INVESTIGATING THE IMPACT OF MULTIFACETED SCHOOL-BASED INTERVENTIONS ON CHILDHOOD AND ADOLESCENT OBESITY PREVENTION IN RURAL COMMUNITIES: A HEALTH EDUCATIONAL APPROACH

Delimaris Ioannis,
Center for Instruction, Research, and Technology, Metropolitan College, Athens, Attica, Greece

ABSTRACT

Introduction: Childhood and adolescent obesity represents a critical public health challenge, particularly in rural communities hindered by unique sociocultural and environmental factors.

Objective: The aim of the present study is to investigate the impact of multifaceted school-based interventions on childhood and adolescent obesity prevention in rural communities using a health educational approach.

Design: Mini narrative review.

Materials and methods: The material of the present study was exclusively Internet-based. The method was comprehensive electronic literature search [literature published from 2009 to 2024 (15 years)] in the databases PubMed and Google Scholar from 10 April 2024 to 10 June 2024.

Results and Discussion: The review of the literature on the impact of multifaceted school-based interventions on childhood and adolescent obesity prevention in rural communities revealed that diverse strategies have been successfully implemented to address this growing epidemic. Studies show that federal policies have effectively increased physical activity in schools despite challenges. Successful interventions improved school food environments and student dietary choices, reducing Body Mass Index (BMI) through initiatives like limiting sugary drinks. Collaborative efforts among stakeholders and culturally-tailored programs proved essential for engaging diverse populations and ensuring intervention success.

Conclusions: The findings suggest that multifaceted school-based interventions can lead to significant improvements in preventing obesity among children and adolescents in rural communities. However, there is a need for further research to explore long-term effects and to identify sustainable strategies that can be adopted across varying educational environments. Continued investigation into stakeholder engagement, policy integration, and the adaptation of interventions to accommodate cultural and contextual factors is essential for advancing obesity prevention efforts in these areas.

Keywords: interventions, children, adolescents, schools, obesity, rural, health education.

* **Corresponding author**: Dr. Ioannis A. Delimaris, Dr.Med.Sc (ClinBiochem), MSc (ClinChem), BSc (BiolSc), PGCE, QTS, Post-Doc (Nutr), Registered College Lecturer (Reg Num 159/2013), Scientific Collaborator at the Center for Instruction, Research, and Technology (C.I.R.T.), Metropolitan College, 42 Akadimias Street, 10672 Athens, Attica, Greece.; e-mail: dr.i.delimaris@gmail.com

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Introduction

School-based interventions refer to strategies enacted within classroom environments aimed at enhancing the health and well-being of students, frequently by mitigating or preventing issues such as depression, social anxiety, substance use (including tobacco and alcohol), bullying, and aggression. These programs necessitate collaborative efforts among school psychologists, counselors, social workers, health educators, and administrative personnel, and may be directed towards specific high-risk subgroups or applied to the broader population of children and adolescents within the school [1]. Health education is the interdisciplinary branch of pedagogy, medico-biological sciences, and health sciences, which addresses issues of prevention and the adoption of practices and strategies to reduce morbidity and mortality of the general population. The field of health education usually includes school-based interventions [2-5]. Such interventions can include a variety of activities, such as tailored lectures, guided online lessons, group discussions, role-playing exercises, and special homework assignments designed to be completed with parental involvement [1].

The World Health Organization (WHO) defines obesity as "abnormal or excessive fat accumulation that presents a risk to health". Pediatric (childhood and adolescent) obesity is defined epidemiologically using the Body Mass Index (BMI), which is adjusted for age and sex because of the physiological changes in BMI during growth [6]. The Body Mass Index (BMI) serves as a cost-effective tool for evaluating body fat, calculated using a formula based on height and weight for children older than 2 years. BMI offers a reliable indirect estimate of body fat in a pediatric population that is otherwise healthy, with research indicating a correlation between BMI values and both adiposity and future health risks. Unlike adult BMI assessments, which provide a straightforward measure, pediatric (2–19 years) BMI is represented using percentiles that account for age and gender variations. The definition of overweight is applied when BMI is between the 85th and 95th percentiles, while obesity is denoted by a BMI exceeding the 95th percentile (BMI percentile for 2–19 years: 1. Normal: 5th–84th, 2. Overweight: 85th–94th, 3.Obese: ≥95th, 4. Morbid obesity: 99th or above) [7,8].

Obesity represents a multifaceted public health challenge impacting children across various age cohorts. In the United States, approximately one-third of children and adolescents are identified as overweight or obese. The presence of obesity in pediatric populations is associated with an elevated risk for a variety of health complications, including precocious puberty in children, irregular menstrual cycles in adolescent females, sleep disturbances such as obstructive sleep apnea (OSA), and various cardiovascular risk factors [7]. These cardiovascular risk factors encompass prediabetes, type 2 diabetes mellitus, dyslipidemia, hypertension, non-alcoholic fatty liver disease (NAFLD), and metabolic syndrome. Additionally, obese youth may experience significant psychological comorbidities, including depression, anxiety, diminished self-esteem, negative body image, challenges in peer relationships, and disordered eating behaviors [7].The management of obesity encompasses the treatment of complications associated with the condition, employs a developmentally appropriate strategy, involves family participation, and facilitates sustained behavioral modifications concerning dietary habits, physical activity, sedentary lifestyles, and sleep patterns [6].

Primary prevention of obesity necessitates the regular tracking of patient growth, alongside education for patients and families regarding weight management. Healthcare providers (HCP) should measure height and weight and calculate body mass index (BMI) at each visit, employing resources such as Centers for Disease Control and Prevention (CDC) and WHO BMI charts to establish percentile rankings for age and sex. Weight gain crossing BMI percentiles is alarming, especially with new-onset obesity in adolescence, highlighting the need for preventive

strategies. Evaluating eating behaviors, physical activity, and family history is crucial. Tertiary prevention should be executed by skilled providers to address associated comorbidities [8].

Despite numerous advantages associated with residing and working in rural areas, various population groups within these regions encounter considerable health disparities. These disparities are defined as differences in health outcomes relative to the general population, frequently manifested through indicators such as elevated disease incidence, increased rates of disability, higher mortality rates, reduced life expectancy, and greater prevalence of chronic pain. Contributing factors to these health disparities in rural populations include geographic isolation, lower socioeconomic status, heightened prevalence of health risk behaviors, restricted access to healthcare specialists and subspecialists, and limited employment opportunities. Furthermore, rural inhabitants are less likely to receive health insurance coverage through their employers [9].

The current body of literature regarding the effectiveness of school-based interventions for the prevention of obesity among children and adolescents in rural communities reveals a significant knowledge gap. While various initiatives have been implemented, empirical evidence elucidating their long-term efficacy and contextual applicability remains sparse. Moreover, the unique socio-environmental factors inherent to rural settings, including limited access to healthy food options and varying physical activity levels, necessitate a tailored approach that is not adequately addressed in existing research.

Objective

The aim of the present mini review is to investigate the impact of school-based interventions on childhood and adolescent obesity prevention in rural communities using a health educational approach.The significance of this mini (brief narrative) review lies in its examination of the variety of school-based interventions aimed at addressing childhood and adolescent obesity in rural communities. It intends to highlight the critical role that educational institutions play in shaping health outcomes and to emphasize the necessity for policies that not only promote physical activity and nutrition but also incorporate community engagement and support. By synthesizing findings from multiple studies, this review aims to underscore the multifaceted nature of obesity prevention, illustrating how collaborative efforts among stakeholders can enhance intervention effectiveness.

Furthermore, the originality and innovation of this review lies in its health educational approach, which integrates educational insights with public health strategies to combat obesity in rural settings. This perspective allows for a nuanced understanding of the interplay between individual behaviors and broader environmental influences, acknowledging the cultural and contextual factors that impact dietary choices and physical activity levels among adolescents. By focusing on tailored, culturally sensitive interventions and the successful implementation of robust policy frameworks, this review aims to set the stage for future research and practical applications that can meaningfully contribute to obesity prevention efforts in diverse educational environments.

It is important to acknowledge that mini reviews offer several distinct advantages compared to traditional reviews. Firstly, their succinct nature facilitates easier comprehension for readers with limited time. Furthermore, mini reviews typically concentrate on specific topics or issues within a discipline, which enables a more thorough examination of particular subjects. Additionally, these reviews are generally composed in a more approachable and comprehensible manner, thus broadening their accessibility to a wider audience. In summary, mini reviews serve as an important resource for researchers and readers alike, delivering a concise and informative summary of contemporary trends and advancements within a given field [10, 11].

Material and methods

Design: A brief review was performed based on a narrative synthesis of previously published literature. The material of the present study was exclusively Internet-based. A comprehensive electronic literature search in the databases PubMed and Google Scholar was performed (from 10 April 2024 to 10 June 2024) using the following terms/key words: 1) «school-based interventions « OR «school-based programs» AND «children» AND «adolescents» AND «obesity prevention» AND «rural communities». In addition, a search in the reference lists was carried out.

Criteria for inclusion of studies were :

- Literature written in English
- Literature published from 2009 to 2024 (15 years)
- Studies that involved children and adolescents
- Studies that had keywords in the title and/or abstract

Criteria for exclusion of studies were :

- Reviews
- Conference papers
- Book chapters
- Books
- Short surveys
- Articles and documents written in languages other than English

Selection of studies

All obtained references from the search were organized and duplicates were excluded. The titles and abstracts were screened for content and relevance to the topic with focus on the inclusion criteria.

The integral text of selected titles was read and the reference list of selected articles was consulted in order to find out other relevant publications.

Additionally, studies which failed to adequately describe the impact of school-based interventions on childhood and adolescent obesity prevention in rural communities were excluded.

Data extraction and analysis

The essential data from each published study were extracted and synthesized. The results are presented in a brief narrative form. Nine (9) research articles were obtained and analyzed.

Impact of multifaceted school-based interventions on childhood and adolescent obesity prevention

In the research of Belansky et.al. [12] it is mentioned that The What's Working initiative evaluated the Local Wellness Policy's impact in 45 rural elementary schools in Colorado, where at least 40% of students qualified for free or reduced-price lunch. Post-implementation, physical education time increased by 14 minutes ($p=0.10$), while recess time decreased by approximately 19 minutes ($p=0.10$). No significant changes in engagement policies for physical education or recess were noted. Researchers found weak policy language led to minimal effects. Interviews revealed challenges such as competing school district priorities, insufficient resources, principal ignorance of the policy, and lack of accountability mechanisms. It was concluded that increased funding and better communication are essential for improvement [12].

The rising obesity rates, particularly in rural areas of the United States, highlight the urgent need for effective prevention programs. The study of Schetzina et.al. [13] initiated a school-based obesity prevention strategy in rural Appalachia, following the Centers for Disease Control and Prevention 's Coordinated School Health Program and community-based research methods. Through focus groups with educators, parents, and fourth-grade students, concerns about childhood obesity and the necessity for better school nutrition and increased physical activity were emphasized. All groups favored healthier food options and more physical engagement opportunities, while facing challenges like academic demands and insufficient parental involvement. Insights gathered will inform the «Winning with Wellness» pilot initiative [13].

In the research of Greening et.al. [14] an evaluation of a school-based obesity intervention in a rural southern community, with a 50% obesity prevalence, involved 450 children aged 6 to 10 years (mean age = 8.34) over nine months. Monthly physical activity and nutrition events were held, assessing factors such as nutritional knowledge, fitness levels, and body metrics. The intervention showed significant improvements in percentage body fat, physical activity, fitness performance, and dietary practices compared to a control school. The findings indicate that early intervention strategies are vital for effective lifestyle changes, benefiting all participants, regardless of gender or ethnicity/race. Population-based strategies are recommended [14].

In the research of Belansky et.al. [15] the School Environment Project examined the effectiveness of an adapted Intervention Mapping (AIM) approach in transforming school environments to enhance nutrition and physical activity. In a randomized design, ten rural elementary schools were assigned to either AIM or the School Health Index (SHI) framework. Baseline data was collected in autumn 2005, with AIM implemented from 2005 to 2006 and follow-ups in 2006 and 2007. AIM schools achieved an average of 4.4 effective changes per institution, with 90% maintained after one year, compared to 0.6 changes and 66% for SHI schools. The AIM framework demonstrated significant success in promoting healthier habits [15].

Sugar-sweetened beverages (SSBs) are a major source of added sugars in the U.S., contributing 13% to 28% of caloric intake among adolescents aged 12 to 19, with the highest consumption in Appalachia. A student-led intervention of Smith et.al. [16] in two rural Appalachian high schools collected data on SSB and water consumption at baseline, post-intervention, and 30 days later. Among 186 participants, SSB purchases from vending machines (41.4%), cafeterias (36.5%), and stores (7.7%) decreased significantly. Daily SSB servings dropped from 2.32 to 1.32 ($p < 0.001$), and weekly consumption fell from 4.30 to 2.64 days ($p < 0.001$), while water consumption rose by 19% [16].

A study of Gustafson et.al. [17] evaluated obesity rates among 432 rural adolescents, indicating a prevalence where 55% were normal weight, 24% overweight, and 21% obese. It explored food purchasing behaviors and environments affecting dietary habits in eight rural high schools in Eastern Kentucky and North Carolina. Unhealthy food purchasing—frequenting gas stations and fast food—correlated with higher sugar intake [Odds Ratio (OR)= 2.41]. Availability of fruits and vegetables at home increased consumption by 0.31 cups (OR). Low healthy food availability in schools resulted in fewer fruit and vegetable servings. The findings inspired the "Go Big and Bring it Home" text messaging initiative [17].

The research study of Gustafson et.al. [18] assessed an eight-week text messaging initiative, "Go Big and Bring It Home," to improve dietary habits among 14 to 16-year-old rural adolescents. Eight rural high schools in eastern Kentucky and North Carolina participated, with four as intervention schools. Messages were sent by nutrition students via «Group Me» every Tuesday and Saturday. In total, 277 adolescents in the intervention group and 134 in the control group were analyzed. The intervention resulted in a significant mean difference of 1.28 additional daily servings of fruits and vegetables (95% CI 1.11, 1.48), with increased goal-setting for healthy diets among participants [18].

The prevalence of obesity in the U.S. has escalated significantly, particularly among children of Mexican heritage. The study of Sadeghi et.al. [19] evaluated the Niños Sanos, Familia Sana initiative, a three-year quasi-experimental intervention in California's Central Valley targeting BMI growth. It involved children aged 3-8 and utilized workshops on nutrition, physical activity, and monthly vouchers for fresh produce. At baseline, the intervention cohort (n = 387) had a mean BMI z-score of 0.97, while the comparison cohort (n = 313) had 0.98. The intervention showed significant effects on BMI among male

participants ($\beta = 0.25$, $p = 0.04$) and obese females ($\beta = -0.04$, $p = 0.04$), highlighting effective strategies against childhood obesity [19].

Interventions in educational institutions can significantly improve nutritional practices and reduce obesity among children and adolescents. A pilot study of Askelson et.al. [20] by the University of Iowa Institutional Review Board and Iowa Department of Education Team Nutrition in six middle schools implemented behavioral economics strategies, including lunchroom environment changes and staff training. This evaluation involved students and food service personnel, using lunchroom assessments, online surveys, production records, and interviews. Results showed that five schools improved their lunchroom assessment scores, and four schools increased healthy food production. Feedback indicated the interventions were practical and well-received, suggesting that school-based policies and environmental changes may be key in combating obesity in youth [20] .

Discussion

Synthesis of the studies

This brief narrative review examines a series of studies that reflect the multifaceted approach to combatting childhood obesity in rural settings, particularly focusing on school-based interventions and policies aimed at enhancing nutrition and physical activity. Collectively, these studies underscore the pressing public health challenge presented by rising obesity rates among children in rural areas and demonstrate a variety of intervention strategies that target this issue. Belansky et al. [12] emphasized the backdrop of federally mandated Local Wellness Policies in rural Colorado schools, reporting an increase in physical education time alongside a decrease in recess duration. The study identified several obstacles hindering effective policy implementation, including weak language, resource limitations, and low levels of awareness and accountability among school leadership. This aligns with the findings of Schetzina et al. [13], which highlighted the necessity for coordinated health strategies that encourage community involvement and address school nutrition and physical activity. Both studies point to the critical need for robust policy frameworks and adequate resources to enhance implementation efficacy. Further illustrating this point, Belansky et al. [15] advanced the dialogue by analyzing the effectiveness of an Adapted Intervention Mapping approach, which demonstrated superior outcomes in modifying school environments and healthy habit formation compared to traditional frameworks, such as the School Health Index. The results indicated a significant capacity for enduring change when robust planning methodologies are deployed, resonating with Greening et al. [14], where a school-based obesity intervention showed significant improvements in body metrics and dietary habits through structured, multi-faceted programming. Additionally, Smith and Holloman [16] provided a targeted intervention aimed at reducing sugar-sweetened beverage consumption in Appalachia, demonstrating marked declines in student intake post-intervention. This effort echoes the findings from Gustafson et al. [17,18], which further delve into the importance of home and school environments on adolescents' dietary choices. The use of text messaging to encourage fruit and vegetable consumption proved effective in reshaping dietary habits among rural youth. Moreover, Sadeghi et al. [19] showcased the impact of a comprehensive, culturally-attuned intervention within Mexican heritage populations, which successfully reduced BMI growth through hands-on workshops and produce vouchers. This study complements the work of Askelson et al. [20] by illuminating how behavioral economics strategies in school lunchrooms can also yield positive dietary changes among adolescents, thereby reinforcing the necessity of involving students in the design and implementation of interventions. Across these studies, key similarities emerge: a strong emphasis on collaborative stakeholder involvement (including parents, educators, and community members), the necessity for policy

integration and robust intervention frameworks, and the importance of addressing contextual and cultural factors influencing childhood obesity. Consistent across all studies is the recognition that effective interventions must transcend merely educational efforts, incorporating structural and environmental changes that enhance access to healthy foods and encourage physical activity. The holistic approach reflected in these studies indicates a pathway towards more effective obesity prevention among rural youth, advocating for continued research, community engagement, and policy development to operationalize these findings in diverse educational settings [12-20]. The main findings regarding the impact of multifaceted school-based interventions on childhood and adolescent obesity prevention in rural communities are shown in **Figure 1.**

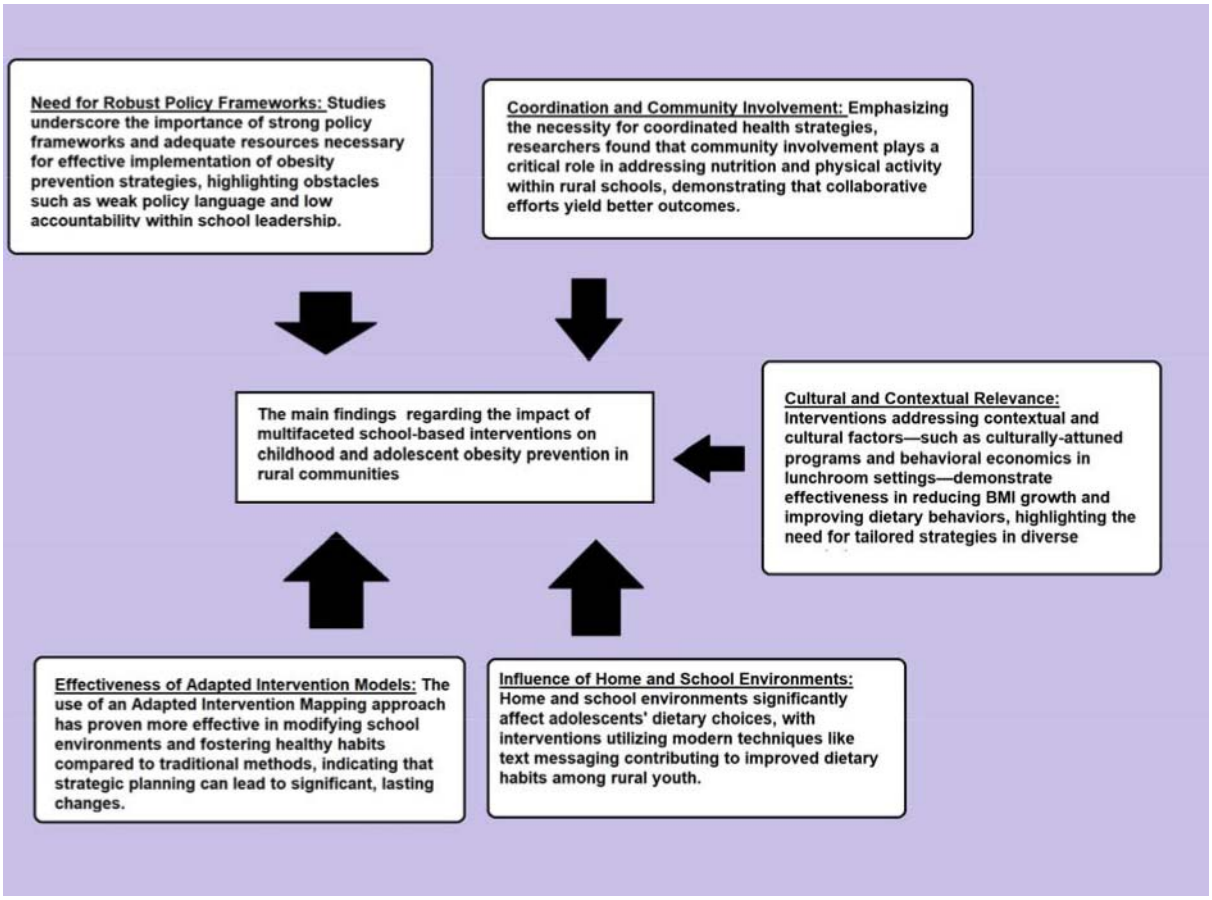

Figure 1. The main findings regarding the impact of multifaceted school-based interventions on childhood and adolescent obesity prevention in rural communities.

Strengths of the studies

The studies highlighted exhibit significant strengths in addressing childhood obesity and promoting healthier lifestyles in rural communities. Belansky et al. [12] provides valuable insights into the Policy's early impacts, emphasizing the necessity of clear language and adequate resources for successful implementation. Schetzina et al. [13] effectively utilizes community focus groups, showcasing stakeholder collaboration, and highlighting the need for better nutrition and physical activity, thus ensuring the intervention is community-driven. Greening et al. [14] bolster the evidence for school-based intervention efficacy, demonstrating improved dietary practices and physical fitness metrics among participants, highlighting the effectiveness of sustained interventions.

Belansky et al. [15] demonstrates the adaptability of intervention frameworks like AIM for meaningful changes, showcasing its success in generating sustainable health benefits in schools. Smith & Holloman [16] illustrates a successful, student-led approach that drastically reduced sugar-sweetened beverage consumption, highlighting the power of peer influence and engagement. Gustafson et al. [17,18] employs a comprehensive approach linking dietary habits and environmental influences, while their text-messaging intervention strikes a significant chord in increasing fruit and vegetable intake among adolescents. Finally, Sadeghi et al. [19] targets a specific demographic effectively, illustrating that multifaceted interventions can yield significant BMI improvements. Overall, these studies present a strong foundation for successful interventions, emphasizing collaboration, adaptability, and community engagement as crucial elements in combating childhood obesity [12-20].

Limitations of the studies

The studies mentioned above illuminate various interventions aimed at addressing childhood obesity through school-based initiatives. However, there are notable limitations across these investigations. One major concern is the reliance on self-reported data, which can introduce biases and inaccuracies. Parents, students, and educators may not accurately report dietary habits or participation in physical activities. Additionally, many studies employ small sample sizes or localized settings, which may limit the generalizability of their findings to broader populations. Moreover, the short duration of some interventions raises questions about the sustainability of any observed effects. For instance, while significant improvements were noted in obesity rates or dietary habits, the long-term maintenance of these changes remains uncertain. The studies also highlight the challenges of implementation, including resource constraints, lack of staff training, and competing educational priorities. Some studies fail to utilize control groups, complicating efforts to establish causality between the intervention and outcomes. Furthermore, variances in the adoption of intervention protocols across schools may dilute the effectiveness and comparability of results. Overall, while the findings contribute valuable insights, the limitations underscore the need for further research with more robust methodologies to enhance the efficacy and applicability of obesity prevention strategies in diverse educational contexts [12-20].

Future directions

The future directions for studies on childhood obesity, wellness policies, and dietary interventions in rural settings are poised to focus on several crucial areas. First, continued evaluation of existing interventions is essential, particularly concerning their long-term sustainability and adaptability across diverse rural contexts. Future research should emphasize examining structural barriers and resource constraints that schools face, as indicated by findings from previous studies, to enhance the effectiveness of wellness policies and school-based interventions.Moreover, leveraging technology through innovative approaches—such as text messaging and mobile apps—can augment these strategies by providing real-time feedback and fostering engagement among adolescents. Understanding the role of community involvement will be vital, as insights from focus groups can guide the co-creation of interventions that address local cultural values and dietary habits.Furthermore, enhanced collaboration between educational frameworks, health professionals, and policymakers is crucial in implementing comprehensive health approaches that encompass nutrition, physical activity, and mental wellness. Continued attention to behavioral economics may yield insights into how environmental changes can promote healthier choices in school settings. Lastly, longitudinal studies assessing the impact of these interventions on broader health outcomes, including mental health and academic performance, will provide a holistic view of children's well-being and inform more effective policy recommendations [12-20].

Conclusions

This mini narrative review underscores the critical role of multifaceted school-based interventions in combating childhood obesity in rural communities using a health educational approach. The examined studies consistently reveal that effective interventions require a collaborative approach involving parents, educators, and community stakeholders. Clear policy frameworks and adequate resources are paramount to overcome barriers faced in implementation, such as limited awareness and competing priorities. Notably, successful strategies incorporate structural and environmental changes that enhance access to healthy foods and promote physical activity, transcending mere educational initiatives. However, notable limitations, including reliance on self-reported data and small sample sizes, highlight the necessity for further research to validate outcomes and enhance generalizability. Longitudinal studies that explore the long-term impacts of these interventions on broader health and academic outcomes are imperative for more holistic insights.

Declarations

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