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# LIFESTYLE INTERVENTIONS FOR CHILDHOOD OVERWEIGHT AND OBESITY: NARRATIVE REVIEW OF RANDOMIZED CONTROLLED TRIALS

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**ABSTRACT**

Childhood overweight and obesity remain major global public health challenges associated with increased cardiometabolic risk, psychosocial complications, and persistence into adulthood. Lifestyle interventions are considered the first-line strategy for obesity prevention and treatment in pediatric populations. The aim of this systematic review was to evaluate the effectiveness of lifestyle interventions in preventing and treating overweight and obesity among children and adolescents aged 0–18 years. A systematic literature review of randomized controlled trials published between January 2016 and March 2026 was conducted using PubMed and Google Scholar databases. Studies involving dietary, physical activity, behavioral, family-based, school-based, or technology-assisted interventions were included. Following screening and eligibility assessment, 39 randomized controlled trials were included in the narrative synthesis. Most interventions combined nutritional education, physical activity, behavioral strategies, and family or school involvement. Family-based and intensive multicomponent interventions demonstrated the most consistent improvements in body mass index (BMI) and health-related behaviors. School-based interventions generally improved lifestyle behaviors; however, their effects on anthropometric outcomes were less consistent. Technology-assisted interventions, including exergaming and wearable devices, produced mixed results. Several studies also reported improvements in metabolic parameters, physical activity, and quality of life despite modest BMI reductions. Overall, lifestyle interventions may support the prevention and treatment of childhood obesity, although their effects on BMI are generally moderate. The most effective interventions appear to be intensive, family-centered, and multicomponent. Future research should focus on long-term follow-up, implementation feasibility, and sustainable intervention strategies.

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**KEYWORDS**

Childhood Obesity, Overweight, Adolescents, Lifestyle Intervention, BMI, Systematic Review

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## 1. Introduction

The prevalence of overweight and obesity among children and adolescents has increased substantially during recent decades, becoming one of the most significant global public health concerns. Childhood obesity is associated with increased risk of cardiovascular disease, insulin resistance, hypertension, dyslipidemia, and psychosocial complications, while excess body weight frequently persists into adulthood (National Institute for Health and Care Excellence [NICE], 2025). These consequences highlight the urgent need for effective prevention and treatment strategies targeting pediatric populations.

Lifestyle interventions remain the cornerstone of obesity prevention and management among children and adolescents. Current evidence indicates that interventions focused on dietary modification, increased physical activity, and behavioral change may improve body weight outcomes, particularly when delivered intensively and over prolonged periods (O'Connor et al., 2017). Moreover, multicomponent interventions combining dietary, behavioral, and physical activity strategies appear more effective than isolated interventions targeting a single lifestyle factor (Brown et al., 2019).

Despite growing research interest, evidence regarding the effectiveness of lifestyle interventions remains inconsistent. Considerable variability exists in intervention design, duration, participant age, outcome measures, and implementation settings, making comparisons between studies difficult (Smith et al., 2020). Furthermore, improvements in dietary habits and physical activity do not always translate into statistically significant reductions in body mass index (BMI), particularly in prevention-oriented school-based programs.

Family involvement has emerged as an important determinant of intervention success. Parents significantly influence children's dietary behaviors, physical activity patterns, and home food environments. Consequently, family-centered behavioral approaches may provide more sustainable lifestyle modifications than interventions directed exclusively toward children.

In addition, technological innovations such as wearable activity trackers, exergaming, and mobile health applications have increasingly been incorporated into obesity interventions. However, their long-term effectiveness and sustainability remain uncertain.

The objective of this systematic review was to evaluate the effectiveness of lifestyle interventions in the prevention and treatment of overweight and obesity among children and adolescents aged 0–18 years.

## **2. Methodology**

### **2.1. Study Design**

This study was conducted as a systematic review of randomized controlled trials evaluating lifestyle interventions targeting childhood overweight and obesity.

### **2.2. Eligibility Criteria**

The review included randomized controlled trials involving children and adolescents aged 0–18 years diagnosed with overweight or obesity or studies focused on obesity prevention in pediatric populations.

The inclusion criteria were:

- randomized controlled trials published between 2016 and 2026;
- participants aged 0–18 years;
- lifestyle-based interventions targeting diet, physical activity, or behavior;
- quantitative anthropometric outcomes including BMI or BMI z-score.

The exclusion criteria were:

- observational or non-randomized studies;
- pharmacological or surgical interventions;
- adult populations;
- lack of obesity-related outcomes.

### **2.3. Search Strategy**

A systematic literature search was conducted using PubMed and Google Scholar databases. The search included studies published between January 2016 and March 2026. The search strategy combined controlled vocabulary and free-text terms associated with pediatric obesity and lifestyle interventions.

The following keywords were used: “obesity,” “overweight,” “children,” “adolescents,” “lifestyle intervention,” “dietary intervention,” “physical activity,” “behavior change,” and “randomized controlled trial.” Boolean operators AND and OR were applied to optimize search sensitivity and specificity.

Manual searches of reference lists and evidence reviews were additionally performed to improve comprehensiveness. Earlier landmark studies published before 2016 were additionally included to provide historical and theoretical context relevant to childhood obesity interventions. However, only randomized controlled trials published between 2016 and 2026 were included in the primary systematic synthesis.

### **2.4. Study Selection**

A total of 412 records were initially identified through database searches. After removing duplicates and screening titles and abstracts, 79 studies were selected for full-text review. Of these, 68 full-text articles were assessed for eligibility. Finally, 39 studies met the inclusion criteria and were included in the narrative synthesis.

### **2.5. Data Extraction and Synthesis**

Data extraction was conducted using a standardized framework to ensure consistency between studies. Extracted variables included study design, participant characteristics, intervention components, intervention duration, follow-up period, and reported outcomes.

The synthesis focused on identifying patterns of effectiveness across intervention categories, including:

- family-based behavioral interventions;
- school-based prevention programs;
- dietary interventions;
- technology-assisted interventions.

Due to substantial heterogeneity among interventions, participant characteristics, intervention duration, and outcome measures, a narrative synthesis approach was applied instead of quantitative meta-analysis.

### 3. Results

#### 3.1. Family-Based Interventions

Family-based interventions demonstrated the most consistent evidence of effectiveness among the included randomized controlled trials. Epstein et al. (2023) reported that family-based behavioral treatment implemented within pediatric primary care improved child weight outcomes over a 24-month period compared with usual care. Improvements were also observed among parents and siblings, suggesting broader household-level behavioral changes.

Similarly, culturally adapted family-centered programs such as “Abriendo Caminos” demonstrated positive effects on BMI outcomes and family lifestyle behaviors (Teran-Garcia et al., 2023). However, not all family-oriented interventions produced statistically significant anthropometric improvements. Robertson et al. (2017) reported no significant BMI z-score reduction after participation in the Families for Health program, while Moore et al. (2019) demonstrated limited effectiveness among low-income urban adolescents.

Overall, the findings suggest that active parental involvement may enhance intervention adherence and sustainability.

#### 3.2. Dietary Interventions

Diet-focused interventions produced mixed findings across the included randomized controlled trials, indicating that nutritional modification alone may not be sufficient to achieve substantial and sustained reductions in obesity-related outcomes among children and adolescents. Although many interventions improved dietary quality, eating behaviors, and nutritional status, the effects on anthropometric measures such as body mass index (BMI) and BMI z-score were frequently moderate or inconsistent. These findings suggest that the long-term sustainability of healthy eating behaviors may be more important than the specific dietary structure applied during the intervention period.

Evidence from the included studies demonstrated that different dietary strategies may produce comparable outcomes when adherence levels are similar. In a randomized controlled trial involving adolescents with obesity, intermittent energy restriction was not found to be superior to continuous energy restriction after 52 weeks of follow-up (Lister et al., 2024). The study demonstrated that both approaches resulted in similar changes in weight-related outcomes and metabolic indicators, suggesting that adherence and long-term behavioral maintenance may play a more significant role than the specific caloric restriction model itself. These findings may indicate that individualized and flexible dietary approaches could improve compliance among adolescents, particularly in long-term obesity management programs.

Positive effects of nutritional interventions on diet quality and nutritional adequacy were also observed in several studies included in the review. The ALINFA intervention demonstrated improvements in overall diet quality and nutritional status among children aged 6–12 years, indicating that structured nutritional education may support healthier food choices and better dietary habits during childhood (Andueza et al., 2023). Similarly, improvements in nutrient adequacy and dietary intake patterns were observed among children with abdominal obesity participating in lifestyle interventions, suggesting that comprehensive nutritional counseling may positively influence metabolic health and reduce obesity-related risk factors (Ojeda-Rodríguez et al., 2018). These findings are clinically relevant because childhood abdominal obesity is strongly associated with increased cardiometabolic risk later in life.

However, not all dietary-focused strategies demonstrated clear additional benefits. Limited evidence was found regarding the effectiveness of portion-control tools when implemented alongside standard nutritional counseling (Ho et al., 2016). The findings suggest that mechanical or educational tools alone may not substantially improve obesity-related outcomes without simultaneous behavioral and environmental support. Children and adolescents often require continuous parental involvement, motivational reinforcement, and structured behavioral guidance to maintain long-term dietary changes. Consequently, isolated dietary tools may be insufficient when used without broader multicomponent intervention strategies.

The reviewed evidence additionally suggests that restrictive or highly structured dietary models may be difficult to maintain over extended periods, particularly among adolescents. Developmental, social, and psychological factors may influence adherence to dietary recommendations, including peer influence, emotional eating behaviors, family food environments, and lifestyle habits. Therefore, interventions emphasizing sustainable healthy eating patterns rather than short-term restrictive dieting may be more appropriate for pediatric obesity prevention and management.

Overall, dietary interventions appear capable of improving eating behaviors, nutritional quality, and selected metabolic outcomes; however, their isolated effects on BMI reduction remain inconsistent. The findings of this review indicate that nutritional strategies may be most effective when integrated into comprehensive multicomponent interventions combining dietary counseling, physical activity promotion, behavioral therapy, and active family involvement. Such integrated approaches may provide greater support for sustainable behavioral modification and long-term obesity management in children and adolescents.

### **3.3. Physical Activity and Technology-Assisted Interventions**

Technology-supported interventions demonstrated variable effectiveness across pediatric obesity prevention and treatment programs. Home-based exergaming interventions were associated with significant reductions in BMI z-scores and improvements in cardiometabolic outcomes among children with overweight and obesity (Staiano et al., 2018).

In contrast, the incorporation of wearable activity trackers into adolescent weight-management programs did not lead to significantly greater weight loss compared with standard clinical care alone (Bowen-Jallow et al., 2021). High attrition rates suggested limited long-term adherence and declining user engagement over time.

Similarly, school-based serious games improved obesity-related knowledge and participant engagement; however, their effects on anthropometric outcomes remained inconsistent (Mack et al., 2020).

Overall, technology-based interventions appeared most effective when integrated into comprehensive behavioral programs including supervision, goal-setting, and ongoing support.

### **3.4. School-Based Prevention Programs**

School-based prevention interventions produced mixed effects on BMI-related outcomes among children and adolescents. The WAVES study did not demonstrate statistically significant reductions in BMI z-scores despite implementing a comprehensive school-based obesity prevention strategy (Adab et al., 2018). Similarly, the Healthy Lifestyles Programme (HeLP) trial failed to demonstrate significant BMI improvements (Lloyd et al., 2018).

Nevertheless, several school-based interventions reported more favorable results. The APPLE project demonstrated significantly lower BMI z-scores among participants after a two-year follow-up period (Taylor et al., 2007). Likewise, Liu et al. (2022) reported greater reductions in obesity prevalence in intervention schools compared with control schools.

Although BMI outcomes remained inconsistent, many school-based interventions improved dietary behaviors, physical activity levels, and health-related quality of life.

### **3.5. Metabolic and Behavioral Outcomes**

Several interventions included in this systematic review demonstrated improvements in metabolic and behavioral outcomes despite relatively modest changes in anthropometric measures such as body mass index (BMI). These findings suggest that the effectiveness of lifestyle interventions should not be evaluated solely on the basis of weight reduction, as clinically meaningful benefits may occur even when decreases in BMI are relatively small. Improvements in metabolic health, physical fitness, behavioral patterns, and psychosocial functioning may represent important indicators of intervention success in pediatric obesity management.

Evidence from intensive lifestyle intervention programs demonstrated favorable effects on cardiometabolic health markers and physical functioning. Improvements in plasma MR-proANP concentrations, enhanced physical fitness, and reductions in BMI were observed among children and adolescents participating in comprehensive lifestyle interventions, indicating that behavioral modification may positively influence both metabolic health and cardiovascular risk factors (Thomsen et al., 2021). These findings are particularly important because obesity during childhood is associated with an increased risk of developing cardiovascular disease, insulin resistance, hypertension, and metabolic syndrome later in life. Consequently, even moderate physiological improvements achieved during childhood may contribute to long-term health benefits and reduced future disease burden.

Positive behavioral and psychosocial outcomes were also reported in lifestyle intervention programs conducted among adolescents with obesity. Improvements in physical activity levels and health-related quality of life were observed among obese adolescents participating in intervention programs in India, although reductions in BMI remained limited (Srivastav et al., 2024). These findings suggest that lifestyle interventions may improve daily functioning, self-perception, emotional well-being, and participation in physical activity

even in the absence of substantial anthropometric changes. Such outcomes are clinically relevant because childhood obesity is frequently associated with reduced self-esteem, social stigmatization, anxiety, and impaired quality of life.

The reviewed evidence additionally indicates that behavioral improvements may precede measurable changes in body composition. Increased participation in physical activity, healthier dietary habits, reduced sedentary behaviors, and improved treatment adherence may require prolonged periods before significant BMI reductions become evident. Therefore, short-term intervention studies may underestimate the broader health benefits associated with behavioral modification programs. In pediatric populations, where growth and developmental changes naturally influence body composition, maintaining stable BMI trajectories or slowing excessive weight gain may itself represent a clinically meaningful outcome.

Another important observation concerns the multidimensional nature of obesity treatment outcomes. Several studies demonstrated that lifestyle interventions may positively influence metabolic parameters, cardiovascular fitness, psychosocial well-being, and lifestyle behaviors simultaneously. These findings support the growing recognition that obesity management should extend beyond weight reduction alone and include broader health-related indicators. Improvements in physical fitness and metabolic functioning may reduce future cardiometabolic risk even when anthropometric improvements remain moderate.

Collectively, the findings of this review suggest that lifestyle interventions may generate meaningful behavioral, metabolic, and psychosocial benefits even when anthropometric improvements are relatively small. Consequently, future pediatric obesity research should incorporate multidimensional outcome measures, including metabolic markers, physical fitness, dietary behaviors, mental health indicators, and quality of life assessments, rather than relying exclusively on BMI reduction as the primary measure of intervention effectiveness.

## 4. Discussion

The findings of this systematic review reinforce existing evidence indicating that lifestyle interventions remain fundamental in childhood obesity prevention and treatment; however, their overall effectiveness is generally moderate and highly dependent on intervention structure, duration, intensity, and participant engagement. Although numerous interventions demonstrated improvements in body mass index (BMI), dietary habits, physical activity levels, and metabolic health indicators, the magnitude of anthropometric change was often relatively modest. These findings emphasize the multifactorial nature of childhood obesity and suggest that sustainable treatment outcomes require comprehensive and long-term approaches rather than isolated or short-duration interventions.

One of the clearest findings across the included studies is the importance of family involvement. Family-centered interventions consistently demonstrated more favorable outcomes than interventions targeting children alone (Epstein et al., 2023; Robertson et al., 2017; Moore et al., 2019). Parents strongly influence dietary patterns, food availability, meal structure, sedentary behaviors, and opportunities for physical activity within the home environment. Consequently, interventions targeting the entire household may promote more sustainable behavioral change by modifying the daily routines and environmental factors contributing to obesity development. In addition, parental participation may improve treatment adherence, reinforce healthy behaviors outside clinical settings, and provide emotional and motivational support for children and adolescents participating in intervention programs.

The review also demonstrated that multicomponent interventions combining dietary modification, physical activity promotion, and behavioral support appear more effective than isolated interventions. Interventions integrating nutritional education with structured exercise programs and behavioral counseling generally produced more consistent improvements in BMI and lifestyle behaviors than single-component approaches. Behavioral strategies such as goal-setting, self-monitoring, motivational interviewing, and reinforcement techniques were commonly associated with greater intervention success. These findings are consistent with broader evidence reviews and current clinical recommendations emphasizing that obesity prevention and treatment require coordinated behavioral and environmental changes rather than simple educational interventions alone.

Technology-assisted interventions produced inconsistent findings. While exergaming demonstrated promising effects on BMI, physical activity participation, and cardiometabolic health outcomes (Staiano et al., 2018), wearable activity trackers alone did not substantially improve outcomes (Bowen-Jallow et al., 2021). This suggests that technology should function primarily as a supportive tool integrated within broader

behavioral programs rather than as an independent intervention. Interactive technologies may increase motivation and engagement among children and adolescents by making physical activity more enjoyable and accessible; however, passive monitoring devices appear insufficient when not accompanied by counseling, supervision, or structured behavioral support. Furthermore, high attrition rates observed in several studies indicate that maintaining long-term engagement with technology-assisted interventions remains a significant challenge.

School-based interventions improved lifestyle behaviors, nutritional knowledge, and physical activity participation but generally produced inconsistent BMI outcomes. Schools represent an important setting for obesity prevention because they provide access to large pediatric populations during critical developmental periods. Nevertheless, the inconsistent anthropometric findings observed across school-based programs may reflect the influence of broader environmental and socioeconomic determinants extending beyond the school setting. Family dietary habits, socioeconomic inequalities, neighborhood safety, food accessibility, and sedentary home environments may substantially influence intervention effectiveness. Therefore, school-based programs should ideally be combined with family involvement and community-level support to maximize their long-term impact on obesity prevention.

Another important observation concerns intervention sustainability. Many randomized controlled trials demonstrated short-term improvements; however, long-term follow-up data remain limited. Weight regain after intervention cessation remains a major challenge in pediatric obesity management, suggesting that temporary interventions may not be sufficient to maintain behavioral changes over time. Sustainable obesity prevention likely requires ongoing reinforcement, continued access to supportive environments, and integration of healthy lifestyle strategies into routine healthcare systems and everyday family life. Future interventions should therefore prioritize long-term maintenance strategies, implementation feasibility, accessibility, and cost-effectiveness, particularly among socioeconomically disadvantaged populations that may experience greater barriers to healthy lifestyle behaviors.

Importantly, several studies included in this review demonstrated clinically meaningful improvements in metabolic health, physical fitness, and quality of life despite relatively modest reductions in BMI. These findings indicate that intervention effectiveness should not be evaluated solely through anthropometric outcomes. Improvements in physical activity, dietary quality, psychosocial well-being, and cardiometabolic risk factors may represent equally important indicators of intervention success and long-term health benefits. Consequently, future obesity research should incorporate broader multidimensional outcome measures beyond BMI reduction alone.

Overall, childhood obesity should be addressed using a multilevel approach incorporating individual, family, school, healthcare, community, and policy-level strategies. Effective prevention and treatment likely require collaboration between healthcare professionals, educators, policymakers, and families to create supportive environments promoting healthy behaviors from early childhood onward. Addressing structural determinants such as food environments, opportunities for physical activity, and socioeconomic inequalities may be essential for achieving sustainable population-level improvements in childhood obesity outcomes.

## 5. Conclusions

Lifestyle interventions remain an essential strategy for preventing and treating overweight and obesity among children and adolescents. However, the findings of the present review indicate that their effectiveness is generally moderate and strongly dependent on intervention intensity, duration, comprehensiveness, and the degree of participant and family engagement. Although many interventions demonstrated positive trends in body mass index (BMI), physical activity, dietary behaviors, and metabolic health, the magnitude of anthropometric improvement often remained limited. This suggests that childhood obesity is a complex multifactorial condition influenced by biological, behavioral, environmental, social, and socioeconomic determinants that cannot be fully addressed through short-term or isolated interventions alone.

The strongest evidence identified in this review supports intensive multicomponent interventions combining dietary modification, physical activity promotion, behavioral therapy, and active family involvement. Interventions integrating several lifestyle components simultaneously appeared more effective than single-component programs focusing only on diet or exercise. These findings are consistent with current recommendations emphasizing that sustainable obesity management requires coordinated behavioral and environmental changes rather than isolated educational strategies. Behavioral support techniques, including

goal-setting, self-monitoring, parental reinforcement, and motivational counseling, were frequently associated with improved adherence and more favorable long-term outcomes.

Family-based interventions appeared particularly effective because they target the home environment and may positively influence parents and siblings in addition to the participating child. Parents play a central role in shaping children's eating habits, physical activity routines, sleep patterns, and screen-time behaviors. Consequently, interventions involving the entire family may facilitate more sustainable behavioral modification and improve adherence to lifestyle recommendations outside structured clinical or school environments. Several studies additionally suggested that positive lifestyle changes among parents may reinforce healthy behaviors among children through role modeling and improved household food environments.

School-based interventions remain valuable for improving health behaviors across large populations because schools provide continuous access to children and adolescents during critical developmental periods. Many school-based programs improved dietary habits, health knowledge, and physical activity participation. However, their impact on BMI outcomes was less consistent across studies. This inconsistency may reflect the influence of broader environmental and socioeconomic factors outside the school setting, including family behaviors, food accessibility, neighborhood safety, and sedentary lifestyles. Therefore, school-based interventions may be most effective when combined with family and community support systems.

Technology-assisted interventions, including exergaming, wearable activity trackers, and mobile health applications, demonstrated mixed effectiveness. Interactive technologies may increase engagement and motivation, particularly among younger populations, by making physical activity more enjoyable and accessible. Some interventions reported improvements in physical activity levels and cardiometabolic outcomes through exergaming approaches. Nevertheless, technology-based interventions alone did not consistently produce significant reductions in BMI, especially when not integrated with behavioral counseling or structured supervision. High attrition rates observed in some studies additionally suggest that maintaining long-term adherence to technology-assisted interventions remains challenging.

An important observation emerging from the reviewed studies is that intervention success should not be evaluated solely on the basis of BMI reduction. Several interventions demonstrated meaningful improvements in metabolic health, physical fitness, quality of life, dietary behaviors, and psychosocial functioning despite relatively modest anthropometric changes. These findings indicate that lifestyle interventions may provide clinically relevant health benefits even when weight reduction is limited. Consequently, future obesity research should incorporate broader outcome measures beyond BMI alone to better assess intervention effectiveness.

Another significant challenge identified in the literature concerns the long-term sustainability of intervention effects. Although short-term improvements were commonly reported, long-term follow-up data remain limited. Weight regain following intervention completion continues to represent a major problem in pediatric obesity management. Future randomized controlled trials should therefore prioritize long-term follow-up, implementation feasibility, cost-effectiveness, and intervention accessibility, particularly among socioeconomically disadvantaged populations who may face additional barriers to healthy lifestyle behaviors.

Overall, childhood obesity should be approached through integrated, multilevel strategies combining behavioral, family, educational, healthcare, community, and policy-based interventions. Effective prevention and treatment likely require sustained collaboration between healthcare professionals, schools, families, and public health systems. Addressing environmental determinants of obesity, including food environments, opportunities for physical activity, and health inequalities, may be essential for achieving long-term and population-level improvements in childhood obesity outcomes.

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## REFERENCES

1. Adab, P., Pallan, M. J., Lancashire, E. R., Hemming, K., Frew, E., Barrett, T., Bhopal, R., Cade, J. E., Canaway, A., Clarke, J. L., Daley, A., Deeks, J. J., Duda, J. L., Ekelund, U., Gill, P., Griffin, T., McGee, E., Hurley, K., Martin, J., ... Cheng, K. K. (2018). Effectiveness of a childhood obesity prevention programme delivered through schools, targeting 6 and 7 year olds: Cluster randomised controlled trial (WAVES study). *BMJ*, 360, k211. <https://doi.org/10.1136/bmj.k211>
2. Ahmad, N., Shariff, Z. M., Mukhtar, F., & Lye, M.-S. (2020). Effect of Family-Based REDUCE intervention program on children eating behavior and dietary intake: Randomized controlled field trial. *Nutrients*, 12(10), 3065. <https://doi.org/10.3390/nu12103065>
3. Andueza, N., Martin-Calvo, N., Navas-Carretero, S., & Cuervo, M. (2023). The ALINFA intervention improves diet quality and nutritional status in children 6 to 12 years old. *Nutrients*, 15(10), 2375. <https://doi.org/10.3390/nu15102375>
4. Bowen-Jallow, K., Nunez-Lopez, O., Wright, A., Fuchs, E., Ahn, M., Lyons, E., Jupiter, D., Berry, L., Suman, O., Radhakrishnan, R. S., Glaser, A. M., & Thompson, D. I. (2021). Wearable activity tracking device use in an adolescent weight management clinic: A randomized controlled pilot trial. *Journal of Obesity*, 2021, 7625034. <https://doi.org/10.1155/2021/7625034>
5. Brown, A. W., Altman, D. G., Baranowski, T., Bland, J. M., Dawson, J. A., Dhurandhar, N. V., Dowla, S., Fontaine, K. R., Gelman, A., Heymsfield, S. B., Jayawardene, W., Keith, S. W., Kyle, T. K., Loken, E., Oakes, J. M., Stevens, J., Thomas, D. M., & Allison, D. B. (2019). Childhood obesity intervention studies: A narrative review and guide for investigators, authors, editors, reviewers, journalists, and readers to guard against exaggerated effectiveness claims. *Obesity Reviews : An Official Journal of the International Association for the Study of Obesity*, 20(11), 1523–1541. <https://doi.org/10.1111/obr.12923>
6. Cohen, T. R., Hazell, T. J., Vanstone, C. A., Rodd, C., & Weiler, H. A. (2016). A family-centered lifestyle intervention for obese six- to eight-year-old children: Results from a one-year randomized controlled trial conducted in Montreal, Canada. *Canadian Journal of Public Health = Revue Canadienne De Sante Publique*, 107(4–5), e453–e460. <https://doi.org/10.17269/cjph.107.5470>
7. Denova-Gutiérrez, E., González-Rocha, A., Méndez-Sánchez, L., Araiza-Nava, B., Balderas, N., López, G., Tolentino-Mayo, L., Jauregui, A., Hernández, L., Unikel, C., Bonvecchio, A., Shamah, T., Barquera, S., & Rivera, J. A. (2023). Overview of systematic reviews of Health interventions for the prevention and treatment of overweight and obesity in children. *Nutrients*, 15(3), 773. <https://doi.org/10.3390/nu15030773>
8. Epstein, L. H., Wilfley, D. E., Kilanowski, C., Quattrin, T., Cook, S. R., Eneli, I. U., Geller, N., Lew, D., Wallendorf, M., Dore, P., Paluch, R. A., & Schechtman, K. B. (2023). Family-Based behavioral treatment for childhood obesity implemented in pediatric primary care: A randomized clinical trial. *JAMA*, 329(22), 1947–1956. <https://doi.org/10.1001/jama.2023.8061>
9. Evidence review for effectiveness and acceptability of weight management interventions in children and young people living with overweight and obesity: Overweight and obesity management: preventing, assessing and managing overweight and obesity: Evidence review G. (2025). National Institute for Health and Care Excellence (NICE). <http://www.ncbi.nlm.nih.gov/books/NBK612636/>
10. Fairclough, S. J., Hackett, A. F., Davies, I. G., Gobbi, R., Mackintosh, K. A., Warburton, G. L., Stratton, G., van Sluijs, E. M. F., & Boddy, L. M. (2013). Promoting healthy weight in primary school children through physical activity and nutrition education: A pragmatic evaluation of the CHANGE! randomised intervention study. *BMC Public Health*, 13, 626. <https://doi.org/10.1186/1471-2458-13-626>
11. Golan, M., Kaufman, V., & Shahar, D. R. (2006). Childhood obesity treatment: Targeting parents exclusively v. parents and children. *British Journal of Nutrition*, 95(5), 1008–1015. <https://doi.org/10.1079/BJN20061757>
12. Ho, J., Pedersen, S. D., Virtanen, H., Nettel-Aguirre, A., & Huang, C. (2016). Family intervention for Obese/Overweight children using portion control strategy (FOCUS) for weight control: A randomized controlled trial. *Global Pediatric Health*, 3, 2333794X16669014. <https://doi.org/10.1177/2333794X16669014>
13. Hofer, M., Ranstam, J., & Atroshi, I. (2021). Extended follow-up of local steroid injection for carpal tunnel syndrome: A randomized clinical trial. *JAMA Network Open*, 4(10), e2130753. <https://doi.org/10.1001/jamanetworkopen.2021.30753>

14. Ickovics, J. R., Duffany, K. O., Shebl, F. M., Peters, S. M., Read, M. A., Gilstad-Hayden, K. R., & Schwartz, M. B. (2019). Implementing School-Based policies to prevent obesity: Cluster randomized trial. *American Journal of Preventive Medicine*, 56(1), e1–e11. <https://doi.org/10.1016/j.amepre.2018.08.026>
15. Jelalian, E., Evans, E. W., Rancourt, D., Ranzenhofer, L., Taylor, N., Hart, C., Seifer, R., Klinepier, K., & Foster, G. D. (2020). JOIN for ME: Testing a scalable weight control intervention for adolescents. *Childhood Obesity*, 16(3), 192–203. <https://doi.org/10.1089/chi.2019.0053>
16. Kalarchian, M. A., Levine, M. D., Arslanian, S. A., Ewing, L. J., Houck, P. R., Cheng, Y., Ringham, R. M., Sheets, C. A., & Marcus, M. D. (2009). Family-based treatment of severe pediatric obesity: Randomized, controlled trial. *Pediatrics*, 124(4), 1060–1068. <https://doi.org/10.1542/peds.2008-3727>
17. Kawabata, M., Chua, K. L., & Chatzisarantis, N. L. D. (2018). A school-based intervention program in promoting leisure-time physical activity: Trial protocol. *BMC Public Health*, 18(1), 433. <https://doi.org/10.1186/s12889-018-5320-1>
18. Lister, N. B., Baur, L. A., House, E. T., Alexander, S., Brown, J., Collins, C. E., Cowell, C. T., Day, K., Garnett, S. P., Gow, M. L., Grunseit, A. M., Henderson, M., Inkster, M.-K., Kwok, C., Lang, S., Paxton, S. J., Truby, H., Varady, K. A., & Jebeile, H. (2024). Intermittent energy restriction for adolescents with obesity: The Fast Track to Health randomized clinical trial. *JAMA Pediatrics*, 178(10), 1006–1016. <https://doi.org/10.1001/jamapediatrics.2024.2869>
19. Lloyd, J., Creanor, S., Logan, S., Green, C., Dean, S. G., Hillsdon, M., Abraham, C., Tomlinson, R., Pearson, V., Taylor, R. S., Ryan, E., Price, L., Streeter, A., & Wyatt, K. (2018). Effectiveness of the Healthy Lifestyles Programme (HeLP) to prevent obesity in UK primary-school children: A cluster randomised controlled trial. *The Lancet. Child & Adolescent Health*, 2(1), 35–45. [https://doi.org/10.1016/S2352-4642\(17\)30151-7](https://doi.org/10.1016/S2352-4642(17)30151-7)
20. Lloyd, J., Dean, S., Creanor, S., Abraham, C., Hillsdon, M., Ryan, E., & Wyatt, K. M. (2017). Intervention fidelity in the definitive cluster randomised controlled trial of the Healthy Lifestyles Programme (HeLP) trial: Findings from the process evaluation. *The International Journal of Behavioral Nutrition and Physical Activity*, 14(1), 163. <https://doi.org/10.1186/s12966-017-0616-6>
21. Lloyd, J., McHugh, C., Minton, J., Eke, H., & Wyatt, K. (2017). The impact of active stakeholder involvement on recruitment, retention and engagement of schools, children and their families in the cluster randomised controlled trial of the Healthy Lifestyles Programme (HeLP): A school-based intervention to prevent obesity. *Trials*, 18(1), 378. <https://doi.org/10.1186/s13063-017-2122-1>
22. Mack, I., Reiband, N., Etges, C., Eichhorn, S., Schaeffeler, N., Zurstiege, G., Gawrilow, C., Weimer, K., Peeraully, R., Teufel, M., Blumenstock, G., Giel, K. E., Junne, F., & Zipfel, S. (2020). The kids obesity prevention program: Cluster randomized controlled trial to evaluate a serious game for the prevention and treatment of childhood obesity. *Journal of Medical Internet Research*, 22(4), e15725. <https://doi.org/10.2196/15725>
23. Marti, A., Martínez, I., Ojeda-Rodríguez, A., & Azcona-Sanjulian, M. C. (2021). Higher lipopolysaccharide binding protein and chemerin concentrations were associated with metabolic syndrome features in pediatric subjects with abdominal obesity during a lifestyle intervention. *Nutrients*, 13(2), 289. <https://doi.org/10.3390/nu13020289>
24. Moore, S. M., Borawski, E. A., Love, T. E., Jones, S., Casey, T., McAleer, S., Thomas, C., Adegbite-Adeniyi, C., Uli, N. K., Hardin, H. K., Trapl, E. S., Plow, M., Stevens, J., Truesdale, K. P., Pratt, C. A., Long, M., & Nevar, A. (2019). Two family interventions to reduce BMI in Low-Income urban youth: A randomized trial. *Pediatrics*, 143(6), e20182185. <https://doi.org/10.1542/peds.2018-2185>
25. O'Connor, E. A., Evans, C. V., Burda, B. U., Walsh, E. S., Eder, M., & Lozano, P. (2017). Screening for obesity and intervention for weight management in children and adolescents: Evidence report and systematic review for the US preventive services task force. *JAMA*, 317(23), 2427–2444. <https://doi.org/10.1001/jama.2017.0332>
26. Ojeda-Rodríguez, A., Zazpe, I., Morell-Azanza, L., Chueca, M. J., Azcona-Sanjulian, M. C., & Marti, A. (2018). Improved diet quality and nutrient adequacy in children and adolescents with abdominal obesity after a lifestyle intervention. *Nutrients*, 10(10), 1500. <https://doi.org/10.3390/nu10101500>
27. Robertson, W., Fleming, J., Kamal, A., Hamborg, T., Khan, K. A., Griffiths, F., Stewart-Brown, S., Stallard, N., Petrou, S., Simkiss, D., Harrison, E., Kim, S. W., & Thorogood, M. (2017). Randomised controlled trial and economic evaluation of the 'Families for Health' programme to reduce obesity in children. *Archives of Disease in Childhood*, 102(5), 416–426. <https://doi.org/10.1136/archdischild-2016-311514>

28. Sahota, P., Rudolf, M. C. J., Dixey, R., Hill, A. J., Barth, J. H., & Cade, J. (2001). Evaluation of implementation and effect of primary school based intervention to reduce risk factors for obesity. *BMJ : British Medical Journal*, 323(7320), 1027. <https://doi.org/10.1136/bmj.323.7320.1027>
29. Samuels, S. L., Hu, P., Maciejewski, K. R., Li, F., Dziura, J., Savoye, M., & Sharifi, M. (2023). Real-world effectiveness of the Bright Bodies healthy lifestyle intervention for childhood obesity. *Obesity*, 31(1), 203–213. <https://doi.org/10.1002/oby.23627>
30. Savoye, M., Shaw, M., Dziura, J., Tamborlane, W. V., Rose, P., Guandalini, C., Goldberg-Gell, R., Burgert, T. S., Cali, A. M. G., Weiss, R., & Caprio, S. (2007). Effects of a weight management program on body composition and metabolic parameters in overweight children: A randomized controlled trial. *JAMA*, 297(24), 2697–2704. <https://doi.org/10.1001/jama.297.24.2697>
31. Srivastav, P., K, V., Bhat, H. V., & Broadbent, S. (2024). Effect of a pragmatic lifestyle modification intervention on physical activity levels and body mass index among obese and overweight adolescents in Udupi, India: A cluster randomized trial. *F1000Research*, 13, 859. <https://doi.org/10.12688/f1000research.153483.1>
32. Staiano, A. E., Beyl, R. A., Guan, W., Hendrick, C. A., Hsia, D. S., & Newton, R. L. (2018). Home-based exergaming among children with overweight and obesity: A randomized clinical trial. *Pediatric Obesity*, 13(11), 724–733. <https://doi.org/10.1111/ijpo.12438>
33. Taylor, R. W., McAuley, K. A., Barbezat, W., Strong, A., Williams, S. M., & Mann, J. I. (2007). APPLE Project: 2-y findings of a community-based obesity prevention program in primary school age children. *The American Journal of Clinical Nutrition*, 86(3), 735–742. <https://doi.org/10.1093/ajcn/86.3.735>
34. Teran-Garcia, M., Hammons, A. J., Olvera, N., Greder, K., Plaza-Delrestre, M., Andrade, F. C. D., Fiese, B., & Wiley, A. R. (2023). Randomized control trial of a childhood obesity prevention family-based program: ‘Abriendo Caminos’ and effects on BMI. *Frontiers in Pediatrics*, 11, 1137825. <https://doi.org/10.3389/fped.2023.1137825>
35. Thomsen, C. F., Goharian, T. S., Larsen, K. T., Goetze, J. P., Andersen, L. B., & Jeppesen, J. L. (2021). Intensive lifestyle intervention increases plasma midregional proatrial natriuretic peptide concentrations in overweight children. *Journal of the American Heart Association*, 10(13), e020676. <https://doi.org/10.1161/JAHA.121.020676>
36. Tomayko, E. J., Prince, R. J., Cronin, K. A., Parker, T., Kim, K., Grant, V. M., Sheche, J. N., & Adams, A. K. (2017). Healthy Children, Strong Families 2: A randomized controlled trial of a healthy lifestyle intervention for American Indian families designed using community-based approaches. *Clinical Trials*, 14(2), 152–161. <https://doi.org/10.1177/1740774516685699>
37. Tronieri, J. S., Wadden, T. A., Leonard, S. M., & Berkowitz, R. I. (2019). A pilot study of acceptance-based behavioural weight loss for adolescents with obesity. *Behavioural and Cognitive Psychotherapy*, 47(6), 686–696. <https://doi.org/10.1017/S1352465819000262>
38. US Preventive Services Task Force, Grossman, D. C., Bibbins-Domingo, K., Curry, S. J., Barry, M. J., Davidson, K. W., Doubeni, C. A., Epling, J. W., Kemper, A. R., Krist, A. H., Kurth, A. E., Landefeld, C. S., Mangione, C. M., Phipps, M. G., Silverstein, M., Simon, M. A., & Tseng, C.-W. (2017). Screening for obesity in children and adolescents: US preventive services task force recommendation statement. *JAMA*, 317(23), 2417–2426. <https://doi.org/10.1001/jama.2017.6803>
39. Willeboordse, M., van de Kant, K. D. G., Tan, F. E. S., Mulkens, S., Schellings, J., Crijs, Y., Ploeg, L. van der, van Schayck, C. P., & Dompeling, E. (2016). A multifactorial weight reduction programme for children with overweight and asthma: A randomized controlled trial. *PloS One*, 11(6), e0157158. <https://doi.org/10.1371/journal.pone.0157158>