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CHILDHOOD OBESITY IN URBAN AND RURAL INDIA: A SYSTEMATIC REVIEW AND META-ANALYSES OF PREVALENCE STUDIES

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Abstract

Background: Childhood obesity has become a pressing global public health issue, particularly in low- and middle-income countries like India. This systematic review aims to investigate the prevalence of childhood obesity and its associated risk factors in urban and rural regions of India.

Methods: A comprehensive systematic search was conducted in PubMed, Embase, and Scopus databases to identify relevant English-language studies published within the past decade. Inclusion criteria included studies conducted in India, focusing on children and adolescents aged 0-18, and reporting either the prevalence of childhood obesity or related risk factors. Ten studies, comprising both cross-sectional and quantitative research designs, met these criteria.

Results: The findings reveal a significant disparity in childhood obesity prevalence between urban and rural areas of India. Urban regions exhibit notably higher rates, with a pooled prevalence estimated at 9.0% (95% CI: 2.0 to 17), compared to 4.0% (95% CI: 4.0 to 5.0) in rural areas. Risk factors associated with childhood obesity in urban settings include unhealthy dietary habits, limited physical activity, higher income levels, parental education, and attendance at private schools. In rural areas, gender, age, and household size emerged as potential risk factors.

Discussion: These findings underscore the urgent need for geographically tailored interventions to address the urban-rural disparities in childhood obesity. Lifestyle-oriented strategies promoting healthier dietary patterns and increased physical activity are essential. Gender-inclusive programs targeting both boys and girls are crucial. Future research should consider regional and cultural diversity to design more effective public health responses.

Conclusion: This systematic review provides valuable insights into the prevalence and risk factors of childhood obesity in India. It highlights the necessity for customized interventions and lifestyle adjustments to combat this escalating public health challenge and reduce disparities in health outcomes.

Keywords Childhood obesity, prevalence studies, urban and rural India.

INTRODUCTION

Childhood obesity has emerged as one of the most pressing global public health issues of the 21st century. Over the last few decades, the prevalence of childhood obesity has risen at an alarming rate, affecting both developed and developing nations. Historically, obesity was largely seen as a problem of high-income countries, but recent data suggest that the phenomenon is increasingly becoming a

concern for low- and middle-income countries (LMICs) as well. This global rise in childhood obesity has profound implications not only for the health and well-being of children but also for the future economic and healthcare burdens on societies. The World Health Organization (WHO) reported that by 2019, there were over 38 million overweight children under the age of five, and in 2016, more than 340 million children and adolescents aged 5-19 were classified as overweight or obese (1). According to the World Obesity Federation, childhood overweight and obesity rates increased by more than double in LMICs from approximately 8.5% in 1980 to over 20% by 2020 (2). A significant amount of change has taken place over a relatively short period of time, which is particularly concerning. There were only 4% of overweight children in the 1970s. According to the NCD Risk Factor Collaboration, that figure rose to over 18% by 2016 (3). These figures reflect a rapid and unprecedented increase in the number of overweight and obese children, presenting a formidable public health challenge.

The escalation of childhood obesity worldwide has not occurred in isolation. A combination of dietary shifts, sedentary lifestyles, and environmental changes has contributed to this phenomenon. Globally, there has been a shift in diets toward energy-dense foods that are high in fats, sugars, and salt but low in essential nutrients like vitamins and minerals (4). These dietary changes are coupled with a decline in physical activity due to the increasingly sedentary nature of work, leisure activities, and transportation (5). Urbanization has played a significant role in exacerbating these issues, as cities tend to promote fewer active lifestyles and provide easier access to unhealthy food options. Children in urban settings are more likely to engage in sedentary activities such as watching television, playing video games, or using smartphones for extended periods, all of which contribute to the rising rates of obesity (5).

In addition to lifestyle factors, several other contributors to childhood obesity have been identified, including genetic, psychological, and socio-environmental factors. While genetics may predispose certain individuals to obesity, it is the interaction with environmental and lifestyle factors that largely determines outcomes. Psychological factors, such as stress, depression, and anxiety, have also been linked to childhood obesity, with some children turning to food as a coping mechanism. Socio-environmental factors, including parental influence, socioeconomic status, and access to health education, also play a crucial role. For instance, children from wealthier families or those attending private schools may have better access to unhealthy foods, such as sugary snacks and fast food, contributing to higher rates of obesity (6).

The health implications of childhood obesity are extensive and often persist into adulthood. Children who are obese are at a higher risk of developing non-communicable diseases (NCDs) such as type 2 diabetes, cardiovascular disease, and various musculoskeletal disorders (6). These conditions, once thought to be primarily adult concerns, are now being diagnosed at increasingly younger ages. Childhood obesity is also associated with a range of psychosocial issues, including low self-esteem, depression, and social isolation (7). Obese children may face discrimination or bullying from their peers, further exacerbating psychological distress and potentially leading to academic underachievement. As these children grow into adults, they often carry these health and psychological challenges with them, increasing their risk of premature death and disability.

Economically, the rise in childhood obesity places a significant burden on healthcare systems worldwide. The direct medical costs associated with treating obesity-related conditions are substantial, and the loss of productivity due to ill

health further compounds this burden (8). In many countries, healthcare systems are already stretched thin, and the growing number of obese children threatens to overwhelm them. The economic implications of childhood obesity are not limited to healthcare costs alone. The societal costs, including lost educational opportunities and decreased workforce participation, further underscore the need for urgent action to address this issue.

While childhood obesity was once considered a problem primarily confined to affluent nations, its prevalence in LMICs has been growing at an alarming rate. This rise in obesity in LMICs can be attributed to the globalization of unhealthy lifestyles, which has led to a dramatic shift in dietary habits and physical activity levels. In these countries, the traditional diets, which were often rich in fibre and low in fat, have been replaced by more Westernized diets that are high in processed foods, fats, and sugars (9). At the same time, technological advances and urbanization have reduced the need for physical activity, both in daily life and in leisure activities. Children in these countries are increasingly adopting sedentary behaviours, such as spending more time watching television or using digital devices, rather than engaging in physical play (10).

India provides a compelling case study of the rise of childhood obesity in an LMIC. The country is currently undergoing a rapid epidemiological transition, with an increase in non-communicable diseases (NCDs) such as obesity, diabetes, and cardiovascular disease, particularly in urban areas (11). Childhood obesity is becoming increasingly prevalent in India, with studies showing a higher burden in urban areas compared to rural regions. This urban-rural divide is likely driven by differences in lifestyle, dietary habits, and access to healthcare and educational resources. In urban areas, children are more likely to consume energy-dense, nutrient-poor foods and engage in sedentary behaviours, while in rural areas, traditional diets and more physically demanding lifestyles may provide some protection against obesity (12).

Despite this, childhood obesity is by no means limited to urban areas in India. As rural areas become more developed and lifestyles change, the prevalence of childhood obesity is also rising in these regions. Access to processed foods is increasing, and rural children are becoming more exposed to the same unhealthy dietary and lifestyle influences as their urban counterparts (13). This shift is concerning, as it suggests that the protective factors traditionally associated with rural life are being eroded, leading to a convergence in obesity rates between urban and rural areas.

The rise in childhood obesity in India has serious implications for the country's future health and economic stability. Obese children are more likely to develop NCDs such as type 2 diabetes and cardiovascular disease, conditions that place a significant burden on healthcare systems. In India, where healthcare resources are already limited, the growing number of obese children threatens to overwhelm an already strained system (14). Moreover, childhood obesity can have long-lasting effects on a child's mental health and academic performance, with potential consequences for their future economic productivity and quality of life.

The National Family Health Surveys (NFHS) in India have consistently shown a worrying trend of increasing obesity among children and adolescents, particularly in urban areas. This trend is reflective of the broader global shift toward unhealthy lifestyles, but it is exacerbated in India by the country's rapid urbanization and economic growth. As India continues to develop, it is likely that the prevalence of childhood obesity will

continue to rise unless urgent action is taken to address the root causes of this epidemic (15).

One of the key challenges in addressing childhood obesity in India is the lack of comprehensive, nationwide data on its prevalence and associated risk factors (16). While several studies have been conducted on childhood obesity in India, they often focus on specific regions or populations, making it difficult to get a clear picture of the overall situation. This systematic review aims to fill this gap by synthesizing the existing research on childhood obesity in India, with a focus on both urban and rural areas. By providing a comprehensive overview of the current state of childhood obesity in India, this review aims to inform policymakers and public health advocates about the scale of the problem and the most effective strategies for addressing it.

Public health interventions aimed at preventing and reducing childhood obesity in India must take into account the country's unique socio-cultural context. For example, interventions in urban areas may need to focus on reducing the consumption of processed foods and encouraging physical activity in a highly sedentary environment. In contrast, interventions in rural areas may need to address the growing availability of unhealthy food options while promoting the retention of traditional, more physically active lifestyles. Moreover, interventions must be tailored to address the socioeconomic disparities that exist between different regions and populations in India. Children from lower-income families may face different challenges in accessing healthy food and opportunities for physical activity compared to their wealthier counterparts (17).

In addition to addressing the immediate health concerns associated with childhood obesity, public health interventions must also consider the long-term economic and societal impacts of this epidemic. Childhood obesity is not only a health issue but also an economic one, as it has the potential to affect a country's workforce and overall productivity. By investing in prevention and early intervention, India can mitigate the long-term costs associated with childhood obesity and ensure a healthier, more productive future for its citizens (18,19).

Essentially, childhood obesity is a growing public health concern in India, with significant implications for the country's future health and economic well-being. The rise in obesity among Indian children is driven by a combination of factors, including dietary shifts, sedentary lifestyles, and the globalization of unhealthy behaviours. Addressing this issue will require a comprehensive, multi-sectoral approach that considers the unique challenges and opportunities presented by India's rapidly changing social and economic landscape. Through targeted interventions and public health initiatives, India can combat the rising tide of childhood obesity and protect the health and well-being of its future generations.

SEARCH STRATEGY

To conduct the literature search, a comprehensive search strategy was developed using the SPIDER (Sample, Phenomenon of Interest, Design, Evaluation, Research type) framework (20,21). The search terms used are presented in the following tables.

Table 1: SPIDER Framework for Literature Search Terms

Element	Description	Search Terms
Sample	Children in urban and rural areas of India	Children, Adolescents, Youth, School-aged
Phenomenon of Interest	Obesity and associated risk factors	Obesity, Overweight, Body Mass Index, BMI
Design	Studies examining prevalence and/or risk factors	Cross-sectional, Cohort, Case-control, Survey
Evaluation	Measurement of obesity and identification of risk factors	Prevalence, Incidence, Risk factors, Determinants
Research type	Both quantitative and mixed method research	Quantitative, Study

Table 2: Search Strategy

Search term	Description
(childhood OR pediatric) AND (obesity OR overweight)	Search terms for childhood obesity
(India OR Indian)	Search term for location
(urban OR rural)	Search term for setting
(prevalence OR incidence)	Search term for outcome measure
(risk factors OR determinants)	Search term for study design

NB: Search terms for childhood obesity, location, setting, outcome measure, and study design are presented in Table 1.

The search strategy was conducted in PubMed, Embase, and Scopus, which are among the most reputable and comprehensive health and biomedical research databases (22-23). PubMed is a premier database for biomedical literature, encompassing a vast range of topics relevant to the study's focus on childhood obesity (22). Embase's strong emphasis on pharmacology and drug research provides extensive literature on clinical and medical interventions, which is invaluable for understanding obesity treatment and prevention (23). Scopus, being one of the largest abstract and citation databases, offers broad interdisciplinary coverage, ensuring a comprehensive scope for collating varied research on obesity (23).

The search results were screened for eligibility based on the inclusion and exclusion criteria, and the quality of the included studies was assessed using the Cochrane Risk of Bias Tool (25). The data

extraction process was conducted using a standardized data extraction form, and the extracted data were analysed using descriptive statistics and meta-analysis (26).

INCLUSION CRITERIA

Inclusion and exclusion criteria are essential components of a systematic review, ensuring consistency, relevance, and rigor. They provide clear guidelines for identifying pertinent studies, eliminating potential biases, and addressing the research question comprehensively. Moreover, they enhance the review's transparency and replicability, establishing trust in the findings (21). This study adopted the following inclusion criteria:

- Geographical context: Studies conducted in India, focusing on either urban or rural settings, or both.
- Target population: Studies examining children and adolescents up to the age of 18 years.
- Outcomes of interest: Studies that report on the prevalence of childhood obesity or identify specific risk factors associated with childhood obesity in India.
- Study types: Both mixed-method studies and quantitative primary research studies, including cross-sectional, cohort, case-control, and observational studies.
- Publication language: Studies published in English.
- Time frame: Studies published in the last ten years to ensure relevance and capture recent trends and developments.

Exclusion Criteria

- Out of scope: Studies focusing on adult obesity without separate data for the child and adolescent age group.
- Geographical irrelevance: Studies that are not specific to India or do not differentiate results between India and other countries.
- Unrelated outcomes: Studies that discuss childhood weight or nutrition but do not specifically report obesity prevalence or associated risk factors.
- Review articles: Systematic reviews, literature reviews, meta-analyses, and other secondary publications.
- Non-empirical studies: Opinion pieces, editorials, and commentaries without original research data
- Language barrier: Studies not published in English and for which a reliable translation is unavailable.

Quality Assessment

Studies meeting a predetermined threshold of quality criteria were included in the review, ensuring that the synthesized findings are both reliable and valid. The "Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE) checklist was used to appraise the studies (26). The checklist includes critical reporting suggestions for the study heading, abstract, introduction or background, utilized methods in each study, findings of the studies, and discussion. Each paper's quality is presented in Appendix 3.

DATA EXTRACTION

Initially, a standardized data extraction form was designed, capturing pertinent details such as authors, publication year, study design, and key findings among others (27). The form's effectiveness was evaluated through pilot testing on select studies, allowing for refinements as needed (28). The compiled data was meticulously documented, with digital tools like spreadsheets facilitating organization (29). As a quality control measure, a random subset of studies underwent a

cross-check to validate the extraction process's accuracy.

Data Synthesis and Analysis

Data synthesis and analysis in systematic reviews are pivotal for amalgamating disparate pieces of information into a cohesive understanding of the studied phenomenon. Narrative synthesis was used to summarize the findings of the selected studies and to meet the objectives of this research study. Pooled prevalence was also assessed. I^2 value was assessed to find out the heterogeneity level of the studies. A forest plot was also created.

RESULTS

Study Selection

The study selection process was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (30). A PRISMA chart (Figure 1) was used to summarize the overall study selection process.

The search strategy identified 861 records, which were then screened for duplicates. A total of 294 duplicate records were removed, leaving 567 unique records. These records were then screened based on the eligibility criteria outlined in the methodology chapter, resulting in the removal of 334 records.

The remaining 233 full reports were assessed for eligibility, and some were deemed ineligible due to their evident ineligibility. After this stage, 10 articles were identified as eligible and selected for this study. All the selected articles were quantitative studies.

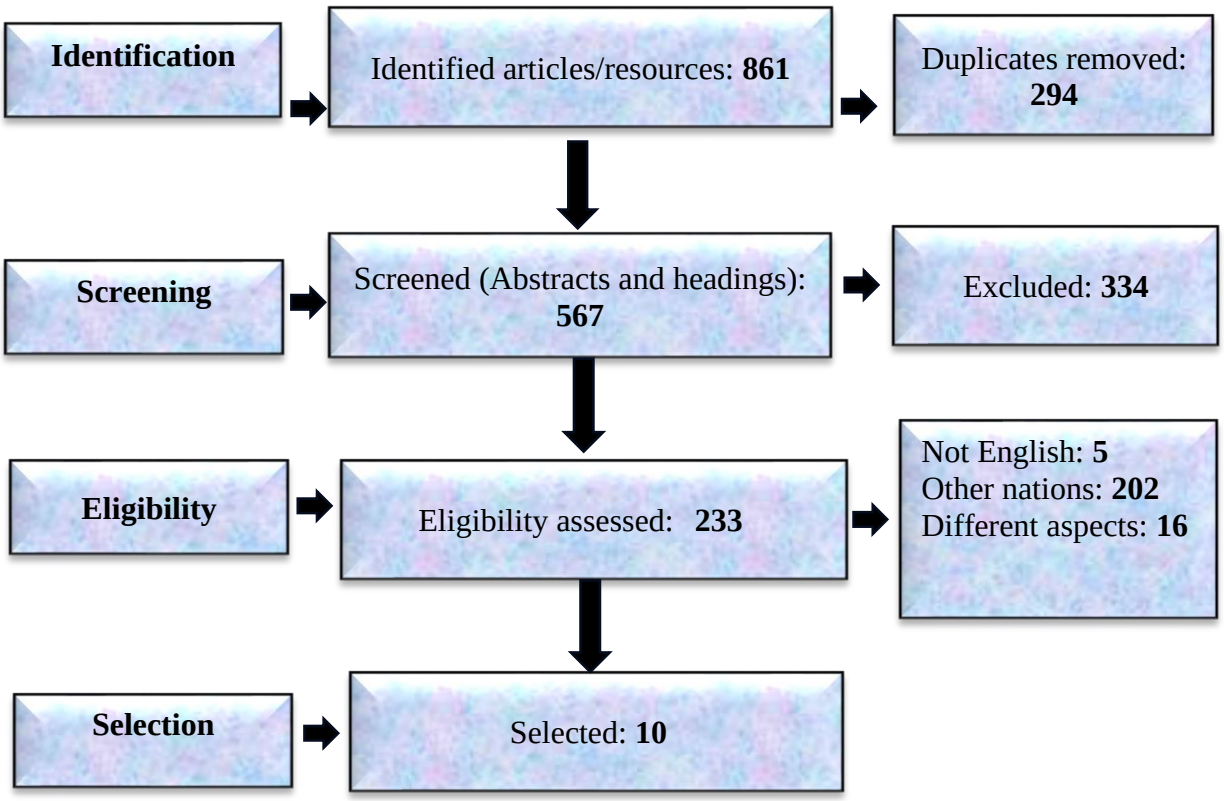

Figure 1: Study selection approach

Study Characteristics

Ten research studies, all employing a cross-sectional design, were included in this review. All studies focused on children or adolescents aged 18 or younger. The specific age groups of participants in each study are detailed in Appendix 2. Table 3 provides information on the study settings, including urban or rural locations, for the ten research studies.

Table 3: Study settings

Study	Study location	Setting information
(30)	Jaipur, Rajasthan	Urban
(38)	Pune, Maharashtra	Urban
(39)	Ganjam, Odisha	Urban and rural
(33)	Chennai, Tamilnadu	Urban
(34)	Vadodara, Gujarat	Urban and rural
(35)	Trichy, Tamilnadu	Rural
(32)	Kanchipuram, Tamilnadu	Rural
(36)	Coimbatore, Tamilnadu	Rural
(37)	Bangalore, Karnataka	Rural
(31)	Trissur, Kerala	Urban

As shown in Figure 2, the sample sizes of the studies included in this review ranged from 100 to 1842 participants. The 10 research studies employed various random sampling methods to recruit eligible study subjects, as detailed in Appendix 2.

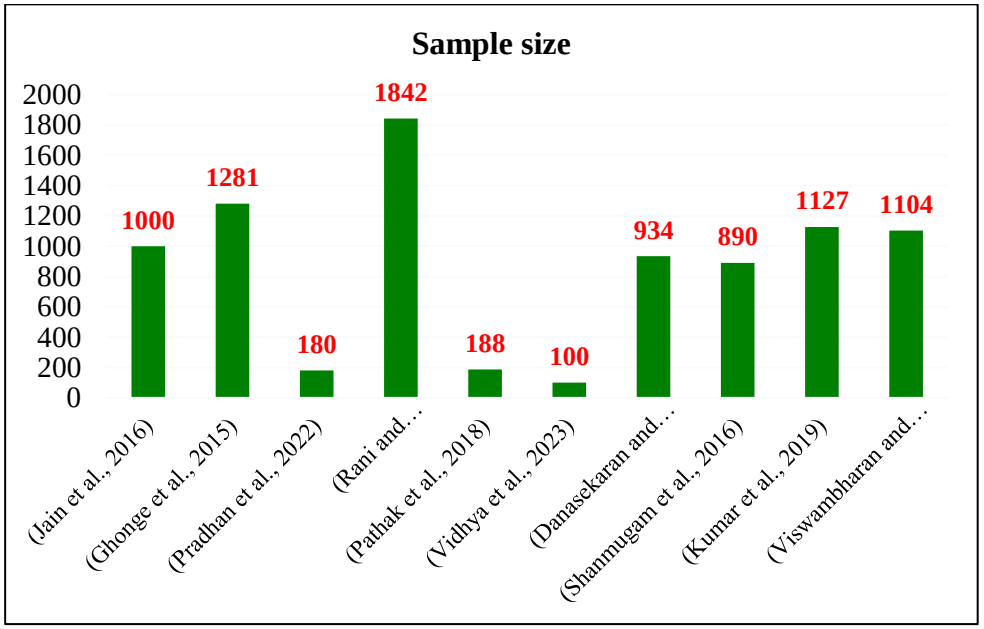

Figure 2: Sample sizes of selected studies

BMI was calculated for all participants in the included studies, along with the administration of other relevant tools and questionnaires. Descriptive and inferential statistics were employed to identify the prevalence and risk factors of childhood obesity. Ethical standards were adhered to in most of the investigations.

Prevalence of Childhood Obesity

A narrative synthesis was conducted to address the research questions. The total prevalence, as well as urban-rural and gender-based prevalence, were reported.

The reported total prevalence among the ten studies ranged from 4.08% to 7.30%, with a mean (SD) of 6.5 (3.9). The specific prevalence rates for each study are as follows: 5.60% (30), 5.62% (38), 5.00% (39), 5.20% (33), 17.60% (34), 6.00% (35), 4.40% (32), 4.72% (36), 4.08% (37), and 7.30% (31).

Urban-Rural Disparities

Eight of the ten studies focused exclusively on either rural or urban settings, while two studies reported on both. In rural areas, the prevalence of childhood obesity ranged from 2.20% to 6.00%, with a mean (SD) of 4.12 (1.2). In urban areas, the prevalence ranged from 5.2% to 31.3%, with a mean (SD) of 10.2 (10.3). The prevalence rates for both rural and urban settings are depicted in Figure 3.

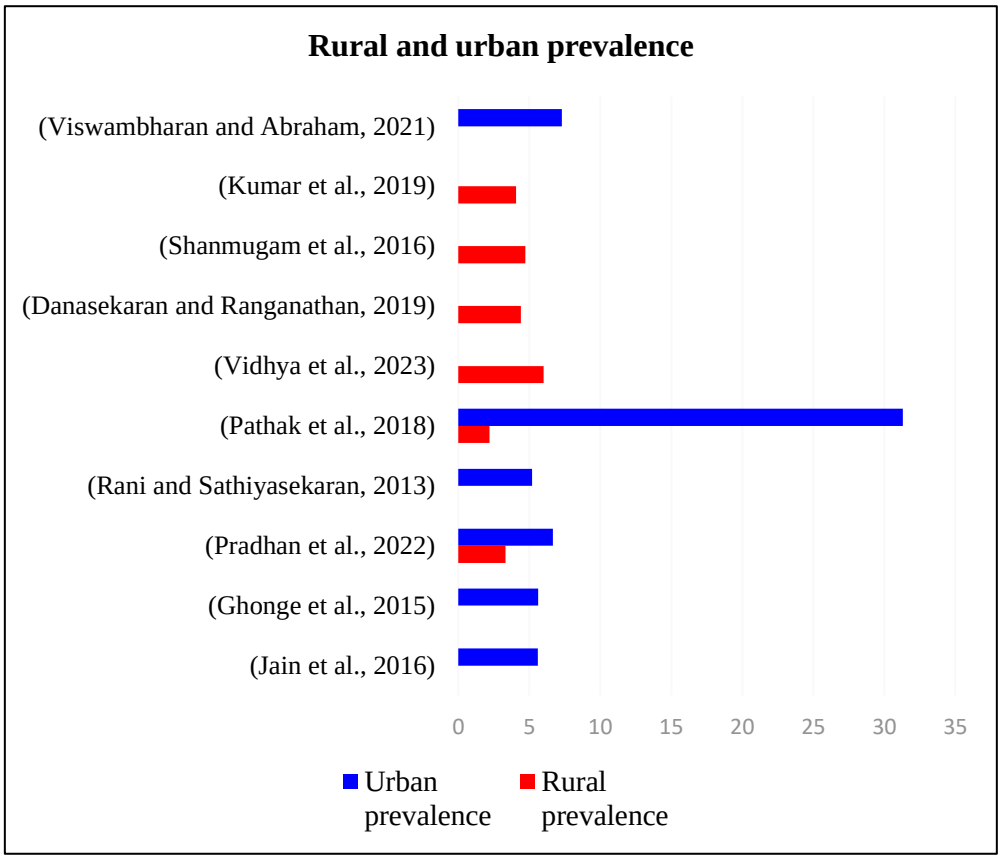

Figure 3: Rural vs urban prevalence of childhood obesity

Pooled prevalence: Rural and urban

Urban

The pooled prevalence of obesity in children from urban areas was estimated to be 9.0% (95% CI: 2.0 to 17), as shown in Figure 4. The results of the I^2 statistic (99.06%) indicate a high level of heterogeneity between the studies, which is statistically significant (p-value < 0.001).

Random-Effects Model (k = 6)

	Estimate	se	Z	p	CI Lower Bound	CI Upper Bound
Intercept	0.0949	0.0358	2.65	0.008	0.025	0.165
	.	.	.	.	.	.

Note. Tau^2 Estimator: Restricted Maximum-Likelihood

Heterogeneity Statistics

Tau	Tau^2	I^2	H^2	R^2	df	Q	p
0.085	0.0073 (SE= 0.0049)	99.06%	105.949	.	5.000	34.904	< .001

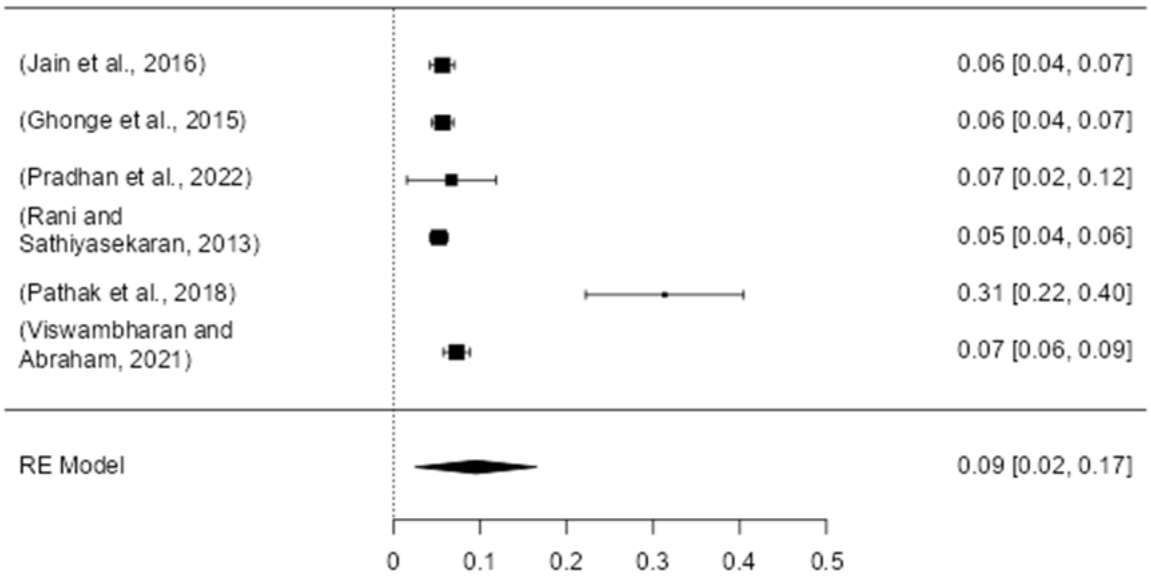

Figure 4: Forest plot of urban settings

Rural

As demonstrated in Figure 5, the pooled prevalence of obesity in rural children is 4.0% (95% CI: 4.0 to 5.0). The I^2 value of 0.0% suggests that there is no significant heterogeneity among the studies, indicating a high degree of consistency in the findings. While this may seem counterintuitive given the diversity of the included studies, it could be attributed to several factors, such as the relatively small number of studies, the similarity in study designs, or the limited variation in the prevalence of childhood obesity across the included rural regions.

Random-Effects Model (k = 6)

	Estimate	se	Z	p	CI Lower Bound	CI Upper Bound
Intercept	0.0425	0.00355	12.0	< .001	0.036	0.049
	.	.	.	.	.	.

Note. Tau^2 Estimator: Restricted Maximum-Likelihood

Heterogeneity Statistics

Tau	Tau^2	I^2	H^2	R^2	df	Q	p
0.000	0 (SE= 0)	0%	1.000	.	5.000	2.963	0.706

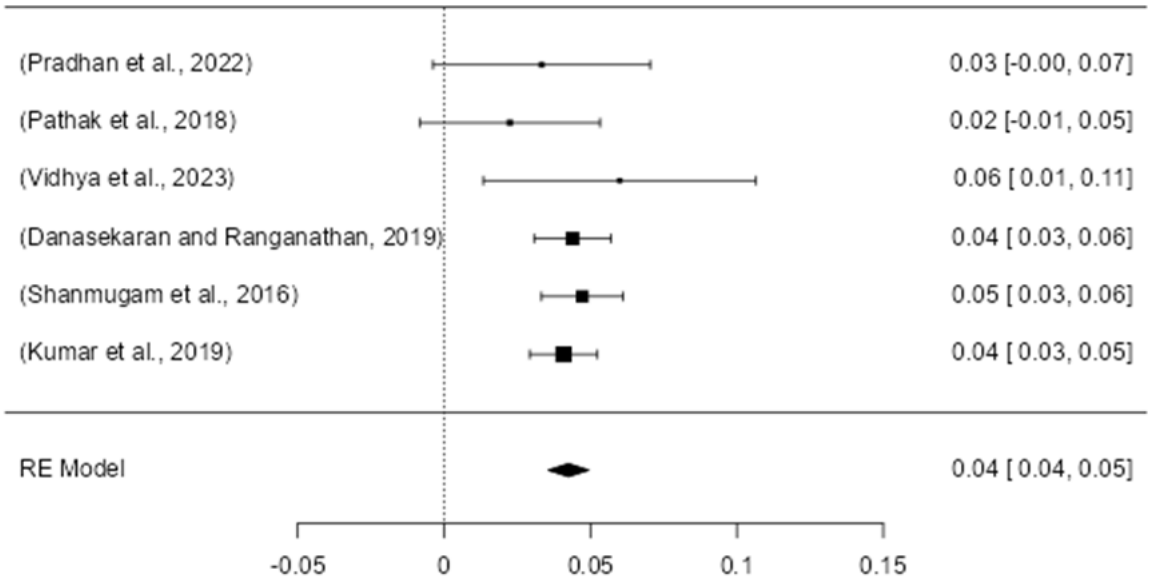

Figure 5: Forest plot of rural prevalence

Gender-Based Prevalence

While gender-based prevalence was reported in only three studies (30,31,38), all conducted in urban settings, significant disparities were observed. Urban male children had a higher prevalence of obesity [mean (SD): 10.27 (6.8)] compared to urban female children [mean (SD): 9.53 (5.53)]. In rural settings, gender differences were less pronounced, with similar prevalence rates for male and female children.

Critical appraisal of selected studies

A systematic review of ten research studies was conducted to assess the prevalence and risk factors of childhood obesity in India. The STROBE checklist was used to appraise the methodological quality of these studies.

While all studies demonstrated various strengths, areas for improvement were also identified. Several studies explicitly outlined their study design in the title or abstract, providing clarity to readers. However, some studies (29) could have benefited from a clearer statement of their

hypothesis to enhance interpretation.

Regarding confounding factors, (30) missed addressing potential confounders, which can significantly impact the depth of a study. The inclusion of rural perspectives by (31) and (32) enriched the overall body of research. However, consistency in addressing potential biases was lacking among the studies. While (32) addressed some biases, a more exhaustive account of statistical methods, particularly concerning confounding variables, was needed in some cases. (33) stood out in terms of methodology, but addressing missing data could have further enhanced the accuracy of their findings.

In terms of results, (27) and (29) effectively linked their findings to the study objectives. However, a more in-depth discussion of missing data, confounding adjustments, and broader implications is necessary for a more holistic interpretation of results.

DISCUSSION

This systematic review presents a comprehensive analysis of the prevalence and risk factors associated with childhood obesity in urban and rural India. The findings indicate an average obesity prevalence of 9.0% in urban areas and 4.0% in rural regions, highlighting a significantly higher burden in urban settings. Notably, gender-based differences were observed, with male children showing higher prevalence rates in urban areas. Several risk factors were identified, including socioeconomic determinants such as higher income and parental education, unhealthy lifestyle behaviours, and environmental factors like increased access to junk food and sedentary habits. These results underscore the critical need for targeted interventions, particularly in urban India, to address childhood obesity.

The outcomes of this systematic review carry significant implications for understanding childhood obesity dynamics in both urban and rural contexts, aligning closely with the primary research objectives. The notably higher prevalence of obesity in urban settings (9.0% versus 4.0% in rural areas) reflects the influence of urbanization on lifestyle and dietary habits, underscoring the need for tailored interventions in urban regions (34,39). While there is a slight gender-based difference in urban areas, with boys showing a higher prevalence, this variation lacks statistical significance. In rural areas, gender differences are less pronounced, suggesting that childhood obesity is a concern that spans across gender boundaries and requires inclusive strategies for both boys and girls (31,33,38).

Socioeconomic and Environmental Risk Factors

Socioeconomic factors, such as higher income, parental education, and private school attendance, emerged as significant contributors to childhood obesity in urban areas (33,38). This finding illustrates the complex relationship between socioeconomic status and childhood obesity, where increased access to resources can lead to both healthier choices and the adoption of unhealthy dietary and lifestyle behaviours. Effective interventions must account for these socioeconomic complexities to be successful in combating childhood obesity in urban settings.

Lifestyle and environmental factors also play a pivotal role. Unhealthy eating habits, such as frequent consumption of junk food, and sedentary behaviours, like excessive screen time, were identified as significant risk factors in both urban and rural settings. The prevalence of unhealthy food options in school canteens and the pervasive influence of technology further underscore the need for comprehensive interventions addressing these lifestyle factors (32,34,36,37,39). Public health policies should be based on empirical evidence and designed to encourage healthier

lifestyles, improve dietary habits, and promote physical activity, particularly in urban areas where childhood obesity is more prevalent. Tailoring these approaches to the socioeconomic and gender dynamics specific to each region is crucial for their success (30,31,38).

Gender-Inclusive and Context-Specific Strategies

While the gender differences in obesity prevalence observed in the included studies were not statistically significant, they do suggest a potential trend that warrants attention in the design of interventions. Public health initiatives should aim to engage both boys and girls equitably, ensuring that all children benefit from these programs (33,38).

This review underscores the urgent need for a multifaceted approach to preventing childhood obesity in India, addressing urban-rural disparities, socioeconomic factors, and lifestyle determinants. Collaborative efforts between policymakers, healthcare professionals, and community stakeholders are essential for developing evidence-based, context-specific interventions that effectively combat childhood obesity.

Some specific strategies include:

- Gender-sensitive interventions: Develop programs that address the unique needs and challenges faced by boys and girls in relation to obesity.
- Community-based initiatives: Implement community-based programs that promote healthy eating habits, increase physical activity levels, and create supportive environments for children and families.
- School-based interventions: Integrate healthy eating and physical activity into school curricula and provide nutrition education to students.
- Healthcare provider education: Train healthcare providers to screen for childhood obesity, provide counselling on healthy lifestyles, and refer patients to appropriate resources.
- Policy interventions: Implement policies that promote healthy eating and physical activity, such as restricting the marketing of unhealthy foods to children and creating safe and accessible spaces for physical activity.
- Socioeconomic interventions: Address underlying socioeconomic factors that contribute to childhood obesity, such as poverty, inequality, and lack of access to healthcare.

By adopting a comprehensive and multi-sectoral approach, India can effectively address the growing problem of childhood obesity and improve the health and well-being of its young population.

Future Research and Policy Recommendations

The findings of this review highlight the importance of adopting longitudinal research designs in future studies to better understand the causal relationships and long-term trends associated with childhood obesity. Furthermore, rigorous evaluations of interventions are needed to assess their effectiveness within the Indian context, considering the unique urban-rural disparities (34,39). This systematic review offers valuable insights into the multifaceted challenge of childhood obesity in India, equipping policymakers, healthcare practitioners, and researchers with the information needed to design targeted interventions that address the complexities faced by both urban and rural populations.

These findings also contribute significantly to the existing literature on childhood obesity in India.

The observed prevalence rates align with previous studies that have documented rising trends in obesity among Indian children (33,38). The higher prevalence in urban areas is consistent with global patterns linking urbanization to unhealthy lifestyles, reinforcing the need for targeted interventions in urban regions (34). This observation mirrors global evidence showing the impact of urbanization on dietary habits and physical activity levels (3). Additionally, the identification of socioeconomic factors as key contributors to childhood obesity in urban areas corroborates international research highlighting the complex relationship between income, education, and obesity (40). This emphasizes the necessity of addressing socioeconomic determinants in any intervention strategy.

Strengths and Limitations

This systematic review employed a rigorous methodology, including comprehensive literature searches, standardized data extraction, and quality assessment of included studies. The inclusion of studies from diverse urban and rural settings across India strengthens the generalizability of the findings.

However, some limitations must be acknowledged. The relatively small number of studies meeting the inclusion criteria and the heterogeneity in prevalence estimates across these studies may limit the generalizability of the findings. While the review provides valuable insights into childhood obesity in India, caution should be exercised when extrapolating the results to all regions and populations within the country.

Further research is needed to validate and expand upon these findings, particularly in local contexts. Addressing existing data gaps, such as the limited number of studies in certain regions, will allow for a more comprehensive understanding of childhood obesity dynamics in India.

Additionally, future research should focus on:

- Longitudinal studies: To track changes in childhood obesity prevalence and risk factors over time.
- Qualitative research: To explore the social, cultural, and environmental factors that contribute to childhood obesity.
- Cost-effectiveness analysis: To evaluate the economic impact of different interventions aimed at addressing childhood obesity.

By addressing these limitations and conducting further research, policymakers and healthcare providers can develop more effective and tailored interventions to combat childhood obesity in India.

CONCLUSION

This systematic review aimed to explore the prevalence of childhood obesity and its associated risk factors in both urban and rural regions of India. The primary research question focused on understanding the extent of childhood obesity in these settings and identifying the factors contributing to this pressing health concern. The study's significance stemmed from the alarming rise in childhood obesity rates across India, necessitating evidence-based insights to inform the development of effective public health policies and interventions.

Employing a rigorous systematic review methodology, this study critically assessed 10 primary research studies conducted within the Indian context. The findings revealed a pronounced disparity in the prevalence of childhood obesity, with higher rates documented in urban areas compared to rural counterparts. Key factors contributing to this disparity included unhealthy dietary practices, insufficient physical activity levels, and socioeconomic determinants. The implications of these findings are substantial, emphasizing the urgent need for region-specific interventions tailored to address the urban-rural

disparity in childhood obesity rates. Such interventions should prioritize promoting healthier lifestyles and improving access to nutritional education and physical activity opportunities, particularly in urban settings where the problem appears more pronounced. Lifestyle-focused strategies that promote healthier diets and increased physical activity are crucial. Gender-inclusive programs should be developed, targeting both boys and girls. Additionally, this study underscores the need for more extensive research in diverse Indian contexts to enhance the evidence base and facilitate effective public health responses. In essence, this systematic review sheds light on the pressing issue of childhood obesity in India, highlighting the importance of tailored interventions, lifestyle modifications, and gender-sensitive approaches to combat this growing public health concern.

Future research endeavours should extend and enhance the insights gained from this study by addressing critical areas in the context of childhood obesity in urban and rural India. Longitudinal studies are essential to track the trajectories of childhood obesity and assess its long-term health outcomes. Geographical variations within urban and rural settings warrant exploration, considering India's diverse cultural, dietary, and socioeconomic landscape. In-depth investigations into cultural and societal determinants, such as food preferences, family dynamics, and peer influences, are needed to uncover underlying causes. Evaluating the effectiveness of interventions, including school-based programs, community initiatives, and policy changes, will provide evidence for evidence-based strategies. Furthermore, studies examining disparities in obesity prevalence and healthcare access among different socioeconomic groups can guide targeted interventions to reduce health inequities. Qualitative research can illuminate the psychosocial aspects and barriers to behaviour change. To comprehensively address childhood obesity in India, future research should embrace a multidisciplinary approach, consider regional and cultural diversity, and foster collaboration among researchers, healthcare professionals, policymakers, and communities.

CONFLICTS OF INTEREST

The author reports no conflicts of interests.

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Supplemental Materials

Appendix 1: Quality Appraisal I

Study 1: The study of obesity among children aged 5-18 years in Jaipur, Rajasthan					
	Item No	**Recommendation**	**Yes/No/ Not clear**	**Page number**	**Comments**
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes	125	Clearly mentioned
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes	125	Clearly mentioned
Introduction					
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes	125-126	Clearly mentioned
Objectives	3	State-specific objectives, including any prespecified hypotheses	Yes	125-126	Hypothesis not mentioned
Methods					
Study design	4	Present key elements of study design early in the paper	Yes	126	Clearly mentioned
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes	126	Dates not mentioned
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Yes	126	Clearly mentioned
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Yes	126	Outcomes defined and others were not applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes	126	No comparison is there
Bias	9	Describe any efforts to address potential sources of bias	Yes	126	Sampling randomly done
Study size	10	Explain how the study size was arrived at	Yes	126	Clearly mentioned
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Not clear	NA	NA
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for	Yes	127-129	Not about confounders

		confounding			
		(*b*) Describe any methods used to examine subgroups and interactions	Yes	127-129	Chi-square test
		(*c*) Explain how missing data were addressed	No	NA	Not mentioned
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not clear	NA	NA
		(*e*) Describe any sensitivity analyses	No	NA	NA
Results					
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Yes	126	As per cross-sectional study
		(b) Give reasons for non-participation at each stage	NA	NA	NA
		(c) Consider use of a flow diagram	NA	NA	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes	126-127	Not about exposure and confounders
		(b) Indicate number of participants with missing data for each variable of interest	NA	NA	No missing data
Outcome data	15*	Report numbers of outcome events or summary measures	Yes	127	Prevalence reported
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA	NA	NA
		(*b*) Report category boundaries when continuous variables were categorized	Yes	127	Age, income, are categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA	NA	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	NA	NA
Discussion					
Key results	18	Summarise key results with reference to study objectives	Yes	128-130	Mentioned
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	No	NA	Not mentioned
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Yes	128-130	Mentioned
Generalisability	21	Discuss the generalisability (external	Yes	130	Implications

		validity) of the study results			provided
Other information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA	130	No funding

Study 2: Prevalence of obesity and overweight among school children of Pune city, Maharashtra, India: a cross-sectional study

	Item No	Recommendation	Yes/No/ Not clear	Page number	Comments
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes	3599	Clearly mentioned
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes	3599	Clearly mentioned
Introduction					
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes	3599- 3600	Clearly mentioned
Objectives	3	State-specific objectives, including any prespecified hypotheses	Yes	3599- 3600	Only objectives mentioned
Methods					
Study design	4	Present key elements of study design early in the paper	Yes	3600	Clearly mentioned
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes	3600	Applicable aspects mentioned
Participants	6	(*a*) Give the eligibility criteria and the sources and methods of selection of participants	Not clear	NA	Eligibility criteria not clear
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Yes	3600	Outcome measures were explained and others were not mentioned
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes	3600	No comparison is there
Bias	9	Describe any efforts to address potential sources of bias	Yes	3600	Random type sampling done
Study size	10	Explain how the study size was arrived at	Yes	3600	Clearly

					mentioned
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Yes	3600	mentioned
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Not clear	NA	Not explained
		(*b*) Describe any methods used to examine subgroups and interactions	Yes	3601-3602	Chi-square test
		(*c*) Explain how missing data were addressed	NA	NA	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not clear	NA	NA
		(*e*) Describe any sensitivity analyses	No	NA	NA
Results					
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Yes	3600	Sample size mentioned
		(b) Give reasons for non-participation at each stage	NA	NA	NA
		(c) Consider use of a flow diagram	No	NA	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes	3600	Mentioned except exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest	NA	NA	NA
Outcome data	15*	Report numbers of outcome events or summary measures	Yes	3601	Prevalence mentioned
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Not clear	NA	Chi-square results only mentioned
		(*b*) Report category boundaries when continuous variables were categorized	Not clear	NA	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA	NA	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	NA	NA
Discussion					
Key results	18	Summarise key results with reference to study objectives	Yes	128-130	Mentioned
Limitations	19	Discuss limitations of the study, taking into	No	NA	Not

		account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias			mentioned
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Yes	128-130	Mentioned
Generalisability	21	Discuss the generalisability (external validity) of the study results	Yes	130	Implications provided
Other information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA	130	No funding

Study 3: Prevalence of obesity among adolescent school children in rural and urban south Odisha

	Item No	Recommendation	Yes/No/ Not clear	Page number	Comments
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes	261	Clearly mentioned
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes	261	Clearly mentioned
Introduction					
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes	261-262	Clearly mentioned
Objectives	3	State-specific objectives, including any prespecified hypotheses	Yes	262	Only objectives mentioned
Methods					
Study design	4	Present key elements of study design early in the paper	Yes	262	Clearly mentioned
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes	262	Applicable aspects mentioned
Participants	6	(*a*) Give the eligibility criteria and the sources and methods of selection of participants	Not clear	NA	Eligibility criteria not clear
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Not clear	NA	Only outcome measures were explained

Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes	262	Mentioned
Bias	9	Describe any efforts to address potential sources of bias	Yes	262	Random sampling done
Study size	10	Explain how the study size was arrived at	Yes	262	Clearly mentioned
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Yes	262	Mentioned about coding
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Yes	262	Not about confounders
		(*b*) Describe any methods used to examine subgroups and interactions	Yes	262	Chi-square test
		(*c*) Explain how missing data were addressed	NA	NA	Not mentioned
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not clear	NA	NA
		(*e*) Describe any sensitivity analyses	No	NA	NA
Results					
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Yes	262	As per the cross-sectional study
		(b) Give reasons for non-participation at each stage	NA	NA	NA
		(c) Consider use of a flow diagram	No	NA	No diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes	262-263	No information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest	NA	NA	NA
Outcome data	15*	Report numbers of outcome events or summary measures	Yes	263	Prevalence mentioned
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	No	NA	NA
		(*b*) Report category boundaries when continuous variables were categorized	Yes	263-264	mentioned
		(*c*) If relevant, consider translating estimates	NA	NA	NA

		of relative risk into absolute risk for a meaningful time period			
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	NA	NA
Discussion					
Key results	18	Summarise key results with reference to study objectives	Yes	264-265	Mentioned
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Yes	264-265	Mentioned
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Yes	264-265	Mentioned
Generalisability	21	Discuss the generalisability (external validity) of the study results	Yes	265	Implications provided
Other information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA	NA	No funding

Study 4: Behavioural Determinants for Obesity: A Cross-sectional Study Among Urban Adolescents in India

	Item No	**Recommendation**	**Yes/No/ Not clear**	**Page number**	**Comments**
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes	192	Clearly mentioned
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes	192	Clearly mentioned
Introduction					
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes	192-193	Clearly mentioned
Objectives	3	State-specific objectives, including any prespecified hypotheses	Yes	193	Only objectives mentioned
Methods					
Study design	4	Present key elements of study design early in the paper	Yes	193	Clearly mentioned
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes	193	Applicable aspects mentioned

Participants	6	(*a*) Give the eligibility criteria and the sources and methods of selection of participants	Not clear	NA	Method of selection mentioned
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Yes (only outcome)	194	Outcome measures were explained and others were not applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes	193-194	Mentioned
Bias	9	Describe any efforts to address potential sources of bias	Yes	193	Random sampling done
Study size	10	Explain how the study size was arrived at	Yes	193	Clearly mentioned
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Yes	194	Grouping based on tools
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Yes	194	Mentioned
		(*b*) Describe any methods used to examine subgroups and interactions	Yes	194	Chi-square test, multivariate analysis
		(*c*) Explain how missing data were addressed	NA	NA	Not mentioned
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not clear	NA	NA
		(*e*) Describe any sensitivity analyses	No	NA	NA
Results					
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Yes	193	As per the cross-sectional study
		(b) Give reasons for non-participation at each stage	Yes	194	Some not provide consent
		(c) Consider use of a flow diagram	No	NA	No diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes	194	No information on exposures and potential confounders
		(b) Indicate number of participants with	NA	NA	NA

		missing data for each variable of interest			
Outcome data	15*	Report numbers of outcome events or summary measures	Yes	196	Prevalence mentioned
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Yes	196	Logistic regression
		(*b*) Report category boundaries when continuous variables were categorized	Yes	195	mentioned
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA	NA	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	NA	NA
Discussion					
Key results	18	Summarise key results with reference to study objectives	Yes	196	Mentioned
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Yes	198	Mentioned
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Yes	196-198	Mentioned
Generalisability	21	Discuss the generalisability (external validity) of the study results	Yes	198	Implications provided
Other information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Yes	198	Just funding only mentioned

Study 5: Prevalence of obesity among urban and rural school going adolescents of Vadodara, India: a comparative study

	Item No	**Recommendation**	**Yes/No/ Not clear**	**Page number**	**Comments**
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes	1355	Clearly mentioned
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes	1355	Clearly mentioned
Introduction					
Background/	2	Explain the scientific background and	Yes	1355-1356	Clearly

rationale		rationale for the investigation being reported			mentioned
Objectives	3	State-specific objectives, including any prespecified hypotheses	Yes	1356	Only purpose mentioned
Methods					
Study design	4	Present key elements of study design early in the paper	Yes	1356	Clearly mentioned
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes	1356	Applicable contents mentioned
Participants	6	(*a*) Give the eligibility criteria and the sources and methods of selection of participants	Not clear	NA	Method of selection mentioned
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Yes (only outcome)	1356	BMI were explained and others were not applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes	1356	Mentioned
Bias	9	Describe any efforts to address potential sources of bias	No	NA	NA
Study size	10	Explain how the study size was arrived at	No	NA	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Yes	1356	Mentioned
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Yes	1356	Mentioned
		(*b*) Describe any methods used to examine subgroups and interactions	Yes	1356	Different tests done
		(*c*) Explain how missing data were addressed	NA	NA	Not mentioned
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not clear	NA	NA
		(*e*) Describe any sensitivity analyses	No	NA	NA
Results					
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Yes	1356	As per the cross-sectional study
		(b) Give reasons for non-participation at each stage	Yes	1356	Mentioned about incomplete data of some children

		(c) Consider use of a flow diagram	No	NA	No diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes	1356	No information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest	Yes	1356	36 data record sheets were incomplete
Outcome data	15*	Report numbers of outcome events or summary measures	Yes	1357	Prevalence mentioned
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Not clear	NA	NA
		(*b*) Report category boundaries when continuous variables were categorized	Yes	1356	mentioned
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA	NA	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Yes	1356	Some analysis done
Discussion					
Key results	18	Summarise key results with reference to study objectives	Yes	1357	Mentioned
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Yes	1358	Mentioned
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Yes	1357-1358	Mentioned
Generalisability	21	Discuss the generalisability (external validity) of the study results	Not clear	NA	NA
Other information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Yes	1358	No funding

Study 6: A cross-sectional study on the Prevalence of overweight and obesity among school children of 6-12 years age in a rural area in Trichy district, Tamil Nadu

	Item No	Recommendation	Yes/No/	Page number	Comments

			Not clear		
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes	210	Clearly mentioned
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes	210	Clearly mentioned
Introduction					
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes	210	Clearly mentioned
Objectives	3	State-specific objectives, including any prespecified hypotheses	Yes	210	Only aim mentioned
Methods					
Study design	4	Present key elements of study design early in the paper	Yes	211	Clearly mentioned
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes	211	Applicable contents mentioned
Participants	6	(*a*) Give the eligibility criteria and the sources and methods of selection of participants	Yes	211	Mentioned
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Yes (only outcome)	211	BMI was explained and others were not applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes	211	Mentioned
Bias	9	Describe any efforts to address potential sources of bias	No	NA	NA
Study size	10	Explain how the study size was arrived at	No	NA	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Yes	211	Grouping not clear
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Yes	211	No mention on control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions	Yes	212	Chi square
		(*c*) Explain how missing data were addressed	NA	NA	Not mentioned
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not clear	NA	NA
		(*e*) Describe any sensitivity analyses	No	NA	NA

Results					
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Yes	211	Sample size mentioned
		(b) Give reasons for non-participation at each stage	NA	NA	NA
		(c) Consider use of a flow diagram	No	NA	No diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes	211	No information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest	NA	NA	NA
Outcome data	15*	Report numbers of outcome events or summary measures	Yes	211	Prevalence mentioned
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	No	NA	NA
		(*b*) Report category boundaries when continuous variables were categorized	Yes	212	mentioned
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA	NA	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	NA	NA
Discussion					
Key results	18	Summarise key results with reference to study objectives	Yes	213	Mentioned
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Yes	213	Mentioned
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Yes	213	Mentioned
Generalisability	21	Discuss the generalisability (external validity) of the study results	Not clear	NA	NA
Other information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No	213	No funding

Study 7: Prevalence of overweight and obesity among rural adolescent school students in Kanchipuram district, Tamil Nadu

	Item No	Recommendation	Yes/No/ Not clear	Page number	Comments
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes	173	Clearly mentioned
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes	173	Clearly mentioned
Introduction					
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes	173	Clearly mentioned
Objectives	3	State-specific objectives, including any prespecified hypotheses	Yes	173	Not specified it as objectives, just mentioned
Methods					
Study design	4	Present key elements of study design early in the paper	Yes	173	In abstract only
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes	174	Not all applicable
Participants	6	(*a*) Give the eligibility criteria and the sources and methods of selection of participants	Not clear	NA	Not clear. But mentioned few points
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Yes (only outcome)	174	BMI were explained and others were not applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Not clear	NA	Not clear
Bias	9	Describe any efforts to address potential sources of bias	Yes	174	Simple random technique used for sampling
Study size	10	Explain how the study size was arrived at	Yes	174	Mentioned
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Yes	174	Grouping not clear
Statistical	12	(*a*) Describe all statistical methods,	No	NA	NA

methods		including those used to control for confounding			
		(*b*) Describe any methods used to examine subgroups and interactions	No	NA	NA
		(*c*) Explain how missing data were addressed	NA	NA	Not mentioned
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not clear	NA	NA
		(*e*) Describe any sensitivity analyses	No	NA	NA
Results					
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Yes	174	Sample size mentioned
		(b) Give reasons for non-participation at each stage	NA	NA	NA
		(c) Consider use of a flow diagram	No	NA	No diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes	174-175	No information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest	NA	NA	NA
Outcome data	15*	Report numbers of outcome events or summary measures	Yes	175	Prevalence mentioned
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	No	NA	NA
		(*b*) Report category boundaries when continuous variables were categorized	Not clear	NA	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA	NA	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	NA	NA
Discussion					
Key results	18	Summarise key results with reference to study objectives	Yes	175	Mentioned
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Yes	175	Mentioned
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar	Yes	175	Mentioned

		studies, and other relevant evidence			
Generalisability	21	Discuss the generalisability (external validity) of the study results	Yes	175	implications
Other information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No	175	No funding

Study 8: Prevalence of overweight and obesity among children aged 5-15 years in a rural school in Coimbatore

	Item No	Recommendation	Yes/No/ Not clear	Page number	Comments
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes	2186	Clearly mentioned
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes	2186	Clearly mentioned
Introduction					
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes	2186-2187	Clearly mentioned
Objectives	3	State-specific objectives, including any prespecified hypotheses	Yes	2186-2187	Not specified about hypothesis
Methods					
Study design	4	Present key elements of study design early in the paper	Yes	2187	mentioned
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes	2187	Not all applicable
Participants	6	(*a*) Give the eligibility criteria and the sources and methods of selection of participants	Not clear	NA	Not clear.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Yes (only outcome)	2187	BMI were explained and others were not applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes	2187	Mentioned
Bias	9	Describe any efforts to address potential sources of bias	No	NA	No mention

Study size	10	Explain how the study size was arrived at	No	NA	No mention
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Yes	2187	Grouping not clear
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	No	NA	NA
		(*b*) Describe any methods used to examine subgroups and interactions	No	NA	NA
		(*c*) Explain how missing data were addressed	NA	NA	Not mentioned
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not clear	NA	NA
		(*e*) Describe any sensitivity analyses	No	NA	NA
Results					
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Yes	2187	Sample size mentioned
		(b) Give reasons for non-participation at each stage	NA	NA	NA
		(c) Consider use of a flow diagram	No	NA	No diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes	2187	No information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest	NA	NA	NA
Outcome data	15*	Report numbers of outcome events or summary measures	Yes	2187	Prevalence mentioned
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	No	NA	NA
		(*b*) Report category boundaries when continuous variables were categorized	Not clear	NA	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA	NA	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	NA	NA
Discussion					
Key results	18	Summarise key results with reference to study objectives	Yes	2187	Mentioned

Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Yes	2187	Mentioned
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Yes	2187-2188	Mentioned
Generalisability	21	Discuss the generalisability (external validity) of the study results	Yes	2188	implications
Other information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No	2189	No funding

Study 9: Study on prevalence of overweight and obesity amongst school children of Bangalore

	Item No	Recommendation	Yes/No/ Not clear	Page number	Comments
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes	159	Clearly mentioned
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes	159	Clearly mentioned
Introduction					
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes	159-160	Clearly mentioned
Objectives	3	State-specific objectives, including any prespecified hypotheses	Yes	160	Not specified about hypothesis
Methods					
Study design	4	Present key elements of study design early in the paper	Yes	160	Mentioned
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes	160	Mentioned applicable aspects
Participants	6	(*a*) Give the eligibility criteria and the sources and methods of selection of participants	Yes	160	Not clear. But mentioned
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Yes (only outcome)	160	Outcomes defined

Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes	160-162	Mentioned
Bias	9	Describe any efforts to address potential sources of bias	No	NA	No mention
Study size	10	Explain how the study size was arrived at	No	NA	No mention
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Yes	160	Grouping not clear
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	No	NA	NA
		(*b*) Describe any methods used to examine subgroups and interactions	No	NA	NA
		(*c*) Explain how missing data were addressed	NA	NA	Not mentioned
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not clear	NA	NA
		(*e*) Describe any sensitivity analyses	No	NA	NA
Results					
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Yes	161	Sample size mentioned
		(b) Give reasons for non-participation at each stage	NA	NA	NA
		(c) Consider use of a flow diagram	No	NA	No diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes	161	No information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest	NA	NA	NA
Outcome data	15*	Report numbers of outcome events or summary measures	Yes	161	Prevalence mentioned
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	No	NA	NA
		(*b*) Report category boundaries when continuous variables were categorized	Yes	161	Mentioned
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA	NA	NA

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	NA	NA
Discussion					
Key results	18	Summarise key results with reference to study objectives	Yes	162-163	Mentioned
Limitations	19	Discuss the limitations of the study, taking into account sources of potential bias or imprecision. Discuss both the direction and magnitude of any potential bias	No	NA	NA
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Yes	161-162	Mentioned
Generalisability	21	Discuss the generalisability (external validity) of the study results	Yes	162-163	Implications
Other information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No	163	No funding

Study 10: A cross-sectional study on the prevalence of overweight and obesity in affluent school children of central Kerala

	Item No	**Recommendation**	**Yes/No/ Not clear**	**Page number**	**Comments**
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Yes	4284	Clearly mentioned
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes	4284	Clearly mentioned
Introduction					
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes	4284-4285	Clearly mentioned
Objectives	3	State-specific objectives, including any prespecified hypotheses	Yes	4284 and 4285	Not specified about hypothesis
Methods					
Study design	4	Present key elements of study design early in the paper	Yes	4285	Mentioned
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes	4285	Mentioned applicable details

Participants	6	(*a*) Give the eligibility criteria and the sources and methods of selection of participants	Yes	4285	Not fully mentioned
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Not clear	4285	Outcome variables measurement mentioned
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Yes	4285	Mentioned
Bias	9	Describe any efforts to address potential sources of bias	Yes	4285	Sampling; universal
Study size	10	Explain how the study size was arrived at	No	4285	Mentioned
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Yes	4285	Grouping not mentioned clearly
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Yes	4285	Not mentioned about confounding
		(*b*) Describe any methods used to examine subgroups and interactions	Yes	4286	Chi-square done
		(*c*) Explain how missing data were addressed	NA	NA	Not mentioned
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not clear	NA	NA
		(*e*) Describe any sensitivity analyses	No	NA	NA
Results					
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Yes	4285	Sample size mentioned
		(b) Give reasons for non-participation at each stage	NA	NA	NA
		(c) Consider use of a flow diagram	No	NA	No diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes	4285	No information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest	NA	NA	NA
Outcome data	15*	Report numbers of outcome events or summary measures	Yes	4285	Prevalence mentioned
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders	No	NA	NA

		were adjusted for and why they were included			
		(*b*) Report category boundaries when continuous variables were categorized	Not clear	NA	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA	NA	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Not clear	NA	NA
Discussion					
Key results	18	Summarise key results with reference to study objectives	Yes	4286	Mentioned
Limitations	19	Discuss the limitations of the study, considering sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	No	4286	NA
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Yes	4286	Mentioned
Generalisability	21	Discuss the generalisability (external validity) of the study results	Yes	4286-4287	Implications
Other information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No	4287	No funding

Appendix 2: Data Extraction Table

Childhood Obesity in Urban and Rural India: A Systematic Review and Meta-Analyses of Prevalence Studies

Authors/year	Aim/objectives	Study design	Study setting	Urban/ rural area	Sample size	Sampling	Study population (age group)	Data collection details
(Jain et al., 2016)	To study the obesity among children of aged 5-18 years in Jaipur, Rajasthan.	Cross sectional study	Jaipur, Rajasthan	Urban	1000	Simple random sampling	Children (5-18 years)	Semi-structured questionnaire, (BMI) was calculated
(Ghonge et al., 2015)	To find out prevalence of obesity and overweight among school children.	Cross sectional study	Pune, Maharashtra	Urban	1281	Random sampling	Children (10 and 15 years)	Pre-designed, pre-tested, semi-structured performa, BMI were calculated
(Pradhan et al., 2022)	Estimating the prevalence of obesity among rural and urban adolescent school children and to assess the risk factors associated with adolescent obesity.	Cross sectional study	Ganjam, Odisha	Urban and Rural	180	Systematic random sampling	Adolescents (high school)	Pre-designed and pre-tested questionnaire, (BMI) was calculated

(Rani and Sathiyasekaran, 2013)	To address the prevalence of behavioural risk factors for obesity among randomly selected urban adolescent students from both private and government schools in Chennai, Tamil Nadu.	Cross sectional study	Chennai, Tamil Nadu	Urban	1842	Simple random sampling	Adolescents (12-18 years)	Age-appropriate modified GSHS self-administered questionnaire, standardized International Physical Activity Questionnaire (short form),(BMI) was calculated
(Pathak et al., 2018)	To compare the prevalence of obesity among urban and rural school going children of adolescent age in district of Vadodara and also to study various predisposing factors.	Cross sectional study	Vadodara, Gujarat	Urban and Rural	188	No details	School going children of adolescent age group (10 to 18 years of age)	(BMI) was calculated, standardized questionnaire
(Vidhya et al., 2023)	To assess the prevalence of obesity among rural school children of 6-12 years of age and to determine factors associated with obesity	Cross sectional study	Trichy district, Tamil Nadu	Rural	100	Multistage cluster sampling	Children aged 6-12 years	(BMI) was calculated, Semi structured questionnaire.

(Danasekaran and Ranganathan, 2	To assess the prevalence of overweight and obesity among the school in the age group of 14-17 years in Kanchipuram district of Tamil Nadu.	Cross sectional study	Kanchipuram, Tamil Nadu	Rural	934	Simple random sampling	Children aged 14-17 years	(BMI) was calculated, questionnaire
(Shanmugam et al., 2016)	To study the prevalence of overweight and obesity among school children in a rural school in Coimbatore using the WHO standard reference for age 5–19 years.	Cross sectional study	Coimbatore, Tamil Nadu	Rural	890	No details	School children aged 5–15 years	(BMI) was calculated, questionnaire
(Kumar et al., 2019)	To assess the prevalence of overweight and obesity amongst school children of Bangalore and to study the association of age and gender with overweight and obesity amongst school children of Bangalore.	Cross sectional study	Bangalore, Karnataka	Rural	1127	No details	School children aged 6 to 16 years	(BMI) was calculated BMI charts based on NCHS (National Centre for Health Statistics), CDC USA (United States of America) standards, questionnaire
(Viswambharan and Abraham, 2021)	To assess the prevalence of obesity among affluent school children in	Cross sectional study	Thrissur, Kerala	Urban	1104	Universal sampling metho	Private school children (4	Semi-structured questionnaire, BMI was

	Thrissur					d	and 18 years)	calculated

Appendix 3: Quality Appraisal II

Childhood Obesity in Urban and Rural India: A Systematic Review and Meta-Analyses of Prevalence Studies

Authors/year	Analysis details	Ethics information	Funding information	Conflict of interest present or not	Total prevalence	Rural prevalence	Urban prevalence	Gender based prevalence	Risk factors
(Jain et al., 2016)	**Software:** No details **Methods:** Descriptives, Chi-square test	**Consent attained:** Yes **IRB approval attained:** No details	No funding	No	5.60 %	NA	5.60 %	**Male:** 17.9 % **Female:** 15.9 %	Less physical activity, High-income family, Male gender, Junk food, chocolate, and eating outside the home, more nonvegetarian diet, lesser physical activity
(Ghonge et al., 2015)	**Software:** Microsoft Excel and Open- Epi Software (Version 2.3). **Methods:** Descriptives,	**Consent attained:** Yes **IRB approval attained:** Yes	No funding	No	5.62 %	NA	5.62 %	**Male:** 4.62 % **Female:** 6.8%	Age groups (15 years age group both in Government schools and private schools), children of Private

	Chi-square test								schools have higher prevalence
(Pradhan et al., 2022)	**Software:** SPSS ver.16.0 **Methods:** Proportions, chi-square test, mean, and standard deviations, unpaired t-test	**Consent attained:** Yes **IRB approval attained:** Yes	No funding	No	5.00 %	3.33 %	6.66 %	More in males	Urban school students, older students, hours of television and/or smartphone and laptop use, Consumption of carbonated drinks, and irregular breakfast, Tiffin from canteen, physical activities like outdoor games and mode of conveyance to school
(Rani and Sathiyasekaran, 2013)	**Software:** SPSS ver 15.0 **Methods:** Descriptives, Pearson's chi-squared test, logistic regression models	**Consent attained:** Yes **IRB approval attained:** Yes	Ramachandra University	No	5.20 %	NA	5.20 %	More in females	Younger age group, female sex, a high level of father's and mother's education, and the type of school they were attending, type of school, and fast-food

									consumption, private schools,
(Pathak et al., 2018)	**Software:** SPSS ver 23 **Methods:** Descriptives, Independent sample test (Kruskal-Wallis test), Spearman's rho, Odds ratio, Mann-Whitney U test, chi-square test	**Consent attained:** Yes **IRB approval attained:** Yes	No funding	No	17.60 %	2.20 %	31.30 %	**Male:** 20.2 % **Female:** 15.4 %	Higher parental Annual income, frequency of restaurant and school canteen food consumption and lesser frequency of physical training sessions conducted in schools.
(Vidhya et al., 2023)	**Software:** SPSS **Methods:** Descriptives, Chi-square test	**Consent attained:** No details **IRB approval attained:** Yes	No funding	No	6.00 %	6.00 %	NA	**Male:** 4.0% **Female:** 2.0%	Number of family members
(Danasekaran and Ranganathan, 2	**Software:** SPSS **Methods:** Descriptives	**Consent attained:** Yes **IRB approval attained:** Yes	No funding	No	4.40 %	4.40 %	NA	**Male:** 4.58 % **Female:** 4.20 %	Not covered
(Shanmugam et al., 2016)	**Software:** SPSS ver 19 **Methods:** Descriptives, Chi-square tests	**Consent attained:** Yes **IRB approval attained:** Yes	No funding	No	4.72 %	4.72 %	NA	**Male:** 6.43 % **Female:** 2.96	No significant findings

								%	
(Kumar et al., 2019)	**Software:** SPSS ver 24 **Methods:** Descriptives, Chi-square tests	**Consent attained:** Yes **IRB approval attained:** Yes	No funding	No	4.08 %.	4.08 %.	NA	**Male:** 2.04 %. **Female:** 2.04 %.	No significant findings
(Viswambharan and Abraham, 2021)	**Software:** SPSS ver 20 **Methods** Proportions, means and standard deviations, Bivariate analysis	**Consent attained:** Yes **IRB approval attained:** Yes	No funding	No	7.30 %	NA	7.30 %	**Male:** 8.3% **Female:** 5.9%	Increase in age and male gender