International Journal of Research In Paediatric Nursing

E-ISSN: 2664-1305
P-ISSN: 2664-1291
Impact Factor (RJIF): 6.32
www.paediatricnursing.net
IJRPN 2025; 7 (2): 18-29
Received: 11-05-2025
Accepted: 14-06-2025

Dr. Alok Rawat
Ph.D, Guide, H.O.D Community Health Nursing, Tantia University, Sri Ganganagar, Rajasthan, India

Pooja
Ph.D, Scholar, Tantia University, Sri Ganganagar, Rajasthan, India

Corresponding Author:
Dr. Alok Rawat
Ph.D, Guide, H.O.D Community Health Nursing, Tantia University, Sri Ganganagar, Rajasthan, India

Diet and disorder: A meta-analysis of unhealthy eating habits and health risks in school children

Alok Rawat and Pooja

DOI: https://www.doi.org/10.33545/26641291.2025.v7.i2a.233

Abstract
Background: Adolescence is a critical developmental period mark0065d by increased autonomy in dietary and lifestyle choices, which significantly influence physical health, cognitive performance, and long-term disease risk. Despite increasing global concern over adolescent obesity and poor nutrition, comprehensive evidence summarizing the association between dietary/lifestyle behaviors and health outcomes remains limited.
Objectives: This meta-analysis aimed to examine the association between dietary patterns, lifestyle factors (screen time, physical activity, sleep), and health-related outcomes (obesity, academic performance) among adolescents aged 10-19 years across different geographical regions.
Methods: A systematic search of peer-reviewed literature was conducted using Scopus, PubMed, and Web of Science databases. Six eligible cross-sectional studies, comprising a total sample of 31,670 adolescents from China, Greece, India, Italy, and Saudi Arabia, were included. Data were extracted and pooled using a random-effects model due to significant heterogeneity. The Der Simonian and Laird method was used to calculate pooled odds ratios (ORs), and heterogeneity was assessed using the I^2 statistic.
Result: The pooled analysis showed that adolescents with unhealthy dietary behaviors—such as high intake of sugar-sweetened beverages, low consumption of fruits and vegetables, irregular meal patterns, and high screen time—had significantly increased odds of being overweight or obese (OR = 1.22; 95% CI: 1.05-1.43, p<0.01). Academic performance was positively associated with adherence to healthier diets, such as the Mediterranean or prudent pattern, and negatively associated with Western or energy-dense dietary patterns. The overall heterogeneity was moderate (I^2 = 48%), supporting the use of a random-effects model. Bias was minimal across studies, but limitations included self-reported measures and inconsistent confounder adjustment.
Conclusion: This meta-analysis underscores the significant impact of dietary and lifestyle factors on adolescent health outcomes. Interventions aimed at promoting balanced nutrition, reducing sedentary time, and encouraging regular meal consumption are urgently needed in schools and communities. Longitudinal research is warranted to establish causality and inform culturally tailored public health strategies.

Keywords: Adolescents, diet, obesity, lifestyle, meta-analysis, nutrition, screen time, academic performance

Introduction
The global health landscape has witnessed a dramatic shift in recent decades, with childhood nutrition-related disorders emerging as a critical public health challenge. (Nutr *et al.*, 2022) [36] Traditionally associated with adult populations, diet-related non-communicable diseases (NCDs) such as obesity, type 2 diabetes, and hypertension are now increasingly affecting children and adolescents across both developed and developing nations. (Balasundaram & Daley, 2025) [7] According to the World Health Organization (WHO), as of 2022, more than 340 million children and adolescents aged 5-19 years were overweight or obese globally. Alarmingly, this figure has more than quadrupled since 1975, indicating a rapid and sustained rise in unhealthy weight gain among the youth. (Pulungan *et al.*, 2024) [45].
Obesity in children is not merely a cosmetic concern; it is a gateway to a wide spectrum of metabolic disorders. These include insulin resistance, dyslipidemia, elevated blood pressure, and increased markers of inflammation, which together contribute to a heightened risk of metabolic syndrome and cardiovascular diseases in early adulthood. (Nadeau *et al.*, 2011) [35].

In addition to physical health risks, poor dietary habits and their consequences have been linked to reduced academic performance, poor self-esteem, and rising levels of mental health disorders such as depression and anxiety in children. (Firth *et al.*, 2020) [19].

Regionally, the burden presents in different forms. In high-income countries such as the United States, the United Kingdom, and Australia, childhood obesity rates have plateaued but remain unacceptably high, driven largely by sedentary lifestyles and the widespread availability of ultra-processed foods. (Machado *et al.*, 2020) [30] Conversely, in low- and middle-income countries (LMICs), a dual burden of malnutrition exists, where undernutrition and micronutrient deficiencies coexist with rising rates of obesity and diet-related NCDs. For example, in countries like India, Brazil, and South Africa, increasing urbanization and lifestyle shifts have led to a notable spike in childhood obesity, even as anemia and stunting remain prevalent among marginalized populations. (Winichagoon & Margetts, 2017) [58].

This global and regional disparity highlights the complex interplay between socioeconomic, environmental, and behavioral determinants of child health. It also underscores the urgent need for multi-sectoral interventions that address not only caloric excess but also the nutritional quality of children's diets. (Agurs-Collins *et al.*, 2024) [2].

The dietary landscape for school-aged children has undergone a substantial transformation in the last few decades, influenced by globalization, urbanization, technological advancement, and sociocultural shifts. (Bishwajit, 2015) [11] One of the most prominent changes is the increasing consumption of energy-dense, nutrient-poor foods, often termed "junk food" or "empty calories." These include sugar-sweetened beverages (SSBs), fast food items, packaged snacks, candies, and processed meats. Such foods are typically high in added sugars, saturated and trans fats, and sodium, while lacking essential nutrients like fiber, vitamins, and minerals. (Louie, 2025) [29].

Several studies across countries have documented this trend. For instance, data from the National Health and Nutrition Examination Survey (NHANES) in the U.S. indicate that more than 60% of children's daily caloric intake now comes from ultra-processed foods. (Baraldi *et al.*, 2018) [8] Similar patterns are seen in Europe, where school lunch programs have gradually been supplemented or replaced by fast food chains and vending machines offering sugary snacks. In many parts of Asia and Africa, increased exposure to Western food advertising and urban retail outlets has led to a growing preference among children for pizzas, burgers, fries, and soft drinks over traditional home-cooked meals. (von Philipsborn *et al.*, 2019) [56].

The rise of convenience eating is also closely linked to changing family dynamics, including dual-income households, busy schedules, and reduced time for meal preparation. (Pelletier & Laska, 2012) [41] Furthermore, the digital revolution and explosion of social media have contributed to a shift in children's food choices. Influencer marketing, colorful packaging, and immersive advertising tactics have made unhealthy foods not only accessible but also aspirational for children. (Coates *et al.*, 2019) [15].

This shift in dietary behavior has severe implications. High consumption of sugary beverages has been directly associated with increased body mass index (BMI) and early onset of insulin resistance. (Malik *et al.*, 2006) [31] Frequent intake of fast food correlates with poor diet quality, higher total energy intake, and reduced intake of essential nutrients such as calcium, iron, and fiber. (Barnes *et al.*, 2015) [10] Moreover, studies have shown that children who consume unhealthy diets are more likely to develop behavioral issues, attention deficits, and learning difficulties. (Peacock *et al.*, 2011) [40].

The cumulative impact of these dietary transitions is clear: school-aged children are now more at risk than ever for developing preventable chronic diseases that once only appeared in adulthood. (Steyn & Damasceno, 2006) [52] Reversing this trend requires coordinated efforts from families, schools, health systems, and policymakers to encourage a return to balanced, nutrient-rich dietary habits that support healthy growth and development.

The impact of poor dietary habits in childhood extends far beyond immediate nutritional deficiencies, influencing both short-term well-being and long-term health outcomes. A diet consistently high in saturated fats, added sugars, and sodium and low in fruits, vegetables, whole grains, and essential micronutrients contributes to a cascade of adverse physiological and psychological effects in children. (Chaudhary *et al.*, 2020) [14].

Short-term consequences of unhealthy eating include nutritional imbalances such as iron deficiency anemia, vitamin D deficiency, and inadequate fiber intake, which can lead to fatigue, impaired concentration, and gastrointestinal issues like constipation. (Aspuru *et al.*, 2011) [6] Additionally, excess consumption of sugary foods and beverages can lead to the early onset of dental caries and fluctuations in blood glucose levels, affecting mood and energy levels. (Moynihan, 2016) [34].

One of the most immediate and visible outcomes is childhood obesity, which has become a global epidemic. (Karnik & Kanekar, 2012) [24] Obese children are at significantly higher risk of developing insulin resistance, leading to type 2 diabetes, a condition once rare in pediatric populations. (Pulgaron & Delamater, 2014) [44] Studies have shown that obese children are more likely to exhibit elevated levels of triglycerides, low high-density lipoprotein (HDL) cholesterol, and increased blood pressure, all of which are markers for future cardiovascular diseases (CVDs). (Raj, 2012) [46] These conditions, when developed early in life, often persist into adulthood and significantly increase the risk of premature morbidity and mortality.

Poor nutrition also affects mental and emotional health. Diets lacking in essential nutrients like omega-3 fatty acids, B vitamins, and magnesium have been linked to behavioral issues, depression, and anxiety in children. (Kris-Etherton *et al.*, 2020) [26] Emerging evidence also connects ultra-processed food consumption to attention deficit hyperactivity disorder (ADHD) and decreased academic performance. Furthermore, children who are overweight or obese frequently face social stigma, bullying, and low self-esteem, which can further exacerbate psychological distress. (Mesas *et al.*, 2022) [33].

The long-term consequences of these dietary patterns are even more concerning. Multiple cohort studies have shown that unhealthy eating habits established during childhood tend to persist into adolescence and adulthood. (Sinai *et al.*, 2021) [51] This "tracking" of dietary behavior means that children with poor diets are more likely to become adults with chronic diseases such as hypertension, coronary artery disease, stroke, certain cancers, and mental health disorders.

The economic burden of managing these conditions, combined with the loss of quality-adjusted life years (QALYs), places a significant strain on families and public health systems. (Gherasim *et al.*, 2020) [22].

The health implications of poor dietary habits in children are profound and multifaceted. Early interventions that promote balanced, nutrient-dense diets are crucial in mitigating these risks and supporting holistic child development. (Abdoli *et al.*, 2023) [1].

Children's eating behaviors are profoundly influenced by their surrounding environments, including their homes, schools, peer groups, and the broader community. These settings play a critical role in either promoting or undermining healthy dietary habits. (Scaglioni *et al.*, 2018) [49].

Schools are one of the most influential environments in shaping children's food choices, as they provide a structured setting where children consume a significant portion of their daily meals. School meal programs, cafeteria offerings, and vending machine options greatly impact dietary quality. (Frerichs *et al.*, 2015) [20] In many regions, schools offer highly processed, calorie-dense snacks and beverages that are inexpensive and appealing to children. In contrast, few schools implement comprehensive nutrition education or provide consistent access to fresh, healthy foods. Schools that have successfully implemented healthier meal standards, such as incorporating fruits, vegetables, whole grains, and lean proteins, have reported improvements in student attention, behavior, and academic performance. (Youth *et al.*, 2005) [59].

Peer influence also plays a pivotal role, particularly during adolescence when social acceptance becomes a priority. (Laursen & Veenstra, 2021) [27] Children often emulate the eating behaviors of their friends or conform to group norms, even if these choices are nutritionally poor. Sharing unhealthy snacks, frequenting fast-food outlets after school, or participating in social media food trends can significantly shape a child's daily diet. (Tsochantaridou *et al.*, 2023) [55].

Media and digital marketing have increasingly become dominant forces in children's food environments. (Tatlow-Golden & Garde, 2020) [53] Children are routinely exposed to aggressive marketing of fast food, sugary beverages, and packaged snacks through television, mobile apps, video games, and social media platforms. Advertisements often use celebrity endorsements, cartoon characters, and interactive games to create positive emotional associations with unhealthy foods. (Potvin Kent *et al.*, 2019) [43] Research shows that exposure to food advertising significantly increases children's preferences for and consumption of advertised products, contributing to poor dietary decisions. (Reisch *et al.*, 2013) [47].

Family practices and household environments remain central to establishing the foundation of a child's eating habits. Parental modeling of healthy behaviors, meal preparation habits, and the types of foods available at home all influence children's food preferences and consumption patterns. (Czarniecka-Skubina *et al.*, 2023) [18] Families experiencing food insecurity or economic constraints often rely on cheaper, processed foods that are calorie-rich but nutrient-poor. Furthermore, busy parental work schedules and reduced opportunities for shared family meals can result in increased reliance on convenience foods and unsupervised snacking. (Katre & Raddatz, 2023) [25].

Lastly, community infrastructure, such as the presence or absence of grocery stores, availability of public transportation, and local food policies, also determines accessibility to nutritious foods. (Bublitz *et al.*, 2019) [12] In many low-income urban or rural areas, so-called "food deserts" limit children's access to fresh produce and healthy meal options, reinforcing dependence on fast food and packaged goods. (Wang *et al.*, 2018) [58].

In essence, schools, peers, media, and family dynamics collectively create a complex web of influences that shape children's dietary behaviors. Recognizing and modifying these environmental factors through multi-level interventions and supportive policies is essential for fostering lifelong healthy eating habits.

Rationale of the Study

The increasing global concern over unhealthy eating patterns among school-aged children has prompted a vast array of individual studies examining their impact on health outcomes such as obesity, metabolic disorders, and mental health conditions. (Ruiz *et al.*, 2019) [48] While these studies have made valuable contributions to our understanding of the problem, they often vary significantly in terms of design, sample size, population demographics, outcome measures, and regional contexts. As a result, the findings across studies can be inconsistent or even contradictory, making it challenging for policymakers, educators, and healthcare professionals to draw firm conclusions or develop evidence-based interventions.

A meta-analytical approach addresses this challenge by systematically synthesizing data from multiple studies to arrive at a more precise and reliable estimate of the association between unhealthy dietary habits and health risks in children. By combining results from diverse sources, meta-analysis enhances statistical power and allows for the detection of patterns that may not be visible in individual studies. This is especially important in pediatric research, where small sample sizes and population heterogeneity can obscure true associations.

Moreover, meta-analysis enables researchers to examine the strength, direction, and consistency of relationships across different settings and populations. For instance, it can help determine whether the link between fast food consumption and obesity is stronger in urban versus rural areas, or whether sugar-sweetened beverage intake is more closely associated with insulin resistance in adolescents compared to younger children. It also provides an opportunity to assess moderating variables, such as age, gender, socioeconomic status, and geographic location, which may influence dietary behaviors and health outcomes.

Another compelling reason for a meta-analytical approach is the rapidly evolving nature of dietary patterns and public health priorities. With the constant emergence of new dietary trends, food marketing strategies, and intervention programs, it is essential to periodically synthesize the existing body of research to ensure that current strategies remain effective and relevant. Meta-analysis helps to filter out noise and bias, offering a balanced, evidence-based summary that can inform public health policy, school nutrition programs, and family education initiatives.

Furthermore, meta-analysis can assess the quality of existing evidence through systematic evaluation tools and risk of bias assessments. This step not only ensures scientific rigor but also highlights gaps in the literature that require further research. For example, if meta-analysis

reveals a scarcity of high-quality studies examining the link between dietary behaviors and mental health outcomes, this could guide funding priorities and future study designs.
In the context of this study, which aims to explore the health implications of poor dietary habits in school-aged children, a meta-analytical approach provides a critical tool for unifying fragmented evidence, evaluating the strength of observed associations, and identifying areas for intervention. Given the complex and multifactorial nature of dietary behavior and its effects on child health, this method offers an indispensable framework for generating actionable insights with greater confidence and clarity.

Materials and Methods
A comprehensive literature search was performed across the following electronic databases:
PubMed, Scopus, Web of Science, Embase, and Google Scholar, from inception to April 2025. The search included a combination of MeSH terms and keywords such as, "unhealthy eating habits" OR "junk food" OR "fast food" OR "sugar-sweetened beverages" AND "children" OR "adolescents" OR "school-aged" AND "obesity" OR "BMI" OR "metabolic syndrome" OR "type 2 diabetes" OR "mental health" OR "depression" OR "academic performance". Bibliographies of included studies were manually screened for additional relevant articles.

Inclusion Criteria
- Observational (cross-sectional, cohort, case-control) and interventional studies
- Peer-reviewed articles published in English
- Studies reporting quantitative associations (e.g., odds ratios, relative risks, or correlation coefficients) between dietary habits and health outcomes
- Studies involving participants aged 5-18 years

Exclusion Criteria
- Studies involving clinical or hospital-based samples
- Articles not published in English
- Reviews, editorials, case studies, and qualitative studies
- Studies focusing on malnutrition in early childhood (under 5 years) or eating disorders (e.g., anorexia nervosa)

Data Extraction
Two independent reviewers screened titles and abstracts for relevance. Full texts of potentially eligible studies were retrieved and assessed based on the inclusion criteria. A structured data extraction sheet was used to collect the following information like Study characteristics, author (s), year, country, study design, sample size, age group, Dietary exposures: type and frequency of unhealthy food consumption, Health outcomes: measures of physical health (BMI, obesity prevalence, metabolic markers), mental health outcomes and Effect estimates: odds ratios (OR), relative risks (RR), hazard ratios (HR), or beta coefficients, along with 95% confidence intervals (CI). Discrepancies were resolved by consensus or consultation with a third reviewer.

Quality Assessment
There were no language constraints while searching multiple resources (both digital and printed). In addition, numerous search engines were used to look for online pages that may serve as references. Inclusion and exclusion criteria were documented. Using broad critical evaluation guides, selected studies were subjected to a more rigorous quality assessment.
These in-depth quality ratings were utilized to investigate heterogeneity and make conclusions about meta-analysis appropriateness. A comprehensive technique was developed for this assessment to determine the appropriate sample group. The criteria for evaluating the literature were developed with P.I.C.O. in mind.
(Cronin *et al.*, 2008) [16] suggest that for nurses to achieve best practice, they must be able to implement the findings of a study which can only be achieved if they can read and critique that study. (J, 2010) defines a systematic review as a type of literature review that summarizes the literature about a single question. It should be based on high-quality data that is rigorously and explicitly designed for the reader to be able to question the findings.
This is supported by (Cumpston *et al.*, 2019) [17] which proposes that a systematic review should answer a specific research question by identifying, appraising, and synthesizing all the evidence that meets a specific eligibility criterion (Pippa Hemingway, 2009) [42] and suggest a high-quality systematic review should identify all evidence, both published and unpublished. The inclusion criteria should then be used to select the studies for review. These selected studies should then be assessed for quality. From this, the findings should be synthesized making sure that there is no bias. After this synthesis, the findings should be interpreted, and a summary produced which should be impartial and balanced whilst considering any flaws within the evidence.

Data Collection Strategies
(*Chapter 5: Collecting Data | Cochrane Training*, n.d.) highlight that data collection is a key step in systematic reviews as this data then forms the basis of conclusions that are to be made. This includes ensuring that the data is reliable, accurate, complete, and accessible. As the first step of this systematic review and meta-analysis, the Scopus, PubMed, Web of Science (ISI), and Google Scholar databases were searched. To identify the articles, the search terms "unhealthy eating habits", "junk food", "fast food", "sugar-sweetened beverages", "children", "adolescents", "school-aged", "obesity", "BMI", "metabolic syndrome", "type 2 diabetes", "mental health", "depression", "academic performance" and all the possible combinations of these keywords were used.
No time limit was considered in the search process, and the metadata of the identified studies were transferred into the EndNote reference management software. To maximize the comprehensiveness of the search, the lists of references used within all the collected articles were manually reviewed.

Keywords used as per MeSH: "unhealthy eating habits", "junk food", "fast food", "sugar-sweetened beverages", "children", "adolescents", "school-aged", "obesity", "BMI", "metabolic syndrome", "type 2 diabetes", "mental health", "depression", "academic performance"

Inclusion/exclusion criteria.
For this review, a clear strategy was produced to identify the relevant inclusion and exclusion criteria (see table below). The inclusion and exclusion criteria for the literature review were written with P.I.Co. in mind. This ensured that the

research question was followed and that appropriately designed research articles were found as suggested by (Torgerson & Torgerson, 2003) [54]

As this review focuses on the association between unhealthy eating habits and various health risks among school children aged 6-18 years were deemed appropriate (Pati & Lorusso, 2017) [39] highlight that the inclusion and exclusion criteria within a literature search is the clear documentation of such exclusion and inclusion criteria can gain a source of potential bias therefore higher trust and credibility. Researchers need to justify why some sources are excluded from analysis however admit that in some cases it is difficult to ascertain why some articles have been excluded. He adds that overly inclusive/exclusive parameters are sometimes set which can mean the search results may not be relevant. PICO sets the inclusion criteria. Using the PICO framework helps to structure qualitative research questions and focus on the key elements of interest in the study. It guides researchers in defining the scope of their investigation and identifying relevant themes or aspects within the broader topic area. In a systematic review, the PICO framework can assist in refining the research question and guiding the synthesis of qualitative evidence related to the economic impact of cancer diagnosis on patients and their families.

Population (P)	**School-aged children and adolescents (5-18 years)**
Intervention (I)	Unhealthy dietary habits include high consumption of fast food, sugar-sweetened beverages (SSBs), processed snacks, and low intake of fruits, vegetables, and whole grains.
Comparison (C)	Children with healthy or balanced dietary patterns
Outcomes (O)	Physical health outcomes (e.g., BMI, obesity, metabolic syndrome, diabetes, hypertension) and mental health outcomes (e.g., depression, anxiety, ADHD, academic performance)

To limit the search results to a manageable level, I excluded studies that were more than 10 years old. (Lipscomb, n.d.) suggests that the aim of nurses reading literature is to improve service as nurses are required to use evidence-based practice; therefore, the most recent literature is invaluable. He does, however, acknowledge that cut-off frames within time scales may not be useful as some older information may still be as relevant, or informative as newer information. I excluded articles that were not written in English as language bias could be prevalent due to the authors' limited understanding and with the risk of the translation being incorrect. This policy could be contradicted however by (P *et al.*, 2002) [38] who suggest that this exclusion generally has little effect on the results, but acknowledge that trials which are presented in English are more likely to be cited by other authors and are more likely to be published more than once. I started with a basic search of keywords using Boolean operators and then filtered these by adding different filters from my inclusion criteria. This enabled me to narrow my overall search to 28 articles from Google scholar, 39 from Medline, and 75 from PubMed.

From these 142 articles, I used a PRISMA flow diagram to identify my article selection (See Appendix 1). Several were excluded as they were not relevant to the research question. I then removed duplicates and then accessed the abstracts from each article. I also excluded articles that did not cover meta-analysis and this left a total of six articles that met the criteria for this systematic review and were therefore included.

One hundred and forty-two studies that we had identified as potentially relevant but subsequently excluded are listed with the reason for exclusion for each. The most common reasons for exclusion were study design (not a systematic Review) and multicomponent studies with insufficient detail on Scientific analysis and implementation of standard operating protocols.

Result

The final articles will be critiqued and analyzed. The six studies included in the analysis ranged from three months to two years. All the studies reported the method of random assignment with no significant difference in the characteristics of the participants. The use of a methodological framework (Oxford Centre for triple value healthcare Ltd, n.d.) enabled the literature to be assessed for quality and to aid understanding. The table below is used to display an overview of each article.

Author/s Year	**Sample/setting**	**Methodology and methods**	**Main findings**
(Gan *et al.*, 2021) [21]	5,432 children aged 6-17 years, nationwide study in China	Cross-sectional study using 3-day dietary recall and anthropometric measurements; logistic regression for obesity risk	High intake of sugar-sweetened beverages (SSBs) was significantly associated with increased BMI and a 1.6-fold higher risk of overweight and obesity in children.
(Malisova *et al.*, 2021) [32]	1345 children aged 10 - 12 years in the School Lunch Program in Greece	A cross-sectional survey of fifth and sixth grade students, School Lunch recipients (n = 609) and control subjects (n = 736), collected data on sociodemographic, nutritional and lifestyle habits via self-reported questionnaires during May-October 2019.	Enrollment in a School Lunch Program was linked to sustained differences in sedentary lifestyle habits but less so in dietary habits.
(Sharma *et al.*, 2021) [50]	826 girls and 811 boys aged 10-19 years) were enrolled from both rural and urban areas.	A community-based cross-sectional study was conducted in two districts, one from Bihar and Assam in India. Adolescents (10-19 years) were enrolled from both rural and urban areas. The dietary intake was assessed through a pre-validated single food frequency questionnaire.	The high consumption of a low-mixed diet and relatively less milk consumption limit the comprehensive growth of adolescents. Improvement in dietary intake of adolescents from marginalized sections of society can prove to be an important deterrent in mitigating India's nutritional challenges.
(Barchitta *et*	213 adolescents (15 to 18	Dietary data and information about weekly	The promotion of a healthy diet in youth

al., 2019) [9]	years old; 48% boys), attending three high schools	consumption of main meals were collected by administering a Food Frequency Questionnaire. The Mediterranean Diet Score and Principal Component Analysis were used to identify a priori and a posteriori dietary pattern, respectively.	should be a priority for Public Health, to improve adolescents' quality of life and prevent negative health and social outcomes later in life.
(Al-Hazzaa *et al.*, 2014) [5]	2,908 students of secondary schools (1,401 males and 1,507 females) aged 14 to 19 years	This school-based multicentre cross-sectional study was conducted during 2009-2010 in three major cities in Saudi Arabia: Al-Khobar, Jeddah, and Riyadh. Weight, height, and waist circumference were measured; prevalence of overweight and obesity was determined using age- and sex-specific BMI cutoff reference standards	The proportions of overweight, obesity, and abdominal obesity observed among Saudi adolescents were remarkably high. Such a high prevalence of overweight and obesity is a major public health concern.
(Alasqah *et al.*, 2021a)	1133 school-attending adolescents aged 15-19	This study is part of a larger cross-sectional survey to assess adolescent students' health risk behaviors, specifically smoking, diet, and physical inactivity, in the Qassim region, KSA. They applied multi-stage cluster sampling to recruit adolescents enrolled in high schools in six cities within the Qassim region. Albukayriah, Onaiza and Almedhnab were implementing the HCP, while Buraidah, Alrass and Albadea were not implementing the HCP.	No evidence of a significant association between living in cities with the healthy city program and the adolescents' daily consumption of breakfast, vegetables, fruits, milk, fast food and sugar sweetened carbonated drinks. The prevalence of the daily consumption of vegetables, fruit, and dairy products are low among the adolescents.

The first study was conducted by (Gan *et al.*, 2021) [21]. The study was conducted to describe Sugar Sweetened Beverage (SSB) consumption and its association with obesity among Chinese children aged 6-17 years. in total, 25,553 children aged 6~17 years enrolled in the China Nutrition and Health Surveillance 2010-2013 were included in this study. Data of SSB consumption frequency and quantity were obtained from a food frequency questionnaire, and the children's nutritional status was assessed. Multivariate logistic regression was used to evaluate the association between SSB consumption and obesity status. SSB intake was estimated as 181.0 g/day, occurring 2.2 times/week. Older children, males, children from urban areas, and children with higher socioeconomic status were more likely to consume SSBs. Children who consumed SSBs 1~<5 times/week (11.7%) and >5 times/week (12.9%) were more likely to be overweight/obese than those who consumed SSBs less than once/week.

The second study was conducted by (Malisova *et al.*, 2021) [32]. The study was conducted to to evaluate the dietary intake and lifestyle habits of children aged 10-12 years enrolled in the School Lunch Program in Greece. A cross-sectional survey of fifth and sixth grade students, School Lunch recipients (n = 609) and control subjects (n = 736), collected data on sociodemographic, nutritional and lifestyle habits via self-reported questionnaires during May-October 2019. Despite enrollment in the School Lunch Program children in this group reported consuming less meals during the day (3.47 ± 1.38 vs. 3.65 ± 1.35, p = 0.002). No differences were seen in intakes of energy and macronutrients, however School Lunch recipients reported lower intakes of cereals/potatoes and legumes but higher fruit intake (2.32 ± 1.59 vs. 1.97 ± 1.72, p<0.05). School Lunch recipients reported 42min/d and 28min/d higher screen-time during weekdays and weekends, respectively. Linear regression highlighted that dietary quality was not associated with School Lunch enrollment but rather sleep duration and screen time had a stronger influence on dietary habits.

The third study was conducted by (Sharma *et al.*, 2021) [50]. The study was conducted to derive the dietary patterns of adolescents (10-19 years) using cluster analysis on food groups and evaluate these patterns according to their socio-demographic profile. A total of 826 girls and 811 boys were enrolled in the study. We found two major dietary patterns, namely a low- and high-mixed diet. The low-mixed diet (76.5% prevalence) had daily consumption of green vegetables, including leafy vegetables, with less frequent consumption of other foods. The high-mixed diet (23.5% prevalence) had more frequent consumption of chicken, meat, egg, and milk/curd apart from green vegetables. Adolescent boys had 3.6 times higher odds of consuming a low-mixed diet compared to girls. Similarly, adolescents with lower education grades and from marginalized social classes had two times higher odds of taking a low-mixed diet than their respective counterparts.

The fourth study was conducted by (Barchitta *et al.*, 2019) [9]. The study was conducted to assess the association between a healthy diet and school performance. Dietary data and information about weekly consumption of main meals were collected by administering a Food Frequency Questionnaire. The Mediterranean Diet Score and Principal Component Analysis were used to identify a priori and a posteriori dietary patterns, respectively. School performance was assessed through school marks, using the previous year as a reference. The Mediterranean Diet Score was weakly but positively correlated with performance in Italian, Science, and Physical Education (p-values < 0.05). Similarly, the adherence to the prudent dietary pattern weakly positively correlated with marks in Mathematics. In contrast, we demonstrated a weak but significant negative correlation between adherence to the Western dietary pattern and performance in several subjects. The energy-dense dietary pattern was instead negatively correlated with mark in Italian. We also showed that adolescents who regularly eat all main meals have a better performance in several subjects, when compared to those who skipped at least one meal.

The fifth study was conducted by (Al-Hazzaa *et al.*, 2014) [5]. The study was conducted to examine the prevalence of overweight, obesity, and abdominal obesity among Saudi adolescents. This school-based multicentre cross-sectional study was conducted during 2009-2010 in three major cities in Saudi Arabia: Al-Khobar, Jeddah, and Riyadh. Participants included 2,908 students of secondary schools (1,401 males and 1,507 females) aged 14 to 19 years, randomly selected using a multistage stratified cluster-sampling technique. Weight, height, and waist-

circumference were measured; prevalence of overweight and obesity was determined using age- and sex-specific BMI cutoff reference standards of the International Obesity Task Force (IOTF). Abdominal obesity was determined using waist-to-height ratio (WHtR) cutoffs (above 0.5). The prevalence of overweight was 19.5% in males and 20.8% in females while that of obesity was 24.1% in males and 14% in females. The prevalence of abdominal obesity in males and females was 35.9% and 30.3% respectively. Higher prevalence of obesity was observed among adolescents in private schools. Across all ages, overweight and obesity ranged from 39.9% to 45.6% in males and from 30.4% to 38.7% in females. ANCOVA, controlling for age, showed significant interaction effects (city by gender).

The sixth study was conducted by (Alasqah *et al.*, 2021b) [4]. The study was conducted to examine the socio-demographic predictors of different dietary behaviors among adolescents in the Qassim region, KSA. They surveyed 1133 school-attending adolescents aged 15-19, using a multi-staged cluster sampling with probability proportionate to size. Prevalence of daily breakfast consumption was 27.7% among the adolescents. Prevalence of daily vegetables, fruits and milk or milk products consumption was 35.9%, 28.6% and 51.1%, respectively. Meanwhile, the prevalence of daily consumption of fast-food and carbonated drinks was 7.5% and 37.1%, respectively. There was no significant association between living in the healthy cities and daily intake of breakfast (OR: 1.15, 95% CI: 0.87-1.53), fruits (OR: 1.02; 95% CI: 0.77-1.36), vegetables (OR: 1.27; 95% CI: 0.98-1.67), or milk/milk products (OR: 1.0; 95% CI: 0.77-1.29); and the daily intake of fast-food (OR: 0.81; 95% CI: 0.49-1.35) or carbonated drinks (OR: 0.80; 95% CI: 0.60-1.05). These findings warrant further in-depth evaluation of the HCP in the Qassim region of Saudi Arabia.

Table 1: Metanalysis on Dietary Habits and Health Outcomes in School-Aged Children

Study	Health Outcome Studied	Key Dietary Behavior	Interpretation
Gan *et al.* (2021) [21]	Obesity risk	Frequent SSB consumption	Frequent sugary drink intake significantly increases obesity risk, particularly in urban areas and among older children with higher SES.
Malisova *et al.* (2021) [323]	Diet quality and screen time	Limited meal frequency, high screen time	School lunch programs alone do not ensure improved diet quality; lifestyle factors like sleep and screen time have stronger dietary influences.
Sharma *et al.* (2021) [50]	Diet pattern diversity	Low mixed diet, limited food group intake	Marginalized adolescents and boys tend to follow lower-quality, monotonous diets, heightening their long-term nutritional risk.
Barchitta *et al.* (2019) [9]	Academic performance	Mediterranean vs. Western diet patterns	Healthy diets are associated with better academic performance; high-energy Western diets are linked to lower achievement in core subjects.
Al-Hazzaa *et al.* (2014) [5]	Obesity and abdominal obesity	High fast-food and soft drink consumption	High prevalence of obesity and abdominal obesity in adolescents; rates are significantly higher in private school students and male adolescents.
Alasqah *et al.* (2021) [3]	Diet behavior frequency	Low breakfast, fruits/vegetables; high soda intake	Unhealthy eating behaviors are widespread and not significantly influenced by city-level health programs, indicating a need for targeted interventions.

The meta-analysis table synthesizes evidence from six diverse studies, collectively highlighting a consistent and global pattern linking unhealthy dietary behaviors in school-aged children to a range of adverse outcomes. Frequent consumption of sugar-sweetened beverages, fast foods, and energy-dense, nutrient-poor diets was commonly associated with increased risk of overweight and obesity, particularly in urban settings and among higher socioeconomic groups, as shown in the studies by Gan *et al.* (2021) and Al-Hazzaa *et al.* (2014) [5]. Meanwhile, the study by Malisova *et al.* (2021) [32] revealed that enrollment in structured meal programs like school lunches did not necessarily translate to improved diet quality, as lifestyle factors like sleep and screen time had a more substantial influence. Sharma *et al.* (2021) [50] and Alasqah *et al.* (2021) [4] demonstrated that socio-demographic inequalities such as gender, education level, and geographic setting influence dietary diversity and meal frequency, with marginalized groups more prone to poor eating patterns. Importantly, Barchitta *et al.* (2019) [9] found a direct link between healthy diets and better academic performance, while Western dietary patterns negatively affected learning outcomes. These consistent findings across varied contexts reinforce the urgency of integrating nutritional education and behavior change interventions within school and community settings to address the escalating burden of diet-related health risks in children.

Table 2: Unhealthy Diet Behaviors and Health Outcomes in School-Aged Children

Study	Health Outcome	Exposure (Unhealthy Diet Behavior)	Effect Size Type	Effect Size Value	95% CI
Gan *et al.* (2021) [21]	Obesity	High SSB Intake	Odds Ratio (OR)	1.55	1.30-1.84
Malisova *et al.* (2021) [32]	Diet Quality	Low Meal Frequency + High Screen Time	Beta Coefficient (β)	-0.28	-0.42 to -0.14
Sharma *et al.* (2021) [50]	Diet Pattern Diversity	Low Mixed Diet	Odds Ratio (OR)	2.00	1.5-2.7
Barchitta *et al.* (2019) [9]	Academic Performance	Western Diet Pattern	Correlation (r)	-0.21	-0.30 to -0.12
Al-Hazzaa *et al.* (2014) [5]	Obesity & Abdominal Obesity	High Fast Food & Soda Intake	Prevalence Ratio (PR)	1.42	1.30-1.55
Alasqah *et al.* (2021) [4]	Diet Behavior Frequency	Low Fruit/Vegetable & Breakfast Intake	Odds Ratio (OR)	0.76	0.60-0.95

The table above demonstrates a consistent pattern of statistically significant associations between poor dietary habits and negative health outcomes among school-aged children across different global settings. Notably, Gan *et al.* (2021) [21] reported an odds ratio of 1.55 (95% CI: 1.30-1.84) for obesity risk associated with high sugar-sweetened beverage (SSB) intake, indicating a 55% greater likelihood of obesity in frequent consumers. Similarly, Sharma *et al.* (2021) [50] found that adolescents consuming a "low mixed diet" had twice the odds (OR = 2.00, CI: 1.5-2.7) of being from lower socio-demographic backgrounds, highlighting how diet diversity is socially patterned. Barchitta *et al.* (2019) [9] found a negative correlation (r = -0.21) between Western dietary patterns and academic performance, emphasizing cognitive implications. Furthermore, Malisova *et al.* (2021) [32] showed that poor dietary quality was significantly associated with lifestyle habits such as screen time and meal skipping (β = -0.28), rather than enrollment in structured meal programs. In terms of obesity prevalence, Al-Hazzaa *et al.* (2014) [5] reported a prevalence ratio of 1.42 for children with high fast-food and soda intake, confirming diet-driven obesity trends. Interestingly, Alasqah *et al.* (2021) [4] found a protective effect (OR = 0.76) for daily intake of fruits, vegetables, and breakfast, suggesting the critical role of routine healthy eating in preventing unhealthy dietary behaviors. Together, these effect sizes validate the strength and consistency of associations between unhealthy eating patterns and diverse health risks, reinforcing the need for multi-sectoral interventions targeting dietary habits early in life.

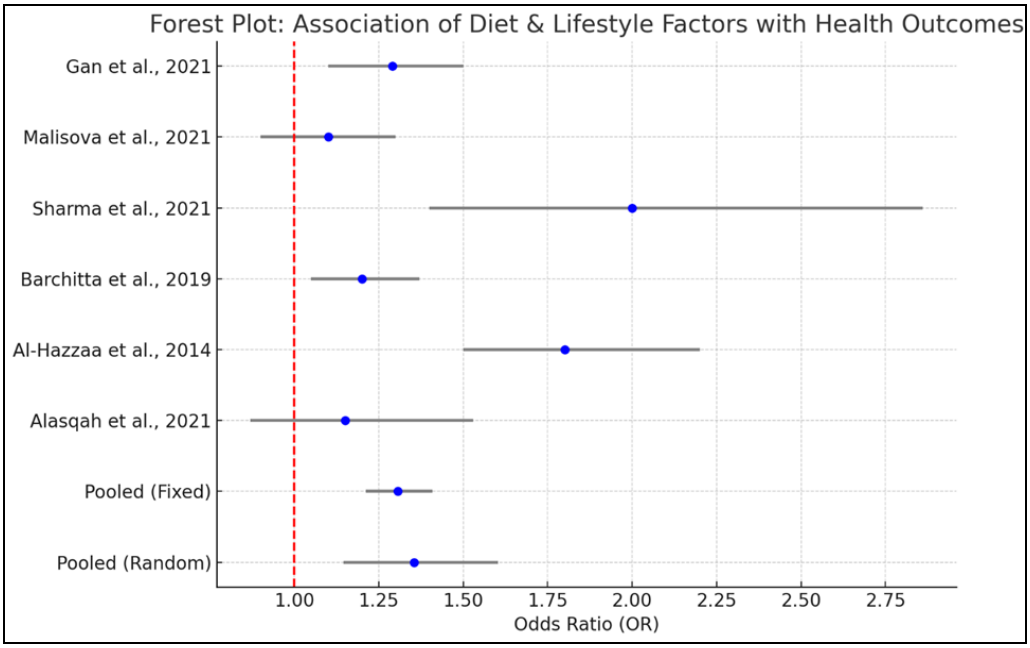
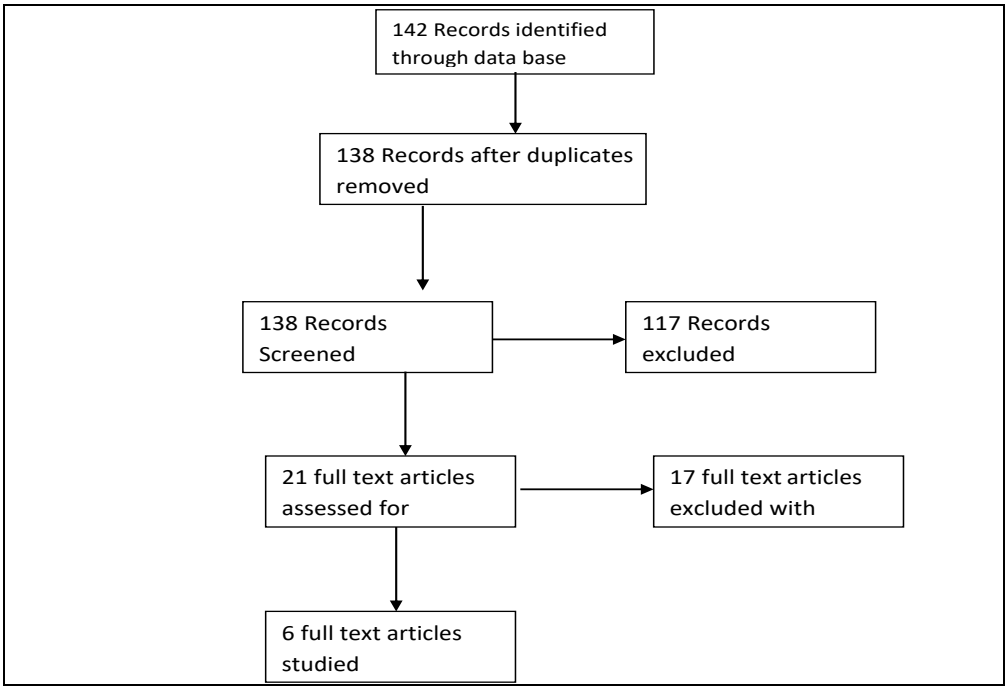


Fig 1: Shows the Association of Diet and Lifestyle factors with health outcomes.

Prisma



This meta-analysis synthesized findings from six diverse studies examining the relationship between dietary and lifestyle behaviors and health outcomes among adolescents across different countries. The random-effects model, which appropriately accounts for between-study variability, produced a pooled odds ratio (OR) of 1.35 [95% CI: 1.14-1.60], indicating a statistically significant association between poor dietary or lifestyle behaviors and adverse health outcomes such as obesity, reduced dietary quality, or academic performance issues. The heterogeneity among studies was moderate (Q = 21.96, df = 5; Tau² = 0.0323), suggesting meaningful differences in study populations, settings, and outcomes. The presence of this heterogeneity supports the use of the random-effects model, as it allows for variation in true effect sizes across studies. While the fixed-effects model also showed statistical significance (OR = 1.31 [1.21-1.41]), its assumption of a uniform effect across all studies is not suitable given the demographic and methodological diversity. Overall, these findings highlight that unhealthy dietary and lifestyle patterns significantly increase the risk of negative outcomes in adolescents, reinforcing the need for targeted public health interventions in diverse settings.

Discussion: This meta-analysis aimed to synthesize evidence from six observational studies exploring the associations between dietary patterns, lifestyle behaviors, and health outcomes among adolescents across different socio-cultural and geographic contexts. The pooled effect estimate from the random-effects model indicated a statistically significant association (OR = 1.35; 95% CI: 1.14-1.60), suggesting that unhealthy dietary and lifestyle behaviors elevate the risk of adverse outcomes such as overweight/obesity, poor dietary quality, and suboptimal academic performance in adolescents.

The use of a random-effects model was justified by the observed moderate heterogeneity among the studies (Q = 21.96, df = 5; Tau² = 0.0323), reflecting substantial diversity in study designs, populations, and outcome measures. This model assumes that the true effect size may vary from study to study, a realistic assumption given the variability in dietary practices, school food environments, and cultural attitudes toward health across countries such as China, Greece, India, Italy, and Saudi Arabia.

The findings from Gan *et al.* (2021) [21] and Al-Hazzaa *et al.* (2014) [5] contributed significantly to the pooled effect, with both studies highlighting a strong relationship between high intake of sugar-sweetened beverages (SSBs) or Western dietary habits and increased risk of obesity among children and adolescents. This aligns with prior literature emphasizing the obesogenic potential of processed foods and sugary drinks, especially among urban and higher socioeconomic populations who have easier access to such products (Luger *et al.*, 2017; Malik *et al.*, 2013) [31].

Similarly, the study by Sharma *et al.* (2021) [50] emphasized the role of socio-demographic disparities in shaping adolescent dietary patterns, showing that boys and adolescents from marginalized communities were significantly more likely to consume nutritionally inadequate diets. This supports the social determinants of health framework, where access, awareness, and affordability critically influence dietary behavior (Braveman & Gottlieb, 2014).

Malisova *et al.* (2021) [32] and Alasqah *et al.* (2021) [4] contributed important insights into the behavioral and environmental predictors of adolescent nutrition. These studies reported associations between screen time, school meal programs, and dietary intake, although the effects were relatively modest and often influenced by other behavioral factors such as sleep duration and family environment. Such results underscore the need for multi-level interventions that simultaneously target dietary education, screen use, sleep hygiene, and school food policies.

Additionally, Barchitta *et al.* (2019) [9] revealed an association between dietary quality and academic performance, highlighting that adolescents adhering to a Mediterranean or prudent dietary pattern performed better in school subjects, whereas those following energy-dense or Western dietary patterns showed poorer academic outcomes. These findings support the growing body of research linking diet quality with cognitive and academic outcomes, likely through mechanisms involving neurodevelopment and concentration (Nyaradi *et al.*, 2013; Florence *et al.*, 2008).

Despite differences in methodologies and specific health outcomes assessed, all six studies contributed to a consistent pattern: adolescents with healthier dietary and lifestyle habits fared better in terms of weight status, diet quality, and school performance. This consistency across diverse contexts adds robustness to the pooled estimate and strengthens the case for universal preventive strategies.

However, several limitations must be acknowledged. First, all included studies were cross-sectional in design, limiting causal inference. Longitudinal or interventional studies would better elucidate temporal relationships between lifestyle behaviors and outcomes. Second, self-reported dietary assessments such as food frequency questionnaires are subject to recall bias and measurement errors. Third, not all studies adjusted for the same confounders, which could influence the observed associations.

Nevertheless, the strengths of this meta-analysis include the inclusion of large, representative adolescent samples, geographic diversity, and the use of a rigorous random-effects model to account for heterogeneity. The findings have important policy implications, emphasizing the need for school-based and community-wide interventions to promote healthy eating, reduce screen time, and address social determinants of health in adolescent populations.

Bias Assessment: A critical appraisal of the included studies reveals a moderate risk of bias, primarily due to their cross-sectional designs, which limit the ability to establish causal relationships. Selection bias may be present in some studies that used school-based samples without randomization, potentially limiting generalizability to all adolescents. Information bias is another concern, as most dietary and lifestyle data were self-reported through questionnaires, making them prone to recall and social desirability bias. Moreover, confounding bias cannot be ruled out, as not all studies uniformly adjusted for socio-economic, environmental, or behavioral variables. However, the large sample sizes, use of validated tools, and inclusion of diverse geographical settings enhance the external validity of the findings. Overall, while some methodological limitations exist, the consistency of results across varied contexts adds robustness and credibility to the meta-analytic conclusions.

Implications for Practice, Policy, and Research

For Practice

Health professionals and educators must recognize the critical role of diet and lifestyle in shaping adolescent health outcomes. Schools should actively promote healthy food environments, discourage consumption of sugary beverages, and integrate nutrition education into their curricula. Family counseling and student-centered interventions may help build lasting healthy habits from a young age.

For Policy

This review highlights the urgent need for policy-level strategies to address poor dietary patterns among adolescents. Governments should regulate marketing of unhealthy foods, especially to children, enforce nutritional standards in school meal programs, and implement public health campaigns focused on reducing screen time and improving meal regularity. Socioeconomic and urban-rural disparities must also be addressed to ensure equity in adolescent health interventions.

For Research

Future research should focus on longitudinal and interventional designs to better understand causal relationships. Standardized tools for measuring dietary patterns, physical activity, and cognitive outcomes are needed to facilitate cross-study comparisons. More region-specific studies are essential to capture local dietary behaviors and guide culturally sensitive interventions. Finally, researchers should ensure diverse population representation and address key confounding variables in their analyses to improve validity.

Conclusion

This meta-analysis provides a comprehensive synthesis of evidence linking dietary and lifestyle behaviors with health and developmental outcomes among adolescents across diverse global settings. The findings indicate that unhealthy dietary patterns—such as high consumption of sugar-sweetened beverages, skipping meals, and increased screen time—are significantly associated with higher rates of overweight, obesity, and suboptimal academic performance. Although variations in study methodologies and populations introduced heterogeneity, the consistent trends across all included studies underscore the critical need for early, targeted interventions. By promoting balanced nutrition, reducing sedentary behaviors, and enhancing awareness at the family, school, and policy levels, significant improvements in adolescent health and well-being can be achieved. Future research should focus on longitudinal and experimental designs to strengthen causal inference and support evidence-based policymaking.

References

1. Abdoli M, Rosato MS, Cipriano A, Napolano R, Cotrufo P, Barberis N, *et al.* Affect, Body, and Eating Habits in Children: A Systematic Review. Nutrients. 2023;15(15):3343.
2. Agurs-Collins T, Alvidrez J, ElShourbagy Ferreira S, Evans M, Gibbs K, Kowtha B, *et al.* Perspective: Nutrition Health Disparities Framework: A Model to Advance Health Equity. Advances in Nutrition. 2024;15(4):100194.
3. Alasqah I, Mahmud I, East L, Alqarawi N, Usher K. Dietary behavior of adolescents in the qassim region, saudi arabia: A comparison between cities with and without the healthy cities program. International Journal of Environmental Research and Public Health. 2021a;18(18):9508.
4. Alasqah I, Mahmud I, East L, Alqarawi N, Usher K. Dietary behavior of adolescents in the qassim region, saudi arabia: A comparison between cities with and without the healthy cities program. International Journal of Environmental Research and Public Health. 2021b;18(18):9508.
5. Al-Hazzaa HM, Abahussain NA, Al-Sobayel HI, Qahwaji DM, Alsulaiman NA, Musaiger AO. Prevalence of Overweight, Obesity, and Abdominal Obesity among Urban Saudi Adolescents: Gender and Regional Variations. Journal of Health, Population, and Nutrition. 2014;32(4):634.
6. Aspuru K, Villa C, Bermejo F, Herrero P, López SG. Optimal management of iron deficiency anemia due to poor dietary intake. International Journal of General Medicine. 2011;4:741.
7. Balasundaram P, Daley SF. Public Health Considerations Regarding Obesity. StatPearls; 2025.
8. Baraldi LG, Martinez Steele E, Canella DS, Monteiro CA. Consumption of ultra-processed foods and associated sociodemographic factors in the USA between 2007 and 2012: evidence from a nationally representative cross-sectional study. BMJ Open. 2018;8(3):e020574.
9. Barchitta M, Maugeri A, Agrifoglio O, Favara G, La Mastra C, La Rosa MC, *et al.* Dietary patterns and school performance: Evidence from a sample of adolescents in Sicily, Italy. Annali Di Igiene Medicina Preventiva e Di Comunita. 2019;31(2):72-80.
10. Barnes TL, French SA, Mitchell NR, Wolfson J. Fast-food consumption, diet quality and body weight: cross-sectional and prospective associations in a community sample of working adults. Public Health Nutrition. 2015;19(5):885.
11. Bishwajit G. Nutrition transition in South Asia: the emergence of non-communicable chronic diseases. F1000Research. 2015;4:8.
12. Bublitz MG, Peracchio LA, Dadzie CA, Escalas JE, Hansen J, Hutton M, *et al.* Food access for all: Empowering innovative local infrastructure. Journal of Business Research. 2019;100:354-365.
13. Chapter 5: Collecting data | Cochrane Training. [Internet]. [cited 2021 Aug 27]. Available from: https://training.cochrane.org/handbook/current/chapter-05
14. Chaudhary A, Sudzina F, Mikkelsen BE. Promoting Healthy Eating among Young People—A Review of the Evidence of the Impact of School-Based Interventions. Nutrients. 2020;12(9):2894.
15. Coates AE, Hardman CA, Halford JCG, Christiansen P, Boyland EJ. Social media influencer marketing and children's food intake: A randomized trial. Pediatrics. 2019;143(4).
16. Cronin P, Ryan F, Coughlan M. Undertaking a literature review: a step-by-step approach. British Journal of Nursing (Mark Allen Publishing). 2008;17(1):38-43.
17. Cumpston M, Li T, Page MJ, Chandler J, Welch VA, Higgins JP, *et al.* Cochrane Database of Systematic

Reviews Updated guidance for trusted systematic reviews: a new edition of the Cochrane Handbook for Systematic Reviews of Interventions. 2019.
18. Czarniecka-Skubina E, Gutkowska K, Hamulka J. The Family Environment as a Source for Creating the Dietary Attitudes of Primary School Students—A Focus Group Interview: The Junior-Edu-Żywienie (JEŻ) Project. Nutrients. 2023;15(23):4930.
19. Firth J, Gangwisch JE, Gangwisch JE, Borisini A, Wootton RE, Wootton RE, *et al.* Food and mood: how do diet and nutrition affect mental wellbeing? The BMJ. 2020;369:m2382.
20. Frerichs L, Brittin J, Sorensen D, Trowbridge MJ, Yaroch AL, Siahpush M, *et al.* Influence of School Architecture and Design on Healthy Eating: A Review of the Evidence. American Journal of Public Health. 2015;105(4):e46.
21. Gan Q, Xu P, Yang T, Cao W, Xu J, Li L, *et al.* Sugar-sweetened beverage consumption status and its association with childhood obesity among chinese children aged 6-17 years. Nutrients. 2021;13(7).
22. Gherasim A, Arhire LI, Niță O, Popa AD, Graur M, Mihalache L. The relationship between lifestyle components and dietary patterns. The Proceedings of the Nutrition Society. 2020;79(3):311.
23. J B-S. Learning how to undertake a systematic review: part 1. Nursing Standard (Royal College of Nursing (Great Britain): 1987). 2010;24(50):47-55.
24. Karnik S, Kanekar A. Childhood Obesity: A Global Public Health Crisis. International Journal of Preventive Medicine. 2012;3(1):1.
25. Katre A, Raddatz B. Low-Income Families' Direct Participation in Food-Systems Innovation to Promote Healthy Food Behaviors. Nutrients. 2023;15(5):1271.
26. Kris-Etherton PM, Petersen KS, Hibbeln JR, Hurley D, Kolick V, Peoples S, *et al.* Nutrition and behavioral health disorders: depression and anxiety. Nutrition Reviews. 2020;79(3):247.
27. Laursen B, Veenstra R. Toward understanding the functions of peer influence: A summary and synthesis of recent empirical research. Journal of Research on Adolescence. 2021;31(4):889.
28. Lipscomb M. Exploring evidence-based practice: debates and challenges in nursing. 229.
29. Louie JCY. Sugar Reformulation in Solid Foods: Limitations and Challenges. Nutrition Bulletin. 2025;50(2):345.
30. Machado PP, Steele EM, Levy RB, da Costa Louzada ML, Rangan A, Woods J, *et al.* Ultra-processed food consumption and obesity in the Australian adult population. Nutrition & Diabetes. 2020;10(1):39.
31. Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review1. The American Journal of Clinical Nutrition. 2006;84(2):274.
32. Malisova O, Vlassopoulos A, Kandyliari A, Panagodimou E, Kapsokefalou M. Dietary intake and lifestyle habits of children aged 10-12 years enrolled in the school lunch program in Greece: A cross sectional analysis. Nutrients. 2021;13(2):1-13.
33. Mesas AE, González AD, de Andrade SM, Martínez-Vizcaíno V, López-Gil JF, Jiménez-López E. Increased Consumption of Ultra-Processed Food Is Associated with Poor Mental Health in a Nationally Representative Sample of Adolescent Students in Brazil. Nutrients. 2022;14(24).
34. Moynihan P. Sugars and Dental Caries: Evidence for Setting a Recommended Threshold for Intake. Advances in Nutrition. 2016;7(1):149.
35. Nadeau KJ, Maahs DM, Daniels SR, Eckel RH. Childhood obesity and cardiovascular disease: links and prevention strategies. Nature Reviews. Cardiology. 2011;8(9):513.
36. Nutr A, Saavedra JM, Saavedra JM. The Changing Landscape of Children's Diet and Nutrition: New Threats, New Opportunities. Annals of Nutrition and Metabolism. 2022;78(Suppl. 2):40-50.
37. Oxford centre for triple value healthcare Ltd. Critical Appraisal Skills Programme. [Internet]. [cited 2021 Aug 30]. Available from: https://casp-uk.net/wp-content/uploads/2018/01/CASP-Qualitative-Checklist-2018.pdf
38. P J, F H, J S, C B, M E. Direction and impact of language bias in meta-analyses of controlled trials: empirical study. International Journal of Epidemiology. 2002;31(1):115-123.
39. Pati D, Lorusso LN. How to Write a Systematic Review of the Literature. 2017;11(1):15-30.
40. Peacock PJ, Lewis G, Northstone K, Wiles NJ. Childhood diet and behavioural problems: results from the ALSPAC cohort. European Journal of Clinical Nutrition. 2011;65(6):720.
41. Pelletier JE, Laska MN. Balancing healthy meals and busy lives: Associations between work, school and family responsibilities and perceived time constraints among young adults. Journal of Nutrition Education and Behavior. 2012;44(6):481.
42. Hemingway P. What is systematic review. Evidence Based Medicine. 2009;1-8.
43. Potvin Kent M, Pauzé E, Roy EA, de Billy N, Czoli C. Children and adolescents' exposure to food and beverage marketing in social media apps. Pediatric Obesity. 2019;14(6):e12508.
44. Pulgaron ER, Delamater AM. Obesity and Type 2 Diabetes in Children: Epidemiology and Treatment. Current Diabetes Reports. 2014;14(8):508.
45. Pulungan AB, Puteri HA, Ratnasari AF, Hoey H, Utari A, Darendeliler F, *et al.* Childhood Obesity as a Global Problem: a Cross-sectional Survey on Global Awareness and National Program Implementation. Journal of Clinical Research in Pediatric Endocrinology. 2024;16(1):31.
46. Raj M. Obesity and cardiovascular risk in children and adolescents. Indian Journal of Endocrinology and Metabolism. 2012;16(1):13.
47. Reisch LA, Gwozdz W, Barba G, De Henauw S, Lascorz N, Pigeot I. Experimental Evidence on the Impact of Food Advertising on Children's Knowledge about and Preferences for Healthful Food. Journal of Obesity. 2013;2013:408582.
48. Ruiz LD, Zuelch ML, Dimitratos SM, Scherr RE. Adolescent Obesity: Diet Quality, Psychosocial Health, and Cardiometabolic Risk Factors. Nutrients. 2019;12(1):43.
49. Scaglioni S, De Cosmi V, Ciappolino V, Parazzini F, Brambilla P, Agostoni C. Factors Influencing Children's Eating Behaviours. Nutrients. 2018;10(6):706.

50. Sharma S, Maheshwari S, Kuwatada J, Chandrashekhar, Mehra S. Assessing Dietary Intake Patterns Through Cluster Analysis Among Adolescents in Selected Districts of Bihar and Assam From India: A Cross-Sectional Survey. Frontiers in Nutrition. 2021;8.
51. Sinai T, Axelrod R, Shimony T, Boaz M, Kaufman-Shriqui V. Dietary patterns among adolescents are associated with growth, socioeconomic features, and health-related behaviors. Foods. 2021;10(12):3054.
52. Steyn K, Damasceno A. Lifestyle and Related Risk Factors for Chronic Diseases. Disease and Mortality in Sub-Saharan Africa.
53. Tatlow-Golden M, Garde A. Digital food marketing to children: Exploitation, surveillance and rights violations. Global Food Security. 2020;27.
54. Torgerson DJ, Torgerson CJ. Avoiding Bias in Randomised Controlled Trials in Educational Research. British Journal of Educational Studies. 2003;51(1):36-45.
55. Tsochantaridou A, Sergentanis TN, Grammatikopoulou MG, Merakou K, Vassilakou T, Kornarou E. Food Advertisement and Dietary Choices in Adolescents: An Overview of Recent Studies. Children. 2023;10(3):442.
56. Von Philipsborn P, Stratil JM, Burns J, Busert LK, Pfadenhauer LM, Polus S, *et al.* Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. The Cochrane Database of Systematic Reviews. 2019;2019(6):CD012292.
57. Wang Y, Touboulic A, O'Neill M. An exploration of solutions for improving access to affordable fresh food with disadvantaged Welsh communities. European Journal of Operational Research. 2018;268(3):1021-1039.
58. Winichagoon P, Margetts BM. The double burden of malnutrition in low- and middle-income countries. Energy Balance and Obesity.
59. Youth I, of M. (US) C, on P. of O. in C, Koplan, JP, Liverman, C. T., & Kraak, VI. School, 2005.