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Systematic Review

The interrelationship between childhood obesity and vitamin D deficiency: a systematic review

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ABSTRACT

Objective was to look into the connection between vitamin D deficiency (VDD) and childhood obesity. The 489 pertinent papers were found after a comprehensive search across four databases. Eight research finally met the requirements for inclusion after 262 full-text publications were screened, duplicates were eliminated using Rayyan QCRI, and relevance was assessed. A total of 1851 obese children from eight trials were included in our analysis; 919 (49.6%) of the patients were female. The prevalence of VDD among obese children ranged from 24.7% to 88.5%, with a total prevalence of 881 (47.6%). Taken together, results have indicated a significant association of obesity in childhood with VDD at high prevalence rates across populations and age groups. Despite receiving enough sunshine in some residential areas, obese children and adolescents have been reported to have low blood vitamin D levels, which reflects behavioral inputs like reduced outdoor activity that add to the VDD. The susceptibility seems to be enhanced by puberty and female gender, emphasizing the need for targeted intervention. Obese children and adolescents are more likely to have VDD, underscoring the need for health interventions targeting both obesity and nutrition. Health professionals can help mitigate obesity-related risks by promoting vitamin D screening and encouraging lifestyle changes that improve physical activity and diet. Future longitudinal studies are necessary to confirm causality and develop evidence-based strategies for enhancing pediatric health.

Keywords: Childhood obesity, Hypovitaminosis D, Public health, Nutritional status, Systematic review

INTRODUCTION

A concerning percentage of children worldwide suffer from childhood obesity, making it one of the most urgent public health issues of the twenty-first century.[1] According to the world health organization (WHO), obesity is a disorder marked by an excessive buildup of fat that may have a detrimental effect on one's health. Concurrently, VDD is increasingly recognized as a common issue that affects children globally, with significant implications for their overall well-being and health.[2]

Childhood obesity is typically assessed using the body mass index (BMI), a metric that relates a child's weight to their height. A BMI at or above the 95th percentile for children of the same age and sex is considered obese. Research suggests that factors influencing childhood obesity are multifaceted, including genetic, environmental, and socio-economic determinants.[3]

When poor eating habits-which include consuming more high-calorie, low-nutrient foods-combine with sedentary lifestyles that result in less physical exercise, contribute significantly to this epidemic. However, the implications of obesity extend beyond physical appearance; In addition to cardiovascular illnesses, insulin resistance, type 2 diabetes, and other physical problems, it is linked to psychological problems such social stigmatization and poor self-esteem.[4]

Vitamin D is a fat-soluble vitamin that is received from exposure to sunshine, certain foods, and dietary supplements. It is essential for immune system function, bone health, and the control of cell development. Notably, vitamin D is connected to several facets of metabolic health and influences children's skeletal growth.[2] Deficiency in vitamin D is characterized by insufficient levels of this vitamin in the body, leading to detrimental health outcomes, including rickets in children and an array of chronic diseases. Despite its importance, VDD is incredibly common in children worldwide, mostly as a result of inadequate food, a lack of sun exposure, and rising obesity rates.[4]

Recent studies have highlighted the intertwined nature of childhood obesity and VDD, establishing that each condition may exacerbate the other. Increased adiposity alters the metabolism of vitamin D, Frequently, those with increased body fat have reduced vitamin absorption. In particular, a significant amount of vitamin D is stored in adipose tissue, which lowers blood levels of the main form of the vitamin that circulates, 25-hydroxyvitamin D. Children who are obese may thus have low vitamin D levels, which can lead to further health problems and increase the chance of acquiring diseases like osteomalacia and other metabolic disorders.[5]

VDD may make obesity worse, indicating a reciprocal link. Vitamin D may be essential for controlling the formation and function of fat cells, according to research. It has been suggested that vitamin D affects metabolism, the inflammatory processes linked to obesity, and the development of adipocytes (fat cells).[3] Moreover, adipocytes and other cells have been found to contain vitamin D receptors, suggesting that vitamin D may alter the metabolic processes that contribute to energy balance and fat storage. While vitamin D supplementation may help reduce body fat and improve metabolic profiles, some studies have found that children with lower vitamin D levels are more likely to become obese.[6]

The interrelationship between childhood obesity and VDD extend to various aspects of public health. Schools and communities play a vital role in addressing these issues by promoting healthy eating, physical activity, and access to sunlight. Safe outdoor recreation and healthy nutrition can provide children with the exposure needed for adequate vitamin D synthesis while also combating obesity. Educational programs highlighting the need of foods rich in vitamin D-such as fatty fish, fortified dairy products, and egg yolks-as well as encouraging outdoor play activities can create healthier lives among children.[7]

In addition to these preventative strategies, healthcare practitioners must recognize the importance of clinical screening for both childhood obesity and VDD. Early identification and intervention may prevent the long-term health repercussions associated with these conditions.[1] Vitamin D supplementation could also be considered as part of a multidisciplinary approach for managing overweight or obese children, especially those identified as deficient. Pediatric and family medicine clinical recommendations should emphasize how crucial it is to keep an eye on children's vitamin D levels, especially those who are obese, in order to enable prompt intervention.[7]

Childhood obesity has emerged as a key public health concern, greatly harming the physical and psychological well-being of children internationally. Concurrently, VDD is increasingly recognized as a prevalent condition in pediatric populations, impacting various aspects of health. The co-occurrence of these two conditions raises questions about their interrelationship, potentially revealing a complex interplay that warrants investigation. The rising incidence of VDD and childhood obesity, necessitating a thorough examination of their interrelations. Existing literature offers fragmented insights into this relationship, according to certain research, obesity may be impacted by low vitamin D levels via pathways including inflammation and metabolism.

This systematic review's objective is to evaluate the connection between VDD and childhood obesity. By synthesizing existing research findings, the study intends to provide clarity on whether VDD serves as a contributing factor to obesity risk among children.

METHODS

Search strategy

The PRISMA and GATHER criteria served as the foundation for the systematic review. A thorough search was conducted to find research that looked at the evidence that was currently available on the connection between childhood obesity and VDD. SCOPUS, Web of Science, Cochrane, and PubMed were the four electronic databases that the reviewers looked at. We used computerized searches to find every abstract and title we could find, then submitted them to Rayyan after eliminating duplicates. Included were only research released in the previous five years (2020-2024). For a thorough examination, the whole texts of the research papers that met the requirements for inclusion based on their abstract or title were obtained. Two impartial reviewers examined discrepancies and judged if the extracted publications were suitable.

Study selection

For our review, the following PEO (Population, exposure, and outcome) components were used as inclusion criteria: (i) Children and adolescents (usually aged 5 to 18) make up the population; (ii) Obesity is the exposure; and (iii) VDD is the result.

Data extraction

Two impartial reviewers used a preset and consistent technique to collect data from papers that matched the inclusion criteria. The data listed below was obtained and noted: (i) First author; (ii) year of publication; (iii) study design; (iv) number of participants; (v) age; (vi) gender; (vii) obesity cut-off point; (viii) VDD cut-off point; (ix) VDD prevalence; (x) Key findings.

Quality asssessment

Since bias resulting from missing factors is frequent in research in this field, we used the ROBINS-I approach to assess the likelihood of bias since it enables a thorough examination of confounding. ROBINS-I tool may be used for cohort designs where individuals exposed to different staffing levels are tracked over time and is designed to assess non-randomized studies.

Each paper's risk of bias was evaluated independently by two reviewers, and differences were settled by group discussion.[8]

RESULTS

Search results

498 papers were found using the given search technique (Figure 1). The 262 trials were assessed based on title and abstract after duplicates (n=236) were eliminated. Only 51 full-text papers remained for further assessment after 211 of these did not meet qualifying requirements.

Eight studies in all met the qualifying conditions for analysis using evidence synthesis.

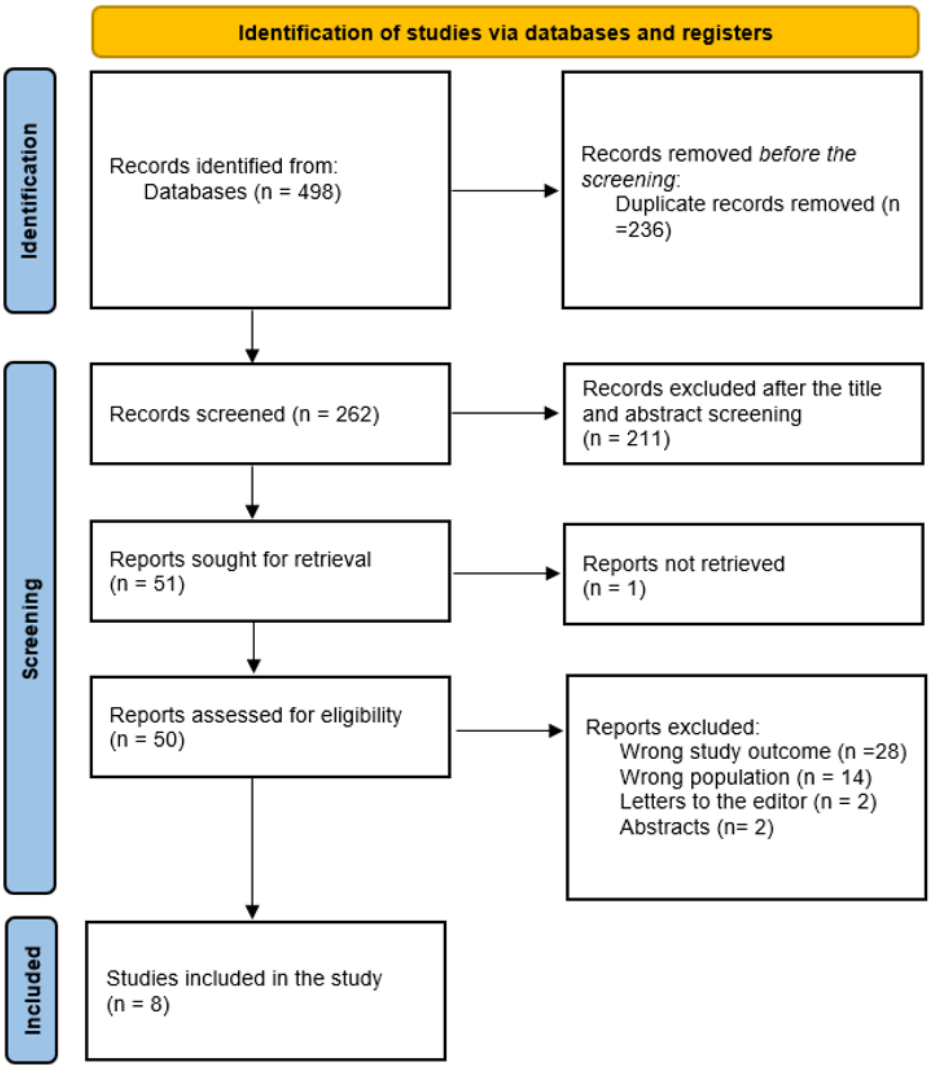

Figure 1: PRISMA flowchart.[9]

Table 1: Outcome metrics of the included studies.

Study ID	Country	Study design	Sociodemographic	Obesity cut-off	VDD cut-off (ng/mL)	VDD prevalence	Key findings
Al Shaikh et al, 2020[10]	Saudi Arabia	Cross-sectional	Participants: 255 Age range: 6-19 years Females: 83 (32.5%)	>2SD	≤10	83 (32.5%)	The extremely high rates of VDD and VDI in obese kids and teenagers highlight how urgently suitable interventions are needed to address the issues of obesity and low vitamin D levels in this age group.
Tunçer et al, 2023[11]	Turkey	Cross-sectional	Participants: 81 Age range: 6-17 years Females: 45 (55.6%)	>2SD	≤12	20 (24.7%)	Serum vitamin D levels are either insufficient or low in most children and adolescents, which suggests that outdoor activities should be promoted, particularly in school health programs.
Saneifard et al, 2021[12]	Iran	Cross-sectional	Participants: 384 Age range: 7-17 years Females: 220 (57.3%)	>2SD	<20	188 (49%)	Despite the sunny atmosphere, children and adolescents frequently suffer from VDD. This study showed that, particularly in girls and obese youngsters, puberty is an additional risk factor for VDD.
López-Galisteo et al, 2022[13]	Spain	Cross-sectional	Participants: 158 Age range: 6-18 years Females: 61 (38.6%)	NS	< 20	101 (64.2%)	This finding further underlines the role of comprehensive health assessments in managing pediatric obesity, since the improvement of general health can rely on correcting the deficiency state of these active components.
Calcaterra et al, 2022[14]	Italy	Cross-sectional	Participants: 120 Mean age: 10.2 years Females: 59 (49.2%)	>2SD	< 20	69 (57.5%)	Considering that VDD is significantly more common in children and adolescents who are overweight or obese.
Patriota et al, 2022[15]	Switzerland	Cross-sectional	Participants: 52 Mean age: 13.1 years Females: 16 (30.8%)	NS	<20	46 (88.5%)	Nearly 90 percent of obese adolescents had VDD upon presentation, and there was no evidence linking VDD to elevated levels of cardiovascular risk factors.

Continued.

Study ID	Country	Study design	Sociodemographic	Obesity cut-off	VDD cut-off (ng/mL)	VDD prevalence	Key findings
Shulhai et al, 2022[16]	Ukraine	Cross-sectional	Participants: 76 Age range: 12-17 years Females: 46 (60.5%)	>2SD	<20	59 (77.6%)	Adolescents who are overweight or obese frequently suffer from VDD. In teenagers who are overweight or obese, vitamin D deficiency is linked to metabolic syndrome criteria.
Durá-Travé et al, 2022[17]	Spain	Cross-sectional	Participants: 725 Age range: 6-17 years Females: 389 (53.7%)	>2SD	< 20	305 (42%)	According to vitamin D photobiology, behavioral variables rather than changed metabolism are the most likely cause of vitamin D deficiency in obese children and adolescents.

Table 2: Risk of bias assessment using ROBINS-I.

Study ID	Bias due to confounding	Bias due to selection of participants	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of the outcome	Bias in selection of the reported result	Overall bias
Al Shaikh et al, 2020[10]	Low	Low	Mod	Low	Low	Low	Mod	Low
Tunçer et al, 2023[11]	Low	Low	Low	Low	Low	Low	Mod	Low
Saneifard et al, 2021[12]	Mod	Low	Low	Low	Low	Low	Mod	Low
López-Galisteo et al, 2022[13]	Mod	Low	Low	Low	Low	Mod	Mod	Moderate
Calcaterra et al, 2022[14]	Mod	Mod	Low	Low	Low	Mod	Low	Moderate
Patriota et al, 2022[15]	Mod	Low	Mod	Low	Low	Mod	Low	Moderate
Shulhai et al, 2022[16]	Mod	Low	Mod	Low	Low	Mod	Low	Moderate
Durá-Travé et al, 2022[17]	Mod	Mod	Low	Low	Low	Mod	Crit	Critical

Clinical results and sociodemographics

We included eight studies with a total of 1851 obese children, and nearly half patients 919 (49.6%) were females. Regarding the study designs, all of the included studies were cross-sectional.[10-17] The prevalence of VDD among obese children ranged from 24.7% to 88.5%, with a total prevalence of 881 (47.6%). The results of all the investigations show a high correlation between childhood and teenage VDD and obesity. Most of the time, it has been found that even in sun-rich areas, obese individuals have a very high prevalence of VDD.[11,12] The results point out the importance of integrating vitamin D monitoring into the management of pediatric obesity across different age groups and populations.[13] The majority of these research have shown that low blood vitamin D levels are frequently linked to obesity, which emphasizes the importance of early intervention through outdoor activities and dietary supplements.[14] Table 1 summarizes the characteristics of the included studies.

Quality assessment

The ROBINS-1 quality assessments of the 8 included cross-sectional studies are summarized in Table 2. Three were judged to have a low risk of bias, four were judged to have a moderate risk, and only one was judged to have a high risk of bias.

DISCUSSION

The findings of this review point out the universality of VDD among obese children and adolescents, underlining the critical interaction between obesity and poor nutritional status. The prevalence of VDD among obese children ranged from 24.7% to 88.5%, with a total prevalence of 881 (47.6%). Zakharova et al stated that epidemiological research indicates a worrying prevalence of childhood obesity and VDD in youngsters.[35] It is crucial to discuss treatment strategies that might lessen the detrimental effects of VDD on the current and future health of overweight and handicapped children and adolescents, given the immunological functions of vitamin D and its influence on insulin resistance mechanisms.[18]

The rather consistent prevalence of VDD throughout multiple studies from different regions in this review and with varied sunlight exposures underlines complex behavioral, physiological, and environmental factors in this interrelationship. The most plausible mechanisms contributing to this state may include reduced outdoor activity, sequestration in the body's fat, and dietary insufficiencies. Fiamenghi et al discovered that this meta-analysis demonstrated a relationship between VDD and obesity in the pediatric population. This research highlights the importance of encouraging healthy lifestyle choices and the need to measure 25(OH)D levels in obese children and adolescents.[19]

We demonstrated that increased susceptibility from female gender and adolescents during puberty relates to the effects of the increase or changes in levels of hormonal steroid regulators of vitamin D metabolism, suggesting that this developmental stage should not be missed for targeted interventions.

Even if earlier research was unable to fully elucidate the underlying processes, certain routes were put up to explain the association between children's abdominal obesity and blood vitamin D. Studies conducted in vitro demonstrated that vitamin D regulates adipogenesis, which is necessary for lipid distribution as well as lipolysis.[20,21] Abdominal obesity and VDD in children and adolescents have also been linked to excessive screen time (television, computers, and tablets), as well as a lack of outdoor physical exercise and sunshine exposure.[22,23] More body fat would also increase the amount of vitamin D stored in adipose tissue because it is a fat-soluble vitamin.[24] Lastly, by altering β-oxidation and uncoupling-protein expression, vitamin D plays a critical role in energy metabolism.[25] Previous studies have suggested that 1, 25 [OH]2D3 may limit the production of adipocyte uncoupling protein 2 [UCP-2], which inhibits lipolysis and stimulates lipogenesis.[26,27] Finally, previous research has shown that fat adolescents do not respond to vitamin D treatment in the same way as non-fat adolescents.[28,29] Therefore, children who are fat should take additional vitamin D supplements. However, no single dosage is generally advised for the treatment of VDD in children.[28,29] It is essential to address the VDD among obese children to avoid metabolic and musculoskeletal complications later in life. Screening for vitamin D levels should be routinely conducted as a part of the management of obesity among pediatric populations, with particular emphasis on those at high risk, such as pubescent females. Interventions promoting outdoor physical activity, dietary modifications, and supplementation can mitigate the effects of deficiency. In addition, school-based health programs that emphasize physical fitness and healthy nutrition may also serve as preventive measures. Addressing vitamin D status in the context of obesity management may lead to better health outcomes and decrease the comorbidity burden associated with obesity.

Strengths

The strengths are that, actually, this review really represents studies from different parts of the world, hence providing a broad perspective on the connection between childhood obesity and VDD. The fact that the prevalence of this comorbidity has been measured is strengthened by the inclusion of cross-sectional research, which further strengthens these findings. The consistency in results across different populations and age groups further cements the generalisability of conclusions that can be drawn.

Limitations

Despite these strengths, some limitations should be outlined. The reliance on cross-sectional data precludes any firm conclusion of causality because the temporal relationship between obesity and VDD cannot be established. Variability in the cut-off values for defining VDD across studies may introduce inconsistencies in prevalence estimates. Furthermore, not all studies controlled for potential confounding factors like dietary intake, sun exposure, and genetic predisposition that may influence the observed associations.

CONCLUSION

There is an urgent need for integrated health treatments that target both obesity and nutritional status, as evidenced by the high prevalence of VDD among obese children and adolescents. Health professionals can play an important role in reducing obesity-related health risks through emphasizing the screening of vitamin D and making lifestyle modifications that enhance physical activity and dietary quality. Longitudinal studies in the future will be required to establish causality and further guide the creation of comprehensive strategies, evidence-based, for improving pediatric health outcomes.

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