenterol Nutr. 2014;58:715–22.
[65] Carlton RM, Ente G, Blum L, Heyman N, Davis W, Ambrosino S. Rational dosages of nutrients have a prolonged effect on learning disabilities. Altern Ther Health Med. 2000;6:85–91.
[66] Carwile JL, Butler LJ, Janulewicz PA, Winter MR, Aschengrau A. Childhood fish consumption and learning and behavioral disorders. Int J Environ Res Public Health. 2016;13:1069.
[67] Richardson AJ, Puri BK. A randomized double-blind, placebo-controlled study of the effects of supplementation with highly unsaturated fatty acids on ADHD-related symptoms in children with specific learning difficulties. Prog Neuropsychopharmacol Biol Psychiatry. 2002;26:233–9.
[68] Thiessen I, Mills L. The use of megavitamin treatment in children with learning disabilities. J Orthomol Psychiatry. 1975;4:288–96. [Article].
[69] Colgan M, Colgan L. Do nutrient supplements and dietary changes affect learning and emotional reactions of children with learning difficulties? A controlled series of 16 cases. Nutr Health. 1984;3:69–77.
[70] Lindmark L, Clough P. A 5-month open study with long-chain polyunsaturated fatty acids in dyslexia. J Med Food. 2007;10:662–6.
[71] Kairaluoma L, Närhi V, Ahonen T, Westerholm J, Aro M. Do fatty acids help in overcoming reading difficulties? A double-blind, placebo-controlled study of the effects of eicosapentaenoic acid and carnosine supplementation on children with dyslexia. Child Care Health Dev. 2009;35:112–9.
[72] IJff DM, Postulart D, Lambrechts D, et al. Cognitive and behavioral impact of the ketogenic diet in children and adolescents with refractory epilepsy: a randomized controlled trial. Epilepsy Behav. 2016;60: 153–7.
[73] Hallböök T, Sjölander A, Åmark P, Miranda M, Bjurulf B, Dahlin M. Effectiveness of the ketogenic diet used to treat resistant childhood epilepsy in Scandinavia. Eur J Paediatr Neurol. 2015;19:29–36.
[74] Rizzo R, Prato A, Scerbo M, Saia F, Barone R, Curatolo P. Use of nutritional supplements based on L-theanine and vitamin B6 in children with Tourette syndrome, with anxiety disorders: a pilot study. Nutrients. 2022;14:852.
[75] Botto LD, Mulinare J, Yang Q, Liu Y, Erickson JD. Autosomal trisomy and maternal use of multivitamin supplements. Am J Med Genet A. 2004;125a:113–6.
[76] Rucklidge JJ, Gately D, Kaplan BJ. Database analysis of children and adolescents with bipolar disorder consuming a micronutrient formula. BMC Psychiatry. 2010;10:74.
[77] Gore N, Emerson E, Brady S. Rates of breastfeeding and exposure to socio-economic adversity amongst children with intellectual disability. Res Dev Disabil. 2015;39:12–9.
[78] Sikora DM, Ruggiero M, Petit-Kekel K, Merkens LS, Connor WE, Steiner RD. Cholesterol supplementation does not improve developmental progress in Smith-Lemli-Opitz syndrome. J Pediatr. 2004;144:783–91.
[79] Del-Ponte B, Santos IS, Tovo-Rodrigues L, Anselmi L, Munhoz TN, Matijasevich A. Caffeine consumption during pregnancy and ADHD at the age of 11 years: a birth cohort study. BMJ Open. 2016;6:e012749.
[80] Loomans EM, Hofland L, van der Stelt O, et al. Caffeine intake during pregnancy and risk of problem behavior in 5- to 6-year-old children. Pediatrics. 2012;130:e305–13.
[81] Raghavan R, Riley AW, Volk H, et al. Maternal multivitamin intake, plasma folate and vitamin B(12) levels and autism spectrum disorder risk in offspring. Paediatr Perinat Epidemiol. 2018;32:100–11.
[82] Li YM, Shen YD, Li YJ, et al. Maternal dietary patterns, supplements intake and autism spectrum disorders: a preliminary case-control study. Medicine (Baltimore). 2018;97:e13902.
[83] DeVilbiss EA, Magnusson C, Gardner RM, et al. Antenatal nutritional supplementation and autism spectrum disorders in the Stockholm youth cohort: population based cohort study. BMJ. 2017;359:j4273.
[84] Tan M, Yang T, Zhu J, et al. Maternal folic acid and micronutrient supplementation is associated with vitamin levels and symptoms in children with autism spectrum disorders. Reprod Toxicol. 2020;91: 109–15.
[85] Bos DJ, Oranje B, Veerhoek ES, et al. Reduced symptoms of inattention after dietary omega-3 fatty acid supplementation in boys with and without attention deficit/hyperactivity disorder. Neuropsychopharmacol. 2015;40:2298–306.
[86] Milte CM, Parletta N, Buckley JD, Coates AM, Young RM, Howe PR. Eicosapentaenoic and docosahexaenoic acids, cognition, and behavior in children with attention-deficit/hyperactivity disorder: a randomized controlled trial. Nutrition. 2012;28:670–7.
[87] Joshi K, Lad S, Kale M, et al. Supplementation with flax oil and vitamin C improves the outcome of attention deficit hyperactivity disorder (ADHD). Prostaglandins Leukot Essent Fatty Acids. 2006;74:17–21.
[88] Hirayama S, Hamazaki T, Terasawa K. Effect of docosahexaenoic acid-containing food administration on symptoms of attention-deficit/

hyperactivity disorder—a placebo-controlled double-blind study. Eur J Clin Nutr. 2004;58:467–73.
[89] Afzal N, Murch S, Thirrupathy K, Berger L, Fagbemi A, Heuschkel R. Constipation with acquired megarectum in children with autism. Pediatrics. 2003;112:939–42.
[90] Alomar RS, Oommen A, Aljofi HE. Vitamin D deficient diet and autism. J Kuwait Med Assoc. 2021;53:179–83. [Article].
[91] Feng J, Shan L, Du L, et al. Clinical improvement following vitamin D3 supplementation in Autism Spectrum Disorder. Nutr Neurosci. 2017; 20:284–90.
[92] Julvez J, Ribas-Fitó N, Forns M, Garcia-Esteban R, Torrent M, Sunyer J. Attention behaviour and hyperactivity at age 4 and duration of breast-feeding. Acta Paediatr. 2007;96:842–7.
[93] Stadler DD, Musser ED, Holton KF, Shannon J, Nigg JT. Recalled initiation and duration of maternal breastfeeding among children with and without ADHD in a well characterized case-control sample. J Abnorm Child Psychol. 2016;44:347–55.
[94] Boucher O, Julvez J, Guxens M, et al. Association between breastfeeding duration and cognitive development, autistic traits and ADHD symptoms: a multicenter study in Spain. Pediatr Res. 2017;81:434–42.
[95] Lien L, Lien N, Heyerdahl S, Thoresen M, Bjertness E. Consumption of soft drinks and hyperactivity, mental distress, and conduct problems among adolescents in Oslo, Norway. Am J Public Health. 2006;96:1815–20.
[96] van Egmond-Fröhlich AW, Weghuber D, de Zwaan M. Association of symptoms of attention-deficit/hyperactivity disorder with physical activity, media time, and food intake in children and adolescents. PLoS One. 2012;7:e49781.
[97] Silva BDPd, Anselmi L, Schmidt V, Santos IS. Caffeine consumption during pregnancy and attention deficit hyperactivity disorder (ADHD): a systematic literature review. Cad Saude Publica. 2015;31:682–90.
[98] Li M, Francis E, Hinkle SN, Ajjarapu AS, Zhang C. Preconception and prenatal nutrition and neurodevelopmental disorders: a systematic review and meta-analysis. Nutrients. 2019;11:1628.
[99] Rosi E, Grazioli S, Villa FM, et al. Use of non-pharmacological supplementations in children and adolescents with attention deficit/hyperactivity disorder: a critical review. Nutrients. 2020;12:1573.
[100] Farsad-Naeimi A, Asjodi F, Omidian M, et al. Sugar consumption, sugar sweetened beverages and Attention Deficit Hyperactivity Disorder: a systematic review and meta-analysis. Complement Ther Med. 2020;53:102512.
[101] Tseng PT, Yen CF, Chen YW, et al. Maternal breastfeeding and attention-deficit/hyperactivity disorder in children: a meta-analysis. Eur Child Adolesc Psychiatry. 2019;28:19–30.
[102] Zeng Y, Tang Y, Tang J, et al. Association between the different duration of breastfeeding and attention deficit/hyperactivity disorder in children: a systematic review and meta-analysis. Nutr Neurosci. 2020; 23:811–23.
[103] Cannell JJ. Vitamin D and autism, what's new? Rev Endocr Metab Disord. 2017;18:183–93.
[104] Kittana M, Ahmadani A, Stojanovska L, Attlee A. The role of vitamin D supplementation in children with autism spectrum disorder: a narrative review. Nutrients. 2021;14:26.
[105] Horvath A, Łukasik J, Szajewska H. ω-3 fatty acid supplementation does not affect autism spectrum disorder in children: a systematic review and meta-analysis. J Nutr. 2017;147:367–76.
[106] Piwowarczyk A, Horvath A, Łukasik J, Pisula E, Szajewska H. Gluten- and casein-free diet and autism spectrum disorders in children: a systematic review. Eur J Nutr. 2018;57:433–40.
[107] Sourbron J, Klinkenberg S, van Kuijk SMJ, et al. Ketogenic diet for the treatment of pediatric epilepsy: review and meta-analysis. Childs Nerv Syst. 2020;36:1099–109.
[108] Frensham LJ, Bryan J, Parletta N. Influences of micronutrient and omega-3 fatty acid supplementation on cognition, learning, and behavior: methodological considerations and implications for children and adolescents in developed societies. Nutr Rev. 2012; 70:594–610.
[109] Barling J, Bullen G. Dietary factors and hyperactivity: a failure to replicate. J Genet Psychol. 1985;146:117–23.
[110] Barry RJ, Clarke AR, McCarthy R, Selikowitz M, MacDonald B, Dupuy FE. Caffeine effects on resting-state electrodermal levels in AD/HD suggest an anomalous arousal mechanism. Biol Psychol. 2012;89: 606–8.
[111] Iv N, Herbein M, Heude B, et al. Children's diet at 2 Years and trajectories of hyperactivity-inattention symptoms and conduct problems between 3 and 8 years: the EDEN cohort. J Nutr. 2022;152: 484–91.
[112] Chan AS, Sze SL, Han YMY, Cheung MC. A chan dietary intervention enhances executive functions and anterior cingulate activity in autism spectrum disorders: a randomized controlled trial. Evid Based Complement Altern Med eCAM. 2012;2012:262136.