



Review

Reasons and promotion strategies of physical activity constraints in obese/overweight children and adolescents

Jiangxi Chen, Yinnengke Bai, Weiguang Ni*

Physical Education College, Jilin University, 130012, Changchun, China

ARTICLE INFO

Keywords:

Obesity
Overweight
Children
Adolescents
Physical activity

ABSTRACT

To explore the reasons for low levels of physical activity in obese/overweight children and adolescents and to propose appropriate strategies to promote their physical activity (PA). This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines by searching and analyzing the literature of studies related to physical activity in obese/overweight children and adolescents published between January 2003 and January 2023 in Web of Science, Scopus, and PubMed databases. A total of 31 relevant studies were included for analysis, of which 16 were quantitative and 15 qualitative. According to these studies, the PA of obese/overweight children and adolescents is mainly constrained by negative factors: Individual, interpersonal, and environmental. Among these factors, low levels of individual motivation and psychological sensitivity and vulnerability, lack of family support, negative social feedback, insufficient protection from government policies, and inadequate support from the built environment are the main reasons that constrain their PA. The promotion of PA in obese/overweight children and adolescents, who are subject to more constraints at all levels, requires a system of security that involves the government, the community, the school, and the family to address the problems they encounter and enhance the sustainability of engagement in PA.

1. Introduction

Global rates of overweight/obesity among children and adolescents have risen over the past few decades. In 2016 alone, over 340 million children and adolescents between the ages of 5 and 19 were overweight or obese worldwide.¹ Overweight and obesity can expose them to severe health problems, with studies showing that overweight (body mass index [BMI] 25.0–29.9 kg/m²) and obesity (BMI ≥ 30.0 kg/m²) are major risk factors for non-communicable diseases.^{2,3} For example, cardiovascular risk factors such as obstructive sleep apnea, type 2 diabetes mellitus, irregular menstruation in adolescent girls, and high cholesterol increase with obesity.⁴ Also, overweight/obese children and adolescents have an exponentially increased risk of developing obesity in adulthood compared to normal-weight children and adolescents.⁵ These chronic adverse outcomes due to obesity increase the medical burden on children and profoundly affect their physical and mental development.

Regular physical activity (PA) plays an essential role in preventing obesity and improving the physical health of children and adolescents.^{6,7} To safeguard the health of children and adolescents, the World Health Organization (WHO) and health guidelines in many countries recommend that at least 60 minutes (min) of moderate to vigorous physical

activity (MVPA) be accumulated daily.⁸ However, a significant proportion of children and adolescents worldwide still need to reach the WHO-recommended physical activity levels.^{9,10} For example, in China, urban children and adolescents spend an average of only 28 min per day on MVPA and up to 521 min on sedentary behaviors,¹¹ in addition to still high rates of overweight and obesity.¹² Persistent evidence demonstrates that physically active youth are at lower levels of adiposity than less active youth,¹³ and that obese/overweight children and adolescents are more sedentary and less active than their normal-weight peers, contributing more to the vicious cycle of obesity.¹⁴ Therefore, promoting regular PA among obese children and adolescents is a critical behavioral goal to break the vicious circle and improve their health.

Promoting PA participation in obese children and adolescents cannot be done in general terms with the same strategies or measures used for normal-weight counterparts. However, it requires a specific focus on the barriers that prevent them from engaging in PA because studies have shown that these barriers may differ from those faced by normal-weight peers.^{7,15,16} Studies have found that obese youth may experience psychological problems such as depression, anxiety, low self-esteem, poor body image, peer relationship difficulties, and eating disorders.¹⁷ In addition, obesity can have adverse effects, such as weakened motor skills and problems integrating into the environment.¹⁸ It follows that in

* Corresponding author.

E-mail address: niwg@jlu.edu.cn (W. Ni).<https://doi.org/10.1016/j.smhs.2023.10.004>

Received 18 August 2023; Received in revised form 14 October 2023; Accepted 27 October 2023

Available online 7 November 2023

2666-3376/© 2023 Chengdu Sport University. Publishing services by Elsevier B.V. on behalf of KeAi Communications Co. Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Abbreviations

ANOVA	analysis of variance
CS	cross-sectional study
PA	physical activity
PC	Pearson correlation
WHO	World Health Organization
E	experimental research
MVPA	moderate to vigorous physical activity
L	longitudinal study
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
LPA	light physical activity
LQ	low quality
NR	not reported
M	moderate quality
SSI	semi-structured in-depth interview
H	higher quality
FGI	focus group interview
PE	physical education
ES	socioeconomic status

assisting such youth, It is necessary to be aware of specific barriers different from those of the general population. Otherwise, it is possible that focusing on the weight of obese children and adolescents negatively will lead to their avoidance of PA promotion programs.¹⁹ This review aims to comprehensively unearth the factors that impede the participation of obese children and adolescents in PA, systematically identify and conceptualize these factors, and accordingly reflect on the strategies and measures to promote the involvement of obese children and adolescents in PA.

2. Materials and methods

2.1. Search strategy

The search used specific subject terms such as “obesity” “overweight” “children” “adolescents” “students” “physical activity” “exercise” “sport” “bullying” “stigma” “victimization” “barrier” in the form of Boolean logic searches (“AND” “OR”) was used in a systematic search of the Web of Science, Scopus and PubMed databases for studies investigating factors influencing physical activity in obese children and adolescents over the last 20 years (2003.01–2023.01). Furthermore, bibliometric trajectories of knowledge domains related to obese youth facing particular encounters in physical activity were analyzed using VOS viewer software based on keyword co-occurrences of specific units of analysis (keywords, titles and abstracts), type of analysis (co-occurrences), and counting methodology (full counts). This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.²⁰

2.2. Inclusion and exclusion criteria

Literature inclusion criteria: (i) quantitative or qualitative studies are published in English; (ii) studies were conducted with children or adolescents who were overweight, obese, or morbidly obese only and did not have an intellectual or physical disability (aged 6–18 years, or an average age within this range, or sampled at primary and secondary school grades); (iii) the studies reported measurements of participants' physical activity as an outcome and evaluated the statistical associations with the associated factors (quantitative studies); and (iv) the studies examined the participant's experience in physical activity and the barriers to participation in exercise (qualitative studies).

Exclusion criteria: (i) studies that measured physical activity as an independent variable (unless an association between the correlate and physical activity as a cause and effect was reported); and (ii) studies published as abstracts, comments or reviews.

2.3. Quality assessment

The criteria for assessing the quality of studies used in quantitative research consisted of five components (study design, study population, outcome measures, measures of relevant factors, and data analysis).²¹ Each study was scored according to whether it answered “yes” (score = 1) or “no” (score = 0) to the quality assessment items.

Qualitative studies were assessed using the critical appraisal skills program (CASP) tool for qualitative methodology, whereby each included study was assessed for quality by answering “yes” (score = 1) or “no” (score = 0) to an assessment criterion consisting of 10 screening questions.²²

Since the evaluation criteria differed for the two assessment methods, quality was thus evaluated as the proportion of each study's score to the total evaluation criteria (score/total score). That is, less than 60% is considered low quality (LQ), 60%–80% is moderate quality (M), and more than 80% is considered higher quality (H).

2.4. Data extraction and process

Data Extraction: The study elements extracted for the descriptive analysis included: authors/year of publication, the purpose of the study, methodology/design of the study, sample, and results of the study (especially variables due to obesity, such as friendship, stigma, and perceived competence).²³

Process: Initially, two authors independently performed the initial and full-text screening of the literature, as well as the final quality assessment and data extraction, based on the established inclusion, exclusion and quality assessment criteria. In case of disagreement, the other authors were involved in the discussion and the final results were decided by consensus.

3. Results

3.1. Bibliometric analysis

The timeline flow illustrated in Fig. 1a demonstrates how the research themes have evolved over time, shifting from an initial emphasis on interpersonal difficulty, peer bullying, stigmatization, and low self-efficacy towards more severe and multifaceted concepts, such as family and teacher support and social context, as well as sexual assault, depression, and suicidal ideation. Fig. 1b highlights the themes of bullying, victimization, parental support, sexual abuse, and stigmatization as hotspots in the research, simultaneously revealing the correlations between them.

3.2. Study selection process

A total of 2 676 documents was eventually retrieved from the database and 31 papers that met the criteria were included. Of these, 16 were quantitative studies and 15 were qualitative studies. The study selection process is illustrated in Fig. 2.

3.3. Studies characteristics

3.3.1. Quantitative studies

Of the 16 quantitative studies, 13 were of high quality (H) and 3 were of moderate quality (M), with weaknesses in the studies primarily including sample size selection and rationality of data interpretation. The quantitative studies mainly examined the relationship between factors such as intrinsic motivation, body and movement perceptual abilities,

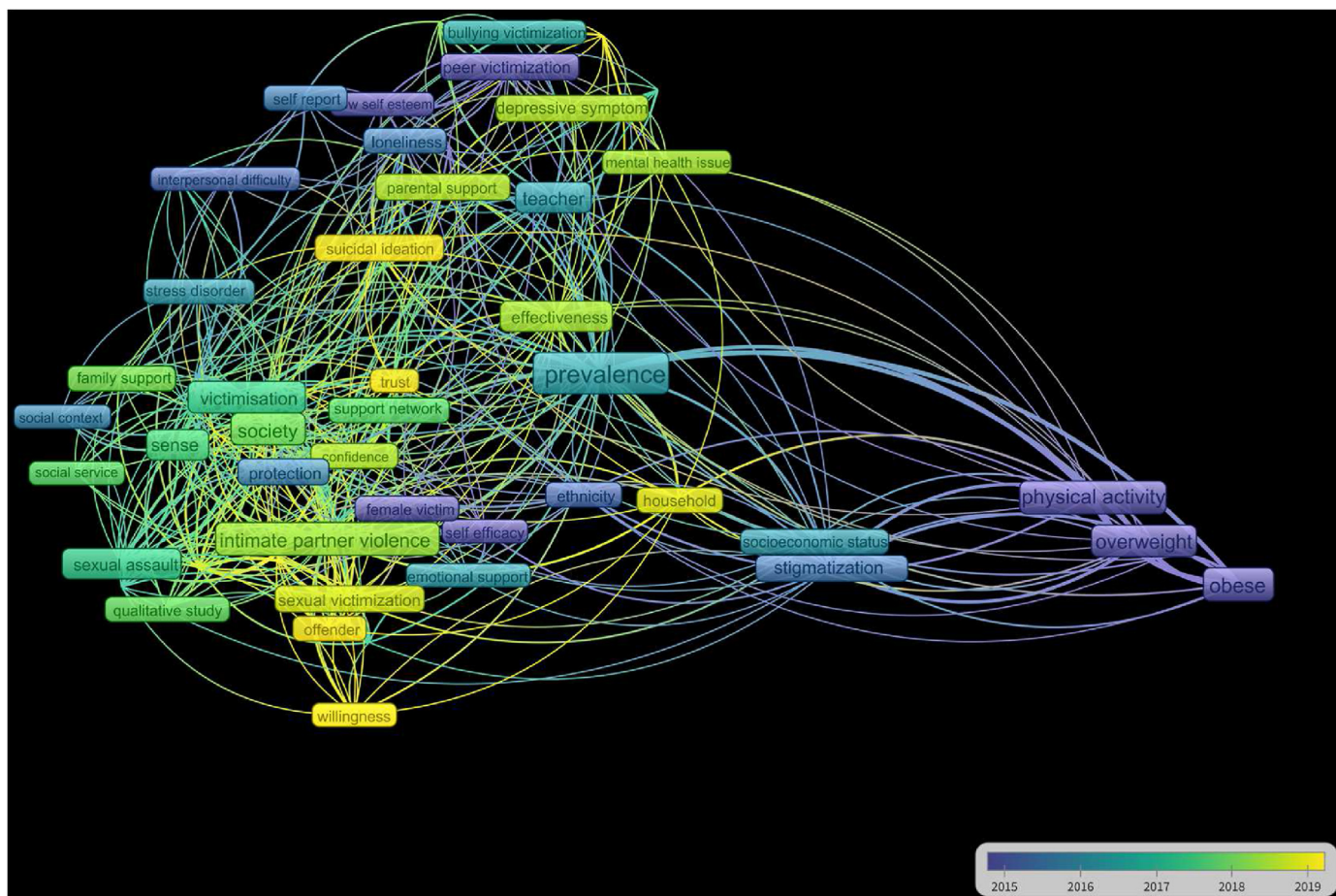


Fig. 1a. Visual analysis of the co-occurrence of keywords in studies on the specific experiences of obese children and adolescents (Timeline of keywords).

social support, school environment and weight stigma of obese/overweight youth and their engagement in PA, as detailed in Table 1.

3.3.2. Qualitative studies

Among the 15 qualitative studies, 10 were of high quality (H) and 5 were of moderate quality (M). Weaknesses in the studies mainly included: (i) participant recruitment strategies; (ii) the soundness of interview outlines and data analyses; (iii) considerations of the relationship between the researcher and the participants; and (iv) the support of the data for the conclusions. The qualitative studies investigated the experiences of obese/overweight children and adolescents in PA, their perceptions of obesity and PA, and the influence of activity environments and social networks on their PA, as shown in Table 2.

4. Discussion of the reasons for PA constraints in obese/overweight children and adolescents

Social-ecological theory, applied widely in behavioral sciences such as health promotion and public health, indicates that individuals are influenced by the specific social, cultural and physical environments in which they live.²⁴ Individual health behavior interventions, in turn, are affected at five primary levels: individual, interpersonal, institutional, community, and public policy.²⁵ We analyzed the results of the above systematic review of the relevant literature in conjunction with the theoretical paradigm and organizational framework of the multilevel perspective of social ecology. We found that barriers to physical activity participation in obese children and adolescents exist in three main dimensions: individual, interpersonal, and environmental (Fig. 3). Differences in PA participation among obese children and adolescents can be

explained as a result of complex interactions between different constraints at multiple levels, such as interpersonal relationships affecting individual psychology, the built environment affecting individual motivation as well as individual performance, and the state of obesity ultimately affecting the launch and implementation of policies. These constraints are not limited to independent influences but also have a cascading and interacting relationship that generates an adverse social ecology that constrains the PA of obese/overweight children and adolescents.

4.1. Individual constraints

4.1.1. Lack of motivation

The level of internal motivation for PA participation tended to be low among obese children and adolescents.¹³ In qualitative interviews, they attributed their poor motive to laziness.²⁶ Children in the context of modern life are bound by virtualized electronic spaces such as online games and entertainment videos, as well as the failure to establish a correct concept of sports,²⁷ resulting in most of them having difficulty developing good habits and being deterred from participating in the MVPA.²⁸ Obese children and adolescents experience poorer emotions and stronger perceptions of fatigue during and after exercise because of reduced physical functioning.^{29,30} In addition, obese children's self-efficacy decreases as they experience continued failure, including unsuccessful weight loss and inability to complete physical education (PE) classroom tasks,³¹ leading to negative attitudes in the face of barriers to PA participation.³² These factors exacerbate the perceived “laziness” of obese children, which in turn reduces interest in maintaining PA. Furthermore, their perception of their abilities and the value

Table 1
Descriptive characteristics of the included quantitative studies (n = 16).

Author (publishing year)	Purpose	Method/study design	Sample		Main findings	Quality assessment
			n	Age (years)		
Zabinski et al., 2003. ⁶⁹	Explored perceived barriers and support for PA in overweight children	Two-way ANOVA CS	84	12.6 ± 2.2	Physical-related, resource, and social barriers to PA were significantly higher in overweight children	4/5 (H)
Deforche et al., 2006. ³²	Explored attitudes towards PA in obese/overweight adolescents	ANOVA, PC CS	89	14.6 ± 1.2	Obese/overweight adolescents showed lower sports participation and negative attitudes towards PA	4/5 (H)
Storch et al., 2006. ⁷⁰	Examined the relationship between peer bullying and PA in obese children	PC CS	92	8–18	Peer bullying was negatively associated with PA participation in obese children	4/5 (H)
Salvy et al., 2009. ⁷¹	Explored whether peers or friends increase PA motivation in obese adolescents	Random-effects model E	88	12–14	Friendships can promote more PA in non-overweight and overweight adolescents	4/5 (H)
Losekam et al., 2010. ⁴⁹	Explored the relationship between being ridiculed and PA in obese students	PC CS	95	13.2 ± 0.8	Overweight students had a higher incidence of being ridiculed during PA	3/5 (M)
Power et al., 2011. ⁷²	Explored the relationship between obese body condition and PA motivation	ANOVA CS	82	12.6 ± 0.42 (12–14)	Obese children with low PA intrinsic motivation compared to average children	4/5 (H)
Seo et al., 2012. ⁴⁴	Examined the relationship between parental attitudes towards PA and PA in obese children	Logistic regression CS	246	NR (sampled by grade)	Parental drive and support promoted PA in obese children	4/5 (H)
Puhl et al., 2012. ⁴¹	Examined the way adolescents cope with weight-based injury experiences at school	Logistic regression, Structural equation modeling CS	394	NR (sampled by grade)	Have chosen not to engage in PA for fear of bullying and ridicule, and have become less interested in PE classes	4/5 (H)
Kim 2013. ²⁷	Explored differences in PA and perceived benefits and barriers in normal weight and overweight/obese adolescents	Hierarchical linear regression CS	773	Group 1: 14.9 ± 0.9 Group 2: 14.8 ± 0.9 Group 3: 15.2 ± 0.9	Overweight/obese adolescents perceived more barriers and fewer benefits to PA	4/5 (H)
Lawman et al., 2014. ⁷³	Explored individual, parental and environmental influences on PA in obese children and adolescents	Multiple regression L	201	10–17	Improvements in self-efficacy and parental and environmental support can help to increased LPA in obese children	5/5 (H)
Valerio et al., 2014. ³⁴	Compared perceived difficulty of PA participation in normal and obese children	ANOVA, PC, Linear regression CS	382	7–14	Obese children had higher perceptual difficulties with PA	5/5 (H)
Oreskovic et al., 2015. ⁵⁷	Explored whether the surrounding built environment influences PA in obese adolescents	ANOVA CS	60	10–16	The accessibility of the surrounding built environment contributed to obese adolescents' PA	3/5 (M)
Nagy et al., 2017. ²⁹	Explored the Emotional Experiences of PA in Obese Primary School Students	Mixed model linear regression E	39	7–11	Obese/overweight students had lower PA emotional experiences than normal weight students	4/5 (H)
Maiano et al., 2018. ⁵²	Explored whether perceived weight-related injuries during school PA affect out-of-school PA	Factor analysis, PC CS	144	14–18	Weight-related injuries often occur during in-school PA but do not predict out-of-school PA	4/5 (H)
Pulido et al., 2019. ⁷⁴	Explored how school bullying affects adolescent PA	Structural Equation Modeling CS	4 509	NR (sampled by grade)	Bullying and body stigma reduced PA in obese adolescents	4/5 (H)
Morano et al., 2020. ⁷⁵	Examined the relationship between school support, body image, and PA	Multiple regression E	18	11.3 ± 0.4	School support promoted PA in obese students, and body image may be an antecedent to PA	3/5 (M)

Legend: PA = physical activity; ANOVA = analysis of variance; PC = Pearson correlation; CS = cross-sectional study; PE = physical education; E = experimental research; L = longitudinal study; LPA = light physical activity; NR = not reported; H = high quality; M = moderate quality.

4.2. Interpersonal constraints

4.2.1. Lack of family support

Parents' exercise habits, perceptions, and attitudes towards PA in the family significantly impact children's PA participation.^{33,43} And parents of obese children may often have deficits in parenting their children about PA.⁴⁴ Parents who do not encourage and motivate their children to exercise, or even do not care about their children's weight, or only discourage them by chastising unhealthy lifestyles such as sedentary lifestyle, can make weight management, including PA, passive in obese children.⁴⁵ Meanwhile, many parents do not provide timely intervention and counseling for their children who are psychologically victimized by obesity in sports or other activities, nor properly instructing their children on how to face and handle peer bullying.²³ These passive practices may also exacerbate the psychological vulnerability of some obese children and discourage them from actively participating in PA.

Bridger found that socioeconomic status (SES) was negatively associated with childhood obesity rates in developed countries and the

opposite pattern in middle-and low-income countries.⁴⁶ Nevertheless, Wheeler concluded that children's PA habits are formed by the economic environment provided by their parents and the co-constructed cultural environment.⁴⁷ A study found that obese adolescents living in large and spatially confined households were more likely to experience a 'chaotic and disorganized' lifestyle, where there were often absentee members of the family and where parents worked long hours or held multiple jobs, leaving little time to spend with them.⁴⁵ Thus, SES may also be a potential barrier to PA among obese children and adolescents.⁴⁸

4.2.2. Negative feedback from society

Verbal taunts and stereotypes are also prevalent in the lives of obese children, often being called "chubby", "butterball", etc., and stereotypically equating obesity/overweight with negative labels such as inactivity and laziness. Social exclusion and physical bullying, on the other hand, are generally found only in schools.¹³

In the school setting, research showed that overweight/obese students were more likely to be stigmatized by their peers during PA.⁴⁹

Table 2
Descriptive characteristics of the included qualitative studies (n = 15).

Author (publishing year)	Purpose	Method/study design	Sample		Main findings	Quality assessment
			n	Age (years)		
Alm et al., 2008. ⁴⁵	To investigate barriers and facilitators to achieving behavioral goals in obese adolescents	SSI	18	Group 1: 14.9 ± 1.73 Group 2: 15.6 ± 0.88	Lack of safe exercise spaces and conditions for female adolescents	7/10 (M)
Daley et al., 2008. ²⁶	To understand barriers to PA in obese students	SSI	25	13 ± 1.7	PA barriers include weather, tiredness or shortness of breath, difficulty exercising after school, lack of time due to schoolwork, feeling lazy/unmotivated	7/10 (M)
Curtis 2008. ⁶²	To explore the experiences associated with obese adolescents in a secondary school environment	FGI	18	10–17	Sportswear reveals body flaws, ridicule in sports	7/10 (M)
Griffiths et al., 2008. ³¹	To investigate the relationship between obesity and bullying	Interpretative phenomenological analysis, SSI	5	12–18	Inability to adapt to the content of PE classes and ridicule during classes	7/10 (M)
Lee et al., 2009. ²⁸	To explore the perceptions of exercise in obese children	SSI, FGI	11	11–13	They have important perceptions of the pros and cons of exercise, but their PA participation is low due to the strenuousness of exercise, false beliefs about exercise, etc.	7/10 (M)
Trout et al., 2009. ⁴⁰	To investigate the perceptions and experiences of overweight students in PE classes	One-to-one open-ended interview and follow-up telephone interview	12	13–18	Overweight students suffer injuries to the extent that they reach symptoms consistent with learned helplessness, leading them to avoid sports participation	8/10 (H)
Chen et al., 2010. ³⁶	To investigate the PA of overweight/obese girls and their attitudes towards obesity and ideal body image	Consensus qualitative research, SSI	13	13–16	Body image plays a dominant role in motivational development and barriers to performing PA in overweight/obese girls	8/10 (H)
Meaney et al., 2011. ³⁷	To explore overweight children's perceptions of different PA environments	SSI	67	10.2 ± 0.7	Few choices of content for PE classes in primary schools, fear of ridicule from peers, and few choices of environments for PA in the community	8/10 (H)
Li et al., 2012. ⁴²	To explore the prevalence of stigmatization of obese students in PA and their psychological state afterwards	SSI	47	11–19	Frequent ridicule and ostracism in sports activities, resulting in low self-esteem among obese children	8/10 (H)
Lewis et al., 2014. ³³	To explore the experiences of overweight/obese children who have successfully increased their levels of PA	SSI	58	6–16	Intrinsic motivation, perceptual ability, pleasure, parental support, school support, peer support, etc. promote PA	8/10 (H)
Olaya-Contreras et al., 2016. ⁷⁶	To explore the context that influences PA in obese children	Non-participant observation, SSI, FGI	31	10–14	Participants found PE lessons too competitive and unmotivating; PA outside of school was associated with fun but just didn't happen often enough	9/10 (H)
Reece et al., 2016. ³⁹	To explore the experiences of obese adolescents and their perceptions of obesity treatment	One-to-one interview, FGI	12	11–16	They are willing to PA with their peers in a safer and highly supportive environment because they will not be stigmatized	8/10 (H)
Oen et al., 2018. ³⁰	To understand the perspectives and life experiences of obese adolescents	SSI	5	12–15	More easily fatigued and fearful of being disliked during physical activities, needing better social support	8/10 (H)
Sundar et al., 2018. ⁷⁷	To investigate the PA experiences of overweight adolescents	SSI	21	13–14	Mastery of a sport and peer participation promotes PA	8/10 (H)
Skogen et al., 2021. ⁴³	To investigate barriers and facilitators to PA participation among obese adolescents in their social networks	Systematic text condensation, SSI	10	13–18	Barriers include lack of support from parents, peers, seriousness of teachers, etc.; facilitators include variety in PA, not feeling inferior to others	9/10 (H)

Legend: PA = physical activity; SSI = semi-structured in-depth interview; FGI = focus group interview; PE = physical education; H = high quality; M = moderate quality.

Although it has also been reported that peer "victimization" did not mediate the negative association between weight status and MVPA (not specifically for the obese group), the results also describe a higher rate of peer "victimization" for overweight/obese adolescents.⁵⁰ And these adverse feedback effects in the obese youth group may cause them to further close themselves off from PA that exposes their body image,⁴¹ leading to their social networks becoming narrower. Vander found that obese adolescents with fewer friends were likelier to use unhealthy weight management behaviors.⁵¹ Also, exercising alone can make obese adolescents bored and perceive exercise as purposeless, and participation can wane.²⁸

School teachers also did not provide enough support in PA promotion for obese students. Firstly, teachers failed to play a good role in

supervising and preventing obese students from being ridiculed or bullied by their peers in school.⁵² Secondly, some teachers did not consider the fun and difficulty of the tasks when setting the curriculum content, which led to many obese students thinking that PE lessons were too competitive. They did not have an advantage in this area, so they felt that PE lessons could not play a positive role, and the content of PE lessons was too little to choose from. Much of the content was unsuitable for obese students, which would make it difficult for them to keep up with the curriculum schedule.^{31,37} Coupled with the fact that many girls perceive PA barriers as stronger than boys, the discomfort of the course content can cause these obese girls to avoid PE classes deliberately.⁵³ In addition, there is a stereotype that obese students cannot do certain physical activities, such as dancing, and some teachers may even go as far

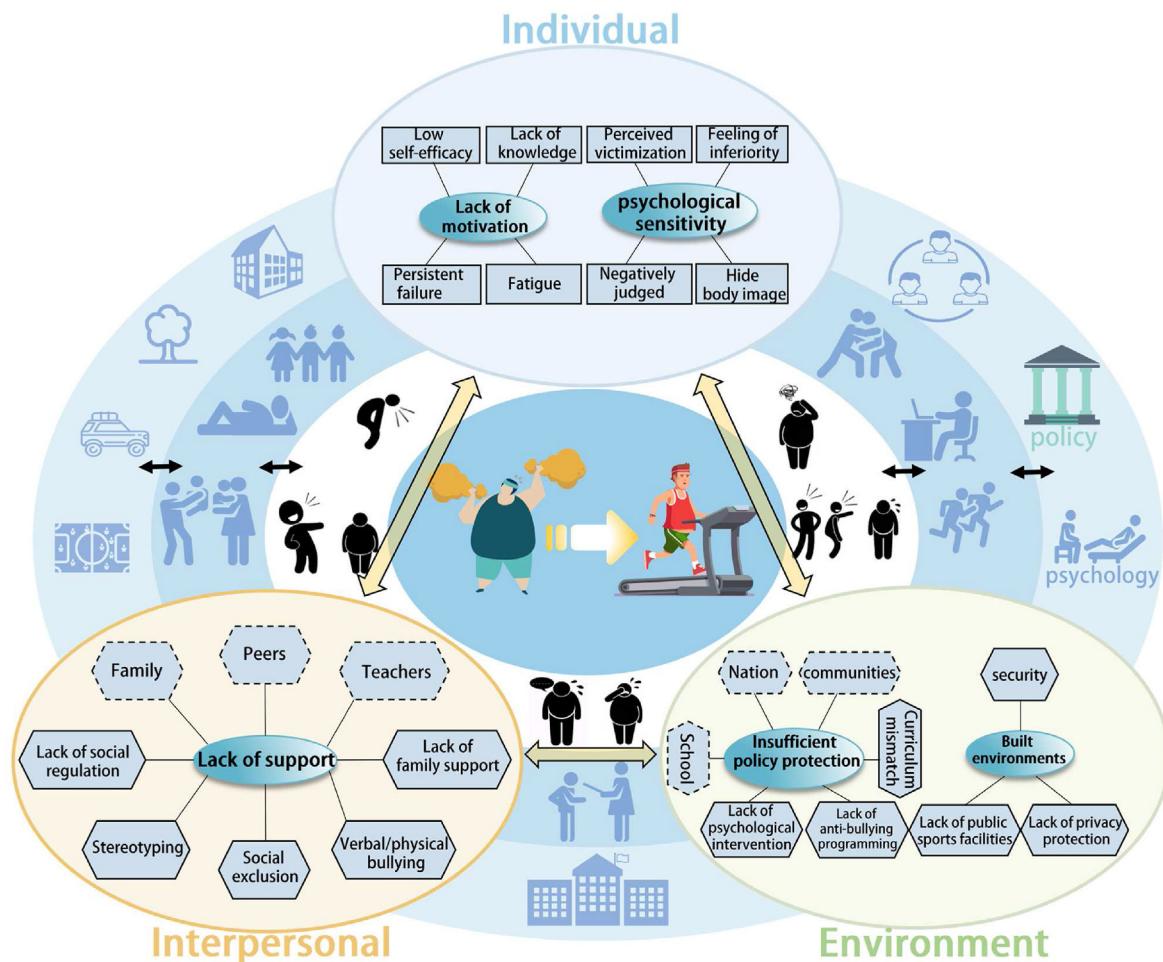


Fig. 3. Factors constraining physical activity (PA) in obese/overweight children and adolescents.

as to say, "It's a little too strenuous ... you might want to sit this one out".⁴⁰ In such situations where students want to participate, disapproval from an authority figure can hit their self-esteem and result in frustration.

4.3. Environmental constraints

4.3.1. Lack of policy safeguards

Many countries have long formulated plans and measures to prevent and control obesity in children and adolescents. However, obese children and adolescents face not only obesity but other encounters brought about by obesity, including social prejudice, psychological or physical injuries, and so on. For these problems, there are few policies to consider and introduce relevant measures to intervene.^{23,54} For example, it has become a common problem that obese/overweight children are more vulnerable to stigma and bullying than their normal-weight peers.⁵⁵ These harms significantly negatively impact obese children's participation in PA and their physical and mental health. Yet, few specific anti-bullying intervention programs/policies are in place to safeguard their physical and mental rights and interests.⁴¹ There has also been insufficient attention paid to the applicability of traditional school PE programs to obese children and teachers' attitudes toward obese students. Moreover, implementing some policies has been hampered by, among other things, a lack of financial and resource support, competing programs, and frequent reforms in education and health care.⁵⁶

4.3.2. Lack of built environment support

There is a positive association between the built environment and the participation of obese children in the MVPA, and they are more likely to

participate in the MVPA when located in outdoor built environments (e.g., playgrounds, sports parks, etc.).^{57,58} A study indicated that high walkability near living areas increases PA levels and decreases obesity rates in children.⁵⁹ In contrast, environments with a lot of fast food vending in the neighborhood may increase the risk of obesity in children.⁶⁰ Besides, the insecurity of the community environment (e.g., traffic safety hazards, stranger threats, etc.) will lead to increased social isolation and reduced opportunities for outdoor PA participation among children and adolescents.⁶¹ Environmental insecurity was also the main reason why obese female adolescents in Alm et al.'s survey perceived their PA participation to be low.⁴⁵ For school buildings, the lack of privacy in changing rooms or the lack of changing rooms at all hinders the active participation of obese/overweight students in PE lessons. Changing in public may "show" their obese bodies more visually and make them uncomfortable, or they may be concerned about not having a place to change their clothes after participating in PE.^{62,63}

5. PA promotion strategies

Against the backdrop of the global public health challenge of physical inactivity in children and adolescents, countries have developed and implemented policies to encourage and enhance PA among youth in various domains, such as PE in schools, health education related to PA, community supportive environments, transport, and the mass media.⁶⁴ However, these policies may not pay particular attention to the situation of obese children. The goal of our strategies is to promote PA among ordinary young people while at the same time focusing on and addressing the specific barriers encountered by obese children and adolescents.

Concerning the participation in PA of obese children and adolescents, the above analyses revealed that: (i) some barriers are specific to this group (e.g., weight stigma, stereotypes, etc.); (ii) some barriers may apply to all children and adolescents (e.g., environment, parental support, etc.); (iii) some general barriers can be exacerbated by the weight status of obese children and adolescents (e.g., physical discomfort/fatigue, etc.). By considering these constraints and their interrelationships, the study proposes a strategy for promoting PA among obese youth that is led by government policies/measures and implemented through “family-school-community” cooperation, from improving the top-level design to constructing the underlying logic (Fig. 4). It is essential to involve and sensitize members of all systems of relationships involved in the lives of children and adolescents (e.g., families, schools, peer groups, educators, and health-care providers).⁶⁵

5.1. Enhancement of government policy support

5.1.1. Improving built environment support for PA

First, the Government should coordinate comprehensive development, focus on solving the imbalance in the distribution of public sports venues and facilities between urban and rural areas and between regions, and improve the equalization of opportunities for young people to participate in sports. For example, innovative use can be made of non-sporting land, such as green space, parks, abandoned factories, and aboveground and underground space, to create “composite” fitness venues. Second, the Administration should enhance the community environment's security to alleviate families' safety concerns about their children exercising outdoors. This can be done by adding surveillance cameras at the entrances and exits of outdoor venues such as neighborhoods and parks and controlling the speed of vehicles in the vicinity.

5.1.2. Focusing on the psychological problems of obese children and adolescents

Attempts should be made to reduce the incidence of bullying in schools caused by obesity or other types of bullying. For instance, the Government can strengthen the anti-bullying legislation in schools and give schools moderate disciplinary powers to prevent some bullies from

being encouraged by the fact that they have not yet reached the age of criminal responsibility and do whatever they want. Apart from that, relevant experts and scholars can be organized to develop teaching materials on anti-bullying in schools. There should also be a network of psychological counseling services to provide psychological counseling and support for obese children and adolescents. This may include setting up special hotlines or online counseling platforms or strengthening public psychologists' community services so they can access professional counselors.

5.1.3. Establishing a PA monitoring and evaluation mechanism

Besides collecting data on obesity continuously, the Government can establish a monitoring and evaluation mechanism for the participation of obese children in PA. Through regular collection of relevant data, including the number, frequency, and duration of participation in physical activities, etc., the effectiveness of policies and measures should be assessed to ensure that the relevant policies can produce actual benefits. Meanwhile, the monitoring results should provide feedback on the participation rate and identify which groups need more support, etc., to help organizations make timely adjustments and improvements to their strategies for promoting PA participation. Additionally, relevant research and evaluation projects can be conducted in collaboration with research organizations and health experts to gain a deeper understanding of PA among obese children and adolescents, as well as the factors that influence it.⁶⁶

5.2. Building a school security system

5.2.1. Enactment of anti-bullying intervention programs

School-based anti-bullying intervention programs can be carried out in the following ways: (i) Establishing a teacher-student-linked bullying early warning mechanism. Firstly, anti-bullying training should be provided to school administrators and teachers to clarify the preventive and intervention responsibilities undertaken, e.g., teachers should take the initiative to learn about the situation and nip bullying in the bud. Secondly, bystanders should be encouraged to show supportive behaviors towards victims, including stopping and reporting upward in time. (ii)

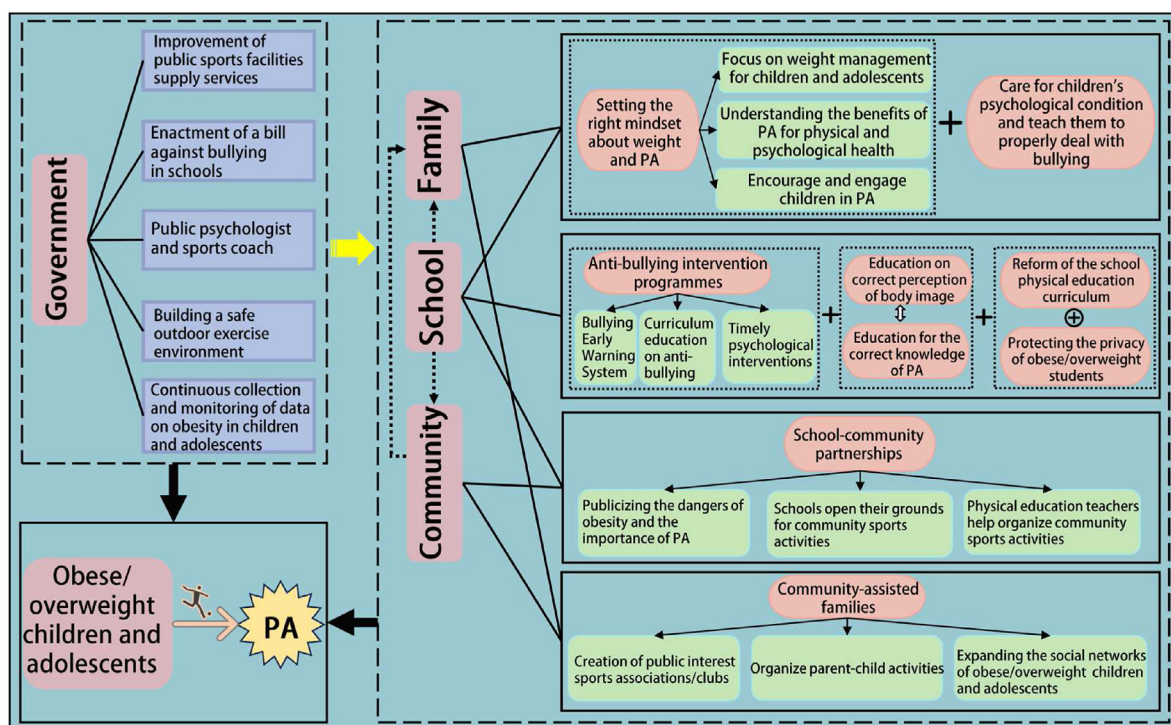


Fig. 4. Physical activity (PA) promotion strategies for obese/overweight children and adolescents.

Provide anti-bullying courses to teach the basics of school bullying and measures to deal with it, and simultaneously, increase the cultivation of students' good character, such as self-respect and self-improvement, and alternative thinking. (iii) Arranging for professional psychological teachers to provide psychological counseling to students who have been bullied promptly.

These plans emphasize raising awareness of the risk factors associated with bullying and peer ridicule, and there is a need to focus these efforts on students who are at higher risk of bullying, such as overweight/obese students. Interventions should not only target individual students but also focus on improving overall stigmatizing attitudes towards overweight/obese students and promoting a school climate that is inclusive and accepting of all body types.

5.2.2. Reinforcement of correct perception of body image and PA

Schools can start from the following aspects: (i) Teach students basic knowledge about the body, help them understand that everybody is unique and that there is no absolute “ideal” body shape, encourage them to accept their bodies, and cultivate students' self-esteem. Also, remind them that excessive obesity poses a significant health risk to the body. (ii) Create a highly supportive environment that encourages students to support and understand each other and promotes peer interaction. Emphasize the value and diversity of each individual and motivate them to focus more on the inner self of others rather than body image. (iii) Teach them the importance of regular participation in PA and healthy eating, provide information on scientific exercise, nutritional balance, and proper diet, and encourage them to develop an active lifestyle.

5.2.3. Promoting reform of the PE curriculum

First of all, teachers should enhance the diversity and entertainment of the contents of PE teaching to attract students to integrate into the curriculum. For instance, a bonus point system can be set up for sports achievement awards, competition rewards, or physical fitness assessments. Second, teachers should focus on teaching students according to their aptitude. For student groups such as the obese and weak athletic ability, individualized evaluation and goal-setting can be conducted for them, and they can be given recognition and rewards according to their progress. Again, a positive sports culture should be fostered to promote mutual support and cooperation among students and encourage students with sporting solid abilities to motivate the weaker ones. In the meantime, it is essential to promote respect and inclusiveness among teachers and students as well as among students to ensure that every student feels accepted and respected in the sporting atmosphere and to avoid discrimination based on obesity or ability. Furthermore, schools can regularly evaluate the effectiveness of their PE curriculum and make improvements and adjustments in the light of feedback and assessment results.

5.3. Strengthening family education

5.3.1. Developing a health perspective in the family

Schools can instill some correct health concepts in parents based on their trust and support for teachers through publicity and parent-teacher conferences: (i) Pay attention to the harm of obesity and the importance of weight management and correct some parents' traditional concepts of obesity, such as “*children who are obese are growing up.*” (ii) To change the family philosophy of putting academic achievement above all else in some families, and to teach parents to pay more attention to their children's health and encourage them to take an active part in PA in their daily life. (iii) To encourage parents to set an example regarding physical exercise, dietary management, and work and rest schedules to motivate their children to maintain healthy behaviors.

5.3.2. Attention to the psychological condition of the child

Apart from physical health, it is also necessary to pay constant attention to children's psychological health. Parents should establish

good communication and trusting relationships with their children, listen patiently to their feelings and thoughts, and pay attention to their attitudes toward body image and weight. They should also observe their children's behavior when interacting with their peers and participating in activities such as sports and exercise to detect whether they are suffering from psychological distress. Parents should not only teach positive coping strategies for external accusations or stigmatization, etc., experienced due to obesity but also convey respect and acceptance to their children. Hence, they know they are loved and accepted regardless of appearance. Parents can also seek professional support from the school or psychologist on time.

5.4. Increasing PA options for obese/overweight children and adolescents

5.4.1. Creation of public interest sports associations/clubs

Schools and communities should establish close partnerships to create public service sports clubs to reduce some families' constraints on children's PA due to lower SES. Both parties can exchange and share resources: (i) Jointly recruit professionals, such as physical education teachers, health educators, and dietitians, to jointly develop programs and goals and provide professional guidance to help obese children and youth engage in effective exercise and health management. (ii) Medical specialists in schools and the community can collaborate with public interest sports associations to conduct comprehensive health assessments on obese children and youth. This includes physical condition, dietary habits, psychological health, and other aspects of the assessment to design a personalized exercise and health plan for each child. (iii) Co-track and monitor the health status and participation of obese children and adolescents, make adjustments, and provide additional support as needed.

5.4.2. Joint school-community extracurricular sports activities

Schools and the community can jointly organize regular weekly sports activities and ensure that the time and place of the activities are convenient for obese children and that appropriate facilities and equipment are available. For example, schools can open up sports ground facilities, including athletic fields and basketball courts, for children and youth in the community after school hours or on weekends. Children's interest is aroused by providing free or low-cost sports venues and being encouraged to participate actively in PA. The community can organize community sports days regularly, inviting school students to participate and offering various sports activities, such as outdoor sports competitions, fitness challenges, etc., to cater to different interests and needs.

5.5. Community-assisted families create an atmosphere of PA

5.5.1. Conducting promotional campaigns on PA

The community should liaise closely with families, and in response to the fact that some families do have no knowledge of, and fail to attach importance to, the physical and mental health of obese children, more health promotion campaigns, including health talks and the dissemination of health information, can be conducted. By promoting the combination of “nurturing” and “teaching” in the family, we can help parents improve their understanding of the health risks and psychological distress of obesity and solve the problem of child obesity with scientific family upbringing. The community should also take the initiative to connect with social sports instructors, which enables the social sports instructors to have more explicit knowledge of the corresponding situation of obese children and their families so that they can be more targeted to guide the participation of obese children in PA with their professional knowledge and experience.

5.5.2. Expanding social networks for obese/overweight children and adolescents

Most of the friends chosen by obese children and adolescents are of similar size to themselves, and this concurrent choice is also the main link

between social networks and the obesity epidemic.⁶⁷ Interventions that leverage social networks will be beneficial in accelerating behavioral change and promoting PA participation among obese children.⁶⁸ Therefore, the community can join hands with families to expand the social network of obese children, such as organizing regular community family sports days, outdoor sports challenges, etc.; and helping to set up parent support groups, where parents can work together to tackle the problem of child obesity by exchanging experiences, providing emotional support and practical advice. Through these team sports and cooperative activities, obese children and youth can interact and socialize with their peers outside of school while enhancing family connectivity and social capital.

6. Limitations

This present study has some limitations. Firstly, the situation varies from country to country, nation to nation, and individual to individual, so there are many constraints associated with PA in obese children and adolescents that have not been considered. Moreover, the methodological quality control of some of the included studies could be improved, which may limit the generalization of the results of this review. Even though we conducted the literature search and tracing with a rigorous literature search procedure, relevant literature may have needed to be included. Concerning the applicability of the promotion strategies we have proposed, the implementation by local organizations has shown the effectiveness of PA promotion for obese children and adolescents. Yet, these strategies can hardly be a universal policy due to each geographical area's different economic and cultural aspects. To encourage and enhance the PA of obese children and adolescents, the strategies we proposed can be used as a reference, and then more suitable policies can be formulated according to the actual situation of the local community.

7. Conclusions

Obese/overweight children and adolescents are more likely to be subjected to constraints from various sources, which may limit their participation in PA. These constraints may be related to an individual's perception, psychology, and physical fitness. Furthermore, family and school support and getting along with teachers and peers may also influence their PA. The lack of external policy safeguards or the low supportive nature of the built environment also deprives them of many opportunities. Considering these constraints and their interrelationships, promoting PA among obese children requires that while the government improves protection and promotion policies, schools, families, and communities should collaborate to focus on the barriers to PA confronted by obese children. And one by one, these obstacles, especially those encountered explicitly by obese individuals, such as injuries based on obesity, are broken down to increase their interest and enhance the security of participation in PA.

Submission statement

We confirm that this article has yet to be published. All authors have seen the manuscript and approved to submit to your journal.

Funding

This study has been funded by the Humanities and Social Sciences Research Planning Fund of the Ministry of Education of China (21YJA890022), and Jilin Province Social Science Foundation Program (2020B152).

Authors' contributions

Jiangxi Chen: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Yinmengke Bai:** Software,

Methodology, Data curation. **Weiguang Ni:** Supervision, Methodology, Funding acquisition, Conceptualization.

Conflict of interest

The authors declare they have no known financial interests or personal relationships that might influence the work reported here.

Acknowledgments

We thank all the funds for their support.

References

- López-Gil JF, Tapia-Serrano MA, Sevil-Serrano J, Sánchez-Miguel PA, García-Hermoso A. Are 24-hour movement recommendations associated with obesity-related indicators in the young population? A meta-analysis. *Obesity*. 2023;2023:23848. <https://doi.org/10.1002/oby.23848>.
- Collaborators GO. Health effects of overweight and obesity in 195 countries over 25 years. *N Engl J Med*. 2017;377(1):13–27. <https://doi.org/10.1056/NEJMoa1614362>.
- Wanjau MN, Kivuti-Bitok LW, Aminde LN, Veerman JL. The health and economic impact and cost effectiveness of interventions for the prevention and control of overweight and obesity in Kenya: a stakeholder engaged modelling study. *Cost Eff Resour Alloc*. 2023;21(1):69. <https://doi.org/10.1186/s12962-023-00467-3>.
- Gurnani M, Birken C, Hamilton J. Childhood obesity: causes, consequences, and management. *Pediatr Clin*. 2015;62(4):821–840. <https://doi.org/10.1016/j.pcl.2015.04.001>.
- Simmonds M, Llewellyn A, Owen CG, Woolacott N. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. *Obes Rev*. 2016;17(2):95–107. <https://doi.org/10.1111/obr.12334>.
- Janssen I, Katzmarzyk PT, Srinivasan SR, et al. Combined influence of body mass index and waist circumference on coronary artery disease risk factors among children and adolescents. *An Pediatr*. 2005;115(6):1623–1630. <https://doi.org/10.1542/peds.2004-2588>.
- Deforche B, De Bourdeaudhuij I, Tanghe A, Debode P, Hills AP, Bouckaert J. Role of physical activity and eating behaviour in weight control after treatment in severely obese children and adolescents. *Acta Paediatr*. 2005;94(4):464–470. <https://doi.org/10.1080/08035250410024204>.
- Piercy KL, Troiano RP, Ballard RM, et al. The physical activity guidelines for americans. *JAMA*. 2018;320(19):2020–2028. <https://doi.org/10.1001/jama.2018.14854>.
- Ezzati M, Bentham J, Di Cesare M, et al. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *Lancet*. 2017;390(10113):2627–2642. [https://doi.org/10.1016/S0140-6736\(17\)32129-3](https://doi.org/10.1016/S0140-6736(17)32129-3).
- Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U. Global physical activity levels: surveillance progress, pitfalls, and prospects. *Lancet*. 2012;380(9838):247–257. [https://doi.org/10.1016/S0140-6736\(12\)60646-1](https://doi.org/10.1016/S0140-6736(12)60646-1).
- Wang C, Chen P, Zhuang J. A national survey of physical activity and sedentary behavior of Chinese city children and youth using accelerometers. *Res Q Exerc Sport*. 2013;84(sup2):S12–S28. <https://doi.org/10.1080/02701367.2013.850993>.
- Zhu Z, Tang Y, Zhuang J, et al. Physical activity, screen viewing time, and overweight/obesity among Chinese children and adolescents: an update from the 2017 physical activity and fitness in chinathe youth study. *BMC Publ Health*. 2019;19:197. <https://doi.org/10.1186/s12889-019-6515-9>.
- Stankov I, Olds T, Cargo M. Overweight and obese adolescents: what turns them off physical activity? *Int J Behav Nutr Phys Activ*. 2012;9(1):1–15. <https://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-9-53>.
- Olds TS, Ferrar KE, Schranz NK, Maher CA. Obese adolescents are less active than their normal-weight peers, but wherein lies the difference? *J Adolesc Health*. 2011;48(2):189–195. <https://doi.org/10.1016/j.jadohealth.2010.06.010>.
- Needham BL, Crosnoe R. Overweight status and depressive symptoms during adolescence. *J Adolesc Health*. 2005;36(1):48–55. <https://doi.org/10.1016/j.jadohealth.2003.12.015>.
- Eisenberg ME, Neumark-Sztainer D, Story M. Associations of weight-based teasing and emotional well-being among adolescents. *Arch Pediatr Adolesc Med*. 2003;157(8):733–738. <https://doi.org/10.1001/archpedi.157.8.733>.
- Rankin J, Matthews L, Cogley S, et al. Psychological consequences of childhood obesity: psychiatric comorbidity and prevention. *Adolesc Health Med Therapeut*. 2016;7:125–146. <https://doi.org/10.2147/AHMT.S101631>.
- Fernandes AC, Viegas AA, Lacerda ACR, et al. Association between executive functions and gross motor skills in overweight/obese and eutrophic preschoolers: cross-sectional study. *BMC Pediatr*. 2022;22(1):498. <https://doi.org/10.1186/s12887-022-03553-2>.
- O'Dea JA. Prevention of child obesity: 'First, do no harm'. *Health Educ Res*. 2004;20(2):259–265. <https://doi.org/10.1093/her/cyg116>.
- Page MJ, McKenzie JE, Bossuyt PM, et al. The prisma 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71. <https://doi.org/10.1136/bmj.n71>.

21. Lu C, Stolk RP, Sauer PJJ, et al. Factors of physical activity among Chinese children and adolescents: a systematic review. *Int J Behav Nutr Phys Activ.* 2017;14(1):36. <https://doi.org/10.1186/s12966-017-0486-y>.
22. Hannes K, Lockwood C, Pearson A. A comparative analysis of three online appraisal instruments' ability to assess validity in qualitative research. *QHR.* 2010;20(12):1736–1743. <https://doi.org/10.1177/1049732310378656>.
23. Thompson I, Hong JS, Lee JM, Prys NA, Morgan JT, Udo-Inyang I. A review of the empirical research on weight-based bullying and peer victimisation published between 2006 and 2016. *Educ Rev.* 2020;72(1):88–110. <https://doi.org/10.1080/00131911.2018.1483894>.
24. Stokols D. Translating social ecological theory into guidelines for community health promotion. *Am J Health Promot.* 1996;10(4):282–298. <https://doi.org/10.4278/0890-1171-10.4.282>.
25. Zhang T, Solmon M. Integrating self-determination theory with the social ecological model to understand students' physical activity behaviors. *Int Rev Sport Exerc Psychol.* 2013;6(1):54–76. <https://doi.org/10.1080/1750984X.2012.723727>.
26. Daley AJ, Copeland RJ, Wright NP, Wales JKH. 'I can actually exercise if I want to; it isn't as hard as I thought' - a qualitative study of the experiences and views of obese adolescents participating in an exercise therapy intervention. *J Health Psychol.* 2008;13(6):810–819. <https://doi.org/10.1177/1359105308093865>.
27. Kim Y. Differences in physical activity and perceived benefits and barriers among normal weight, overweight, and obese adolescents. *Percept Mot Skills.* 2013;116(3):981–991. <https://doi.org/10.2466/06.10.PMS.116.3.981-991>.
28. Lee P-H, Lai H-R, Chou Y-H, Chang L-I, Chang W-Y. Perceptions of exercise in obese school-aged children. *J Nurs Res.* 2009;17(3):170–178. <https://doi.org/10.1097/JNR.0b013e3181b2554b>.
29. Nagy MR, O'Sullivan MP, Block SS, et al. Affective responses to intermittent physical activity in healthy weight and overweight/obese elementary school-age children. *J Phys Activ Health.* 2017;14(11):845–851. <https://doi.org/10.1123/jpah.2016-0552>.
30. Oen G, Kvilhaugsvik B, Eldal K, Halding A-G. Adolescents' perspectives on everyday life with obesity: a qualitative study. *Int J Qual Stud Health Well-Being.* 2018;13(1):1479581. <https://doi.org/10.1080/17482631.2018.1479581>.
31. Griffiths LJ, Page AS. The impact of weight-related victimization on peer relationships: the female adolescent perspective. *Obesity.* 2008;16:S39–S45. <https://doi.org/10.1038/oby.2008.449>.
32. Deforche BI, De Bourdeaudhuij IM, Tanghe AP. Attitude toward physical activity in normal-weight, overweight and obese adolescents. *J Adolesc Health.* 2006;38(5):560–568. <https://doi.org/10.1016/j.jadohealth.2005.01.015>.
33. Lewis K, Fraser C, Manby M. 'Is it worth it?' A qualitative study of the beliefs of overweight and obese physically active children. *J Phys Activ Health.* 2014;11(6):1219–1224. <https://doi.org/10.1123/jpah.2012-0295>.
34. Valerio G, Gallarato V, D'Amico O, et al. Perceived difficulty with physical tasks, lifestyle, and physical performance in obese children. *BioMed Res Int.* 2014;2014:735764. <https://doi.org/10.1155/2014/735764>.
35. Kantanista A, Osiński W, Borowiec J, Tomczak M, Król-Zielińska M. Body image, bmi, and physical activity in girls and boys aged 14–16 years. *Body Image.* 2015;15:40–43. <https://doi.org/10.1016/j.bodyim.2015.05.001>.
36. Chen L-J, Fox KR, Haase AM. Body image and physical activity among overweight and obese girls in Taiwan. *Womens Stud Int Forum.* 2010;33(3):234–243. <https://doi.org/10.1016/j.wsif.2010.01.003>.
37. Meaney KS, Hart MA, Griffin LK. Do you hear what I hear? Overweight children's perceptions of different physical activity settings. *J Teach Phys Educ.* 2011;30(4):393–409. <https://doi.org/10.1123/jtpe.30.4.393>.
38. Skogen IB, Båtevik FO, Krumsvik RJ, Høydal KL. Weight-based victimization and physical activity among adolescents with overweight or obesity: a scoping review of quantitative and qualitative evidence. *Front Sports Act Living.* 2022;4:7. <https://doi.org/10.3389/fspor.2022.732737>.
39. Reece LJ, Bissell P, Copeland RJ. 'I just don't want to get bullied anymore, then I can lead a normal life': insights into life as an obese adolescent and their views on obesity treatment. *Health Expect.* 2016;19(4):897–907. <https://doi.org/10.1111/hex.12385>.
40. Trout J, Graber KC. Perceptions of overweight students concerning their experiences in physical education. *J Teach Phys Educ.* 2009;28(3):272–292. <https://doi.org/10.1123/jtpe.28.3.272>.
41. Puhl RM, Luedicke J. Weight-based victimization among adolescents in the school setting: emotional reactions and coping behaviors. *J Youth Adolesc.* 2012;41(1):27–40. <https://doi.org/10.1007/s10964-011-9713-z>.
42. Li W, Rukavina P. The nature, occurring contexts, and psychological implications of weight-related teasing in urban physical education programs. *Res Q Exerc Sport.* 2012;83(2):308–317. <https://doi.org/10.1080/02701367.2012.10599862>.
43. Skogen IB, Høydal KL. Adolescents who are overweight or obese - the relevance of a social network to engaging in physical activity: a qualitative study. *BMC Public Health.* 2021;21(1):701. <https://doi.org/10.1186/s12889-021-10727-7>.
44. Seo D-C, Lee CG. Association of school nutrition policy and parental control with childhood overweight. *J Sch Health.* 2012;82(6):285–293. <https://doi.org/10.1111/j.1746-1561.2012.00699.x>.
45. Alm M, Soroudi N, Wylie-Rosett J, et al. A qualitative assessment of barriers and facilitators to achieving behavior goals among obese inner-city adolescents in a weight management program. *Diabetes Educ.* 2008;34(2):277–284. <https://doi.org/10.1177/0145721708314182>.
46. Bridger Staatz C, Kelly Y, Lacey RE, et al. Socioeconomic position and body composition in childhood in high- and middle-income countries: a systematic review and narrative synthesis. *Int J Obes.* 2021;45(11):2316–2334. <https://doi.org/10.1038/s41366-021-00899-y>.
47. Wheeler S. The significance of family culture for sports participation. *Int Rev Sociol Sport.* 2012;47(2):235–252. <https://doi.org/10.1177/1012690211403196>.
48. Woronko C, Merry L, Uckun S, et al. Prevalence and determinants of overweight and obesity among preschool-aged children from migrant and socioeconomically disadvantaged contexts in Montreal, Canada. *Prev Med Rep.* 2023;36:102397. <https://doi.org/10.1016/j.pmedr.2023.102397>.
49. Losekam S, Goetzky B, Kraeling S, Rief W, Hilbert A. Physical activity in normal-weight and overweight youth: associations with weight teasing and self-efficacy. *Obes Facts.* 2010;3(4):239–244. <https://doi.org/10.1159/000319433>.
50. Stearns JA, Carson V, Spence JC, Faulkner G, Leatherdale ST. The role of peer victimization in the physical activity and screen time of adolescents: a cross-sectional study. *BMC Pediatr.* 2017;17(1):1–11. <https://doi.org/10.1186/s12887-017-0913-x>.
51. Vander Wal JS. The relationship between body mass index and unhealthy weight control behaviors among adolescents: the role of family and peer social support. *Econ Hum Biol.* 2012;10(4):395–404. <https://doi.org/10.1016/j.ehb.2012.04.011>.
52. Maiano C, Lepage G, Aime A, Morin AJS, Team A. Perceived weight-related victimization and physical activity outcomes among adolescents with overweight and obesity: indirect role of perceived physical abilities and fear of enacted stigma. *Psychol Sport Exerc.* 2018;34:70–78. <https://doi.org/10.1016/j.psychsport.2017.08.007>.
53. Delfa-De-La-Morena JM, Bores-García D, Solera-Alfonso A, Romero-Parra N. Barriers to physical activity in Spanish children and adolescents: sex and educational stage differences. *Front Psychol.* 2022;13:910930. <https://doi.org/10.3389/fpsyg.2022.910930>.
54. Puhl RM, Luedicke J, Heuer C. Weight-based victimization toward overweight adolescents: observations and reactions of peers. *J Sch Health.* 2011;81(11):696–703. <https://doi.org/10.1111/j.1746-1561.2011.00646.x>.
55. Goldweber A, Waasdorp TE, Bradshaw CP. Examining associations between race, urbanicity, and patterns of bullying involvement. *J Youth Adolesc.* 2013;42:206–219. <https://link.springer.com/article/10.1007/s10964-012-9843-y>.
56. Simovska V, Dadaczynski K, Woyrnarowska B. Healthy eating and physical activity in schools in Europe. *Educ Health.* 2012;112(6):513–524. <https://doi.org/10.1108/09654281211275863>.
57. Oreskovic NM, Goodman E, Park ER, Robinson AI, Winickoff JP. Design and implementation of a physical activity intervention to enhance children's use of the built environment (the cube study). *Contemp Clin Trials.* 2015;40:172–179. <https://doi.org/10.1016/j.cct.2014.12.009>.
58. Oreskovic NM, Perrin JM, Robinson AI, et al. Adolescents' use of the built environment for physical activity. *BMC Public Health.* 2015;15(1):1–9. <https://doi.org/10.1186/s12889-015-1596-6>.
59. DeWeese RS, Ohri-Vachaspati P, Adams MA, et al. Patterns of food and physical activity environments related to children's food and activity behaviors: a latent class analysis. *Health Place.* 2018;49:19–29. <https://doi.org/10.1016/j.healthplace.2017.11.002>.
60. Hamano T, Li X, Sundquist J, Sundquist K. Association between childhood obesity and neighbourhood accessibility to fast-food outlets: a nationwide 6-year follow-up study of 944,487 children. *Obes Facts.* 2017;10(6):559–568. <https://doi.org/10.1159/000481352>.
61. D'Haese S, Timperio A, Veitch J, Cardon G, Van Dyck D, Salmon J. Neighborhood perceptions moderate the association between the family environment and children's objectively assessed physical activity. *Health Place.* 2013;24:203–209. <https://doi.org/10.1016/j.healthplace.2013.09.012>.
62. Curtis P. The experiences of young people with obesity in secondary school: some implications for the healthy school agenda. *Health Soc Care Community.* 2008;16(4):410–418. <https://doi.org/10.1111/j.1365-2524.2008.00759.x>.
63. Neumark-Sztainer D, Story M, Faibisch L, Ohlson J, Adamiak M. Issues of self-image among overweight African-American and Caucasian adolescent girls: a qualitative study. *J Nutr Educ.* 1999;31(6):311–320. [https://doi.org/10.1016/S0022-3182\(99\)70484-X](https://doi.org/10.1016/S0022-3182(99)70484-X).
64. Pate RR, Trilk JL, Byun W, Wang J. Policies to increase physical activity in children and youth. *J Exerc Sci Fit.* 2011;9(1):1–14. [https://doi.org/10.1016/S1728-869X\(11\)60001-4](https://doi.org/10.1016/S1728-869X(11)60001-4).
65. Scotto di Luzio S, Martinet G, Popa-Roch M, et al. Obesity in childhood and adolescence: the role of motivation for physical activity, self-esteem, implicit and explicit attitudes toward obesity and physical activity. *Children.* 2023;10(7):1177. <https://www.mdpi.com/2227-9067/10/7/1177>.
66. Kepper MM, Walsh-Bailey C, Brownson RC, et al. Development of a health information technology tool for behavior change to address obesity and prevent chronic disease among adolescents: designing for dissemination and sustainment using the orbit model. *Front Digit Health.* 2021;3:64877. <https://doi.org/10.3389/fdgh.2021.648777>.
67. de la Haye K, Robins G, Mohr P, Wilson C. Obesity-related behaviors in adolescent friendship networks. *Soc Network.* 2010;32(3):161–167. <https://doi.org/10.1016/j.socnet.2009.09.001>.
68. Valente TW. Network interventions. *Science.* 2012;337(6090):49–53. <https://doi.org/10.1126/science.1217330>.
69. Zabinski MF, Saelens BE, Stein RI, Hayden-Wade HA, Wilfley DE. Overweight children's barriers to and support for physical activity. *Obes Res.* 2003;11(2):238–246. <https://doi.org/10.1038/oby.2003.37>.
70. Storch EA, Milsom VA, DeBraganza N, Lewin AB, Geffken GR, Silverstein JH. Peer victimization, psychosocial adjustment, and physical activity in overweight and at-risk-for-overweight youth. *J Pediatr Psychol.* 2006;32(1):80–89. <https://doi.org/10.1093/jpepsy/jsj113>.
71. Salvy S-J, Roemmich JN, Bowker JC, Romero ND, Stadler PJ, Epstein LH. Effect of peers and friends on youth physical activity and motivation to be physically active. *J Pediatr Psychol.* 2009;34(2):217–225. <https://doi.org/10.1093/jpepsy/jsn071>.
72. Power TG, Ullrich-French SC, Steele MM, Daratha KB, Bindler RC. Obesity, cardiovascular fitness, and physically active adolescents' motivations for activity: a

- self-determination theory approach. *Psychol Sport Exerc.* 2011;12(6):593–598. <https://doi.org/10.1016/j.psychsport.2011.07.002>.
73. Lawman HG, Wilson DK. Associations of social and environmental supports with sedentary behavior, light and moderate-to-vigorous physical activity in obese underserved adolescents. *Int J Behav Nutr Phys Activ.* 2014;11:92. <https://doi.org/10.1186/s12966-014-0092-1>.
74. Pulido R, Banks C, Ragan K, Pang D, Blake JJ, McKyer EL. The impact of school bullying on physical activity in overweight youth: exploring race and ethnic differences. *J Sch Health.* 2019;89(4):319–327. <https://doi.org/10.1111/josh.12740>.
75. Morano M, Robazza C, Rutigliano I, Bortoli L, Ruiz MC, Campanozzi A. Changes in physical activity, motor performance, and psychosocial determinants of active behavior in children: a pilot school-based obesity program. *Sustainability.* 2020; 12(3):1128. <https://doi.org/10.3390/su12031128>.
76. Olaya-Contreras P, Ocampo D-C, Ladekjar Larsen E. Perceptions and practices of physical activity among colombian overweight/obese schoolchildren. *Glob Qual Nurs Res.* 2016;3:92. <https://doi.org/10.1177/2333393616681392>.
77. Sundar TKB, Londal K, Lagerlov P, Glavin K, Helseth S. Overweight adolescents' views on physical activity - experiences of participants in an internet-based intervention: a qualitative study. *BMC Public Health.* 2018;18:448. <https://doi.org/10.1186/s12889-018-5546-y>.