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Obes Rev. 2016 December ; 17(12): 1276–1286. doi:10.1111/obr.12468.**Child and youth participatory interventions for addressing lifestyle-related childhood obesity: a systematic review****Leah Frerichs, PhD¹, Onomeasike Ataga, MBBS, MPH¹, Giselle Corbie-Smith, MD, MSc¹, and Stacy Tessler Lindau, MD, MAPP²**¹Center for Health Equity Research, University of North Carolina, Chapel Hill, NC²Departments of Obstetrics and Gynecology and Medicine-Geriatrics, The Maclean Center on Clinical Medical Ethics, and the Comprehensive Cancer Center, University of Chicago, and the University of Chicago Medicine Urban Health Initiative, Chicago, IL**Abstract**

A growing number of childhood obesity interventions involve children and youth in participatory roles, but these types of interventions have not been systematically reviewed. We aimed to identify child and youth participatory interventions in the peer-reviewed literature in order to characterize the approaches and examine their impact on obesity and obesity-related lifestyle behaviors. We searched PubMed/Medline, psychINFO, and ERIC for quasi-experimental and randomized trials conducted from date of database initiation through May 2015 that engaged children or youth in implementing healthy eating, physical activity, or weight management strategies. Eighteen studies met our eligibility criteria. Most (n=14) trained youth to implement pre-defined strategies targeting their peers. A few (n=4) assisted youth to plan and implement interventions that addressed environmental changes. Thirteen studies reported at least one statistically significant weight, physical activity, or dietary change outcome. Participatory approaches have potential, but variation in strategies and outcomes leave questions unanswered about the mechanisms through which child and youth engagement impact childhood obesity. Future research should compare child- or youth- to adult-delivered health promotion interventions and more rigorously evaluate natural experiments that engage youth to implement environmental changes. With careful attention to theoretical frameworks, process and outcome measures, these studies could strengthen the effectiveness of child- and youth- participatory approaches.

Keywords

Childhood Obesity; Participatory Research; Healthy Lifestyles

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Conflicts of Interest:

The authors of this review did not author nor have involvement with any of the primary studies reviewed. Dr. Lindau is President of MAPSCorps, 501(c)(3) and co-owner and Chief Information Officer of NowPow, LLC, a social enterprise company. The remaining co-authors report no conflicts of interest.

Introduction

As obesity reaches epidemic proportions, there is a critical need to improve the effectiveness of interventions that address childhood obesity, especially in low-income and racial and ethnic minority communities where disparities in prevalence and severity are persistent.^{1,2} Participatory approaches to public health intervention research are recommended due to their potential to improve cultural relevance, acceptability among participants, and sustainability in the community.^{3,4} Adult community members are important to engage, but as the intended intervention recipients, children and youth also can provide valuable insight and play important roles in community engaged or patient centered lifestyle-related childhood obesity interventions.

Models of child and youth engagement can yield many potential benefits. The degree of participation ranges from a functional approach where youth are “assigned but informed” (i.e., provided clear information about the purpose of the project and volunteer for meaningful roles) to more interactive approaches where youth conceive and carry-out their projects with adult guidance.^{5,6} Participatory approaches may be more sustainable because the research tends to focus on interests that arise from the community, rather than solely driven by researchers’ academic pursuits. Underserved communities may be especially invested due to the potential benefits for engaged children and youth, including improvements in leadership, personal agency, and collective empowerment.⁵ Children and youth have a unique perspective that can be incorporated into strategies and messages to improve an intervention’s relevance, acceptability, and cultural appropriateness among its intended participants.⁷ Also, youth are recognized to have influence on a young person’s healthy eating and physical activity behaviors,⁸ and children and youth may be more accepting and motivated to change health behaviors when messages come from individuals closer in age and similar to themselves.⁹

There has been an increase in interventions that involve children or youth as research partners to address health and social issues. A recent review found 56 studies across disease conditions that partnered with youth in some phase of the research process and concluded that youth participation improved research quality and youth’s empowerment.¹⁰ However, the studies in the review were diverse in content areas and research designs, and provided limited information about interventions specific to childhood obesity. To our knowledge, no review has yet systematically examined the evidence on childhood obesity interventions that involve children or youth in participatory roles.

In this systematic review, we identify child and youth participatory interventions that address lifestyle-related (diet and physical activity) childhood obesity and draw conclusions about benefits and challenges of engaging children and youth in participatory roles. Our aims were to identify and describe the specific types of interventions, theoretical foundations, engagement strategies and challenges involved in these studies, examine the impact of child and youth participatory interventions on obesity and obesity-related lifestyle, and summarize reported adverse effects. This review seeks to identify gaps in current knowledge about child- and youth-engaged efforts in order to inform the design of future interventions and research studies.

Methods

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines for this systematic review.¹¹

Eligibility Criteria

Inclusion criteria were studies that engaged a subset of children or youth (from age 5 up to college-age youth) in participatory roles to design or implement obesity or obesity-related lifestyle interventions that targeted their peers or younger children. Studies that engaged older youth (ages 19–26) in participatory roles were excluded unless the targeted intervention recipients were ages 5–18. Studies were excluded if engagement of children or youth was limited to involvement of a few children or youth on majority adult advisory committees. Studies were also excluded if engagement with children or youth was limited to formative research (e.g., focus groups, interviews). For inclusion, studies were required to report a diet, physical activity, or weight outcome that was measured at baseline and at least once following intervention implementation among the peers or younger children who were targeted by the intervention. We included prevention, early intervention, or treatment studies that used controlled before and after (CBA), individual randomized controlled trial (RCT), or cluster randomized controlled trial (CRT) designs; all other study designs were excluded.

Search Strategy

We conducted a comprehensive literature search (through May of 2015) in the following databases: PubMed/Medline, psychINFO, and ERIC. We used Medical Subject Headings (MeSH) search codes in PubMed, with the following terms: (“Adolescent”[Mesh] OR “Child”[Mesh] OR youth) AND (“Obesity”[Mesh] OR “Nutritional Status”[Mesh] OR “Diet”[Mesh] OR “Exercise”[Mesh] OR “physical activity” OR “healthy eating” OR “healthy lifestyle”) AND (“participatory” OR “advocacy” OR led OR advocate OR activism OR leadership OR “peer to peer” OR mentor). For psychINFO and ERIC, we used a similar key word search strategy.

Study Selection and Data Extraction

One author (LF) conducted initial screening of citations by title and abstract for potentially eligible studies, excluding articles that did not address obesity or obesity-related lifestyle, involve children or youth, or describe results of an intervention. Two authors (LF, OA) independently reviewed the potentially eligible articles by full-text for further exclusion. The two authors reviewed discrepancies regarding eligibility and resolved via consensus to determine final articles for review. The two authors then independently reviewed each article to extract information. Discrepancies on abstracted parameters were reviewed and discussed in order to reach a consensus.

Risk of Bias

We assessed the risk of bias for each study using guidelines from the Cochrane Collaboration Handbook for Systematic Review of Interventions based on domains of: sequence generation, allocation concealment, blinding of outcome assessment, incomplete outcome data, and selective reporting.¹² Among studies that used quasi-experimental

designs, we assessed the appropriateness of the comparison group. Performance bias was not assessed as it is difficult to blind participants to this type of intervention. Instrumentation bias was also assessed, examining the validity and reliability of measurement tools.¹³

Study Information

Information extracted from each study included: typology of youth participation (i.e., *functional* or *interactive*),⁶ intervention and control/comparison group procedures, intervention setting, age or school grade and race and ethnicity of children and youth in participatory roles, characteristics of the participants in the implemented interventions, duration of intervention, participant retention, intervention theory or conceptual frameworks, strategies used to identify and train children or youth, outcome measures, key challenges, and adverse effects. Sources cited in the original identified studies were also used to obtain study information as appropriate.

Results

Figure 1 shows the procedure used to conduct our literature search and screening process, including the numbers and reasons for exclusion. Most exclusions were due to content areas not related to lifestyle-related obesity interventions or a lack of focus on children or youth. Seventy-five full-text sources were reviewed, of which 18 studies met our defined criteria. Fourteen of the interventions used functional participation approaches⁶ (n=4 RCTs, n=5 CRTs, and n=5 CBAs), in which youth had some shared decision-making with adults, but intervention goals and objectives were largely pre-determined and older youth were trained as educators or mentors of their peers or younger children. Four of the studies used interactive participation approaches⁶ (n=2 CRTs and n=2 CBAs), in which youth were involved in joint decision-making processes with adults who guided the youth to design and implement their own intervention strategies.

Risk of Bias

Low, unclear, and high risk bias ratings of each risk of bias domain by study can be found in Table 1. Among the eleven RCTs and CRTs, half had unclear risk and half had low risk of both random sequence generation and allocation bias. Among CBA studies, one study had high risk of selection bias due to concerns related to differences in the comparison group. The majority of studies (n=12) did not provide adequate descriptions to ascertain if research staff were blinded to outcome assessment. Approximately equal number of studies had low (n=7) and high risk (n=8) of attrition bias. Over half of the studies had a low risk of bias in the domain of selective reporting (n=11). There was a high risk of instrumentation bias in n=7 studies, most often due to use of instrumentation to measure diet and physical activity that lacked or had limited description of reliability and validity.

Study Characteristics

Table 2 provides characteristics of reviewed studies. Most of the studies were in school-based settings (n=16); two were in community settings. Twelve of the studies were conducted in the US, four in Canada, and one each in New Zealand and the United Kingdom. Most studies (n=15) indicated the intervention was located in communities that

were underserved or had obesity disparities based on rurality, income-level, or racial and ethnic minority composition. All but one intervention was prevention-oriented; the exception was an early intervention, i.e., individuals with risk factors for obesity or diabetes were targeted. Intervention durations ranged from 5 weeks to 3 years with a median duration of 6 months.

The reviewed interventions targeted a diverse range of age groups. The sample size of targeted intervention participants ranged from $n=67$ to $n=2,809$ (median=320), and involved a range of elementary to high school age youth across studies. Some studies ($n=7$) targeted single grades, and the remaining studies targeted a range spanning two or more grades (or corresponding age ranges), including one that spanned from kindergarten to high school.

Intervention Theoretical Frameworks and Strategies

Fourteen studies communicated that their intervention was based on a theoretical approach or framework, and of these, nine were informed by Bandura's social cognitive theory (SCT).¹⁴ Other theories or frameworks referenced included the theory of planned behavior,¹⁵ diffusion of innovations,¹⁶ self-determination theory,¹⁷ circle of courage,¹⁸ the four R's model,¹⁹ peer-teaching model,²⁰ positive youth and life development frameworks,^{21–23} and ecological models.^{24–26} Table 3 includes a summary of how each study described the referenced theoretical frameworks informed their intervention strategies. Interventions that referenced SCT noted strategies that targeted self-efficacy, used observational learning techniques such as peer modeling, or targeted the reciprocal influences of individual, behavior, and environment. Interventions that used the circle of courage, four R's, peer-teaching and development frameworks largely noted that their strategies focused on developing youths' leadership skills to improve their ability to mentor peers and younger children. Interventions that used diffusion of innovations used strategies that engaged youth to promote transmission of healthy behaviors through their social networks. Finally, interventions that were informed by ecological models noted using strategies to change the social or physical environment to support behavior change.

Among interventions that used functional participatory models, most ($n=9$) engaged older youth to deliver healthy eating and physical activity curricula developed for the study to younger children in group formats. In contrast, Black et al.²⁷ and Vivian et al.²⁸ used a less structured approach and trained youth to provide one-on-one counseling and support (e.g., using motivational interviewing techniques) to their peers or younger children in community settings. Bell et al.²⁹ and Bogart et al.^{30,31} trained youth in motivational interviewing and engaged them in diffusing healthy eating and physical activity messages among their peers via activities such as distribution of healthy food samples and dissemination of print educational materials.

Interventions that used interactive participatory approaches involved a range of strategies to change either the social or physical environment. French et al.³² involved high school students in designing and implementing promotions (marketing, taste testing, etc.) of healthy foods in the cafeteria. Dziewaltowski et al.³³ focused on place-based tactics wherein youth 'change teams' chose a target place for environmental change (e.g., school lunch, classroom) and then received guidance on planning, monitoring, and implementing program, policy or

practice changes within that setting to promote healthy diets (e.g., fruits and vegetables) or physical activity. The youth in this study also received training and assistance to create videos to increase awareness about their activities. Jones et al.³⁴ engaged fourth grade students to develop strategic plans for changing their school food environment, which they implemented in their fifth grade year. Finally, Utter et al.³⁵ guided youth to implement a diverse array of activities such as ‘breakfast clubs’ that provided healthy items and structured physical activity time, organized exercise and dance competitions, school gardens, and changes to cafeteria policies.

Identification and Training of Children and Youth for Participatory Roles

Varied strategies were used to identify youth for participatory roles in the interventions. A few studies (n=4) indicated that adult community leaders (e.g., teachers, principals) recommended and identified youth for recruitment to participatory roles using criteria such as leadership skills, health interests, and academic standing.^{34,36–38} Other studies used open recruitment strategies (e.g., presentations to student groups, posted flyers in public locations) and either allowed all interested to participate or used an application process.^{30–32,39} Bogart et al.^{30,31} used a rolling, snow-ball recruitment process that involved training an initial small group of youth who were then asked to recruit their friends to participate in subsequent training sessions. Bell et al.²⁹ used a social network-based recruitment process; students were identified based on nominations of influential peers from a survey of the entire student body.

Among interventions that used a functional participatory approach, nine indicated that adult research team members, specialized trainers, or school teachers provided training on curricula or specific approaches such as motivational interviewing. The studies provided limited details about the frequency or duration of the training sessions.^{28–31,36,39–42} Of studies that did provide frequency and duration details, training ranged from 3 to 40 hours.^{27,37,38,43} All four studies that used interactive participatory approaches indicated adult facilitators worked with youth on an ongoing basis over months to years in order to provide leadership skills development and guidance in areas such as intervention planning and evaluation.^{32–35,44}

Intervention Challenges

Recruitment and retention of youth were not noted as challenges, but several studies^{29,36,43,45,46} identified challenges to identify the most appropriate youth for engaging in participatory roles or concerns with implementation quality due to youth’s varying abilities and skills. Bell et al.²⁹ indicated critical challenges to translate complex diet and physical activity messages into simple messages that youth felt comfortable promoting to their peers, which resulted in the need for considerably high resource needs for their training program.

Impact of Interventions on Outcomes

Of the 18 studies in this review, thirteen demonstrated statistically significant improvements in at least one weight, physical activity, or dietary change outcome (Table 3). Six of ten studies that reported a weight-related measure as a primary outcome reported significant

improvements. Three studies, including one 5-month and two 10-month interventions, reported significant decreases on measured body mass index (BMI) or BMI z-score.^{39,40,42} Also, one study each reported significant decreases in: percent overweight or obese (at 11 months)²⁷, waist circumference (at 10 months)⁴¹, and weight (at 12 weeks).³⁷

Eight studies reported physical activity outcomes, and two had a significant positive effect. Based on a self-report questionnaires, Dzewalktowski et al.³³ found a significant increase in the percent of time spent in moderate to vigorous physical activity after school following a 2 year intervention, and Smith et al.⁴⁶ found a significant increase in participants who reported physical activity in the past week. Based on accelerometer data, Bell et al.²⁹ reported a significant increase in sedentary activity levels (opposite of the intended effect) following a 7-month intervention.

Twelve studies reported dietary outcomes. Seven studies reported significant effects on diet. Based on self-reported questionnaire measures, Black et al.²⁷ reported a significant decrease in number of snacks/desserts per day, Smith et al.⁴⁶ reported a significant increase in a measure of healthy food intake in the past week, and Muth et al.⁴³ found an increase in fruit and vegetable servings per day, and Bogart et al. found an increase in water consumption.³⁰ Based on school cafeteria sales and records, both studies by Bogart et al.^{30,31} found increases in fruit servings during lunch and French et al.³² found improvements in the sales of healthy a la carte items. Finally, based on a 24-hour recall questionnaire, Jones et al.³⁴ found a significant increase in servings of fruit in one of two intervention schools. In contrast, the second intervention school in Jones et al.'s³⁴ study found a significant decrease in fruit and vegetable servings.

Adverse Effects

Two studies had significant findings opposite of intended effect (i.e., Jones et al.'s³⁴ decrease in fruit and vegetable servings and Bell et al.'s²⁹ increase in sedentary activity). Only one study explicitly noted assessment for potential adverse or unintended consequences, which reported no excessive weight loss, gain or eating disorders were observed.²⁷

Discussion

The purpose of this review was to characterize and examine the impact of lifestyle-related childhood obesity interventions that involve children or youth in their implementation. We identified 18 RCT, CRT, and CBA studies. There was considerable heterogeneity in theoretical frameworks, specific intervention strategies, and youth recruitment and training strategies. Broadly, most studies used functional participatory approaches and many described strategies informed by SCT. In many cases, the studies lacked details to allow for risk of bias assessments and about half had high risk of attrition bias. Approximately three-fourths (n=13) of the studies reported statistically significant improvements in either weight, physical activity, or dietary changes in the intervention compared to a control group; two studies reported significant effects opposite of intended directions. The heterogeneity of study designs and outcomes limit drawing conclusions about their impact on obesity and obesity-related lifestyle.

Several interventions did not describe any theoretical framework and many were relatively underspecified to adequately describe the hypothesized mechanisms through which child or youth participation influenced outcomes. Some of the reviewed studies noted positive youth development frameworks, which indicate the overarching value of life and leadership skill development among the engaged youth, but provide limited description of the explicit link to obesity prevention. The reviewed studies most commonly noted their interventions were informed by SCT and used strategies based upon hypothesized relationships between child or youth participation and a change in the social environment to support behavior change. A noted weakness of SCT is that it lacks specificity in connecting constructs between individual, social, and environmental levels.⁴⁷ Integration of positive youth development's constructs related to individual life skill development with SCT's constructs and reciprocal influences among individuals, behavior, and environment may provide a stronger framework for intervention development.

Many of the studies indicated challenges for identifying and providing appropriate training for youth engaged in participatory roles. We found many interventions appeared to use self-selection and volunteer processes to identify and recruit youth. Flexible processes will likely result in recruitment of health-conscious and civically-minded youth, which can be beneficial for their fit and level of engagement. However, these youth may not necessarily be the most influential among their peers nor be the individuals who stand to benefit the most from the leadership skills gained from involvement in such efforts. Novel recruitment methods such as social network-based approaches such as that employed by Bell et al.²⁹ to identify youth identified by their peers as influential merit further consideration. Research across health and non-health areas indicates network-based interventions are effective, but the science of how to use networks to accelerate behavior change is still in its infancy.⁴⁸ Interventions that target youth based on their location within larger peer-network structures to address lifestyle behavior change can advance this research.

In our review, interventions that either trained youth to provide healthy eating or physical activity lessons to younger children or youth^{36,38,39,43} or to promote similar health messages among peers close in age²⁷⁻³¹ were most prevalent. There were four studies that used interactive approaches, which engaged youth to identify and make a variety of changes to their school food or physical activity environments.³²⁻³⁵ Thirteen of the eighteen interventions found a statistically significant improvement on at least one weight, physical activity, or dietary change outcome (intervention arm compared to a control or comparison group). Many studies had limited information and details that resulted in assessments of unclear risk and eight studies had high risk due to attrition bias. The considerable heterogeneity in the strategies for training child and youth engaged in implementing interventions, the specific education, health promotion, and environmental change strategies implemented, the duration of interventions, and outcomes measured limited our ability to evaluate and draw conclusions about impact across interventions. Other reviews of participatory intervention approaches have also indicated that challenge of evaluating effectiveness due to the heterogeneity in study designs, types of collaborative involvement, and activities that generate an array of potential short- and long-term outcomes.^{49,50} Similar to those for community based participatory research,⁵¹ evaluation frameworks that identify

key process and outcome dimensions of youth participatory interventions are needed to help standardize research in this area.

Although no studies reported adverse events, two studies indicated significant effects opposite of the intended direction. Jones et al.³⁴ found decreases in fruit and vegetable consumption in a school where youth had advocated and gained access to a teacher's salad bar once per week. Unfortunately, post-measurements were not collected on a day with access to the salad bar, which possibly influenced the adverse result. Bell et al.²⁹ trained youth to promote health messages among their peers, but reported a significant increase in objectively measured sedentary activity in an intervention arm compared to the control arm. The authors in this study noted that social norms in the larger community that were unsupportive of the healthy behaviors potentially contributed to the inconsistent result. Studies should use validated tools to assess the environmental context in which interventions are placed in order to identify important factors to address and interpret results. For example, prior to a multi-site, multi-component childhood obesity intervention, Millar et al.⁵² used a structured community readiness assessment tool to examine and target increases in community norms and capacity. They observed greater decreases in obesity prevalence among communities that had the largest increases in readiness. As another example, Epstein et al. found participants in family-based interventions had greater reductions in BMI z-scores if they lived in neighborhoods with greater parkland.⁵³ It is of critical importance that childhood obesity interventions consider and attempt to address environmental factors that may constrain individual-level change.

This review has several limitations. Only three databases were searched and grey literature was not considered. The studies provided insufficient detail to allow us to assess the extent of youth's participatory involvement, which likely varied across the studies and could have influenced outcomes. The extent of engagement is noted as a key quality measure in prior reviews of participatory research^{50,54} and, as the evidence for this approach grows, is important to include to assess the robustness of the findings. Furthermore, some interventions were excluded because we found no evidence of significant youth involvement in participatory roles; it is possible, especially in larger community-based participatory studies, that this detail was omitted. Finally, our inclusion criteria resulted in interventions that were heterogeneous in strategies and outcomes, which limits our ability to evaluate impact. However, tighter criteria would have resulted in too few studies that would have similarly limited conclusions on impact and, furthermore, limited our ability to adequately characterize how child and youth participatory approaches are being used to address childhood obesity, which is a gap in the research and strength of our review.

More work is needed to examine the theoretical foundations of child and youth participatory approaches for childhood obesity interventions across age groups. Integrating concepts from positive youth development and social cognitive theory may yield better understanding of how to blend functional and interactive participatory approaches to align and synergize behavioral and environmental changes. For example, an interactive approach can engage youth as leaders in mobilizing social and environmental change that can support healthy diet and activity choices (e.g., creating community gardens), and simultaneously use functional strategies to train youth to provide evidence-based healthy eating curricula to peers and

younger children that take advantage of environmental changes. However, these approaches require careful consideration of capabilities of and benefits to children (depending on age) and of explicit links between individual, social, and broader environmental constructs. The field of systems science has tools such as causal loop diagramming noted for their potential to help make such links explicit,⁵⁵ and should be considered as a tool to help develop interventions that are synergistic and identify appropriate outcomes for evaluation.

More study designs should compare youth- to adult-delivered options, and more research on treatment-oriented interventions is also warranted. All but two studies were prevention-oriented, and only one study, Smith et al.⁴⁶, specifically compared a healthy eating and physical activity program delivered by youth (intervention arm) to a program delivered by adults. All other studies compared the youth engaged intervention to control groups that involved measurement-only or educational materials. Smith et al.⁴⁶ found significant improvements on both diet and activity behavioral outcomes after a 3-month intervention. This finding underscores the potential value of youth-delivered interventions; yet, measures of cost and effect size need to be carefully evaluated.

We only found four studies that used interactive participatory approaches to engage youth. As with other content areas such as tobacco prevention^{56–58} and asset mapping,^{59–61} most involve older adolescents. More research is needed about engaging adolescents in obesity prevention, and Jones et al.'s³⁴ success with 4th–5th grade students suggest a younger age range should also be considered. Interactive approaches hold promise to change environmental context and yield long-term societal benefits. For example, French et al.³² reported a more significant increase in cafeteria sales of healthy snack items compared to a control group, which was a consistent change in relation to the intervention strategies - social marketing to promote healthy snack items in the cafeteria - the youth in the study employed. Interactive approaches can develop and harness youth's leadership skills to plan and implement interventions that create changes in social and physical environments by using strategies such as social marketing and policy advocacy. Indeed, studies that did not meet inclusion criteria for this review due to their study design highlighted successful youth-led efforts to create such changes;^{62–64} yet, it is difficult to apply controlled study designs and quantitatively measure benefits of such interventions. These approaches may also be resource intensive, and research is needed to understand their costs, infrastructure requirements, and potential for sustainability. Mixed methods evaluation of natural experiments and practice-based efforts may be valuable to build further evidence regarding this type of approach, and measures of social and physical environment change including environmental audits and community capacity and readiness metrics should be emphasized as outcomes.

In conclusion, we identified 18 studies that used child and youth participatory intervention approaches to address lifestyle-related childhood obesity. There was considerable variability across studies of the intervention strategies, study designs, and endpoints reported. When ascertainable, the risk of bias was relatively low across studies except for attrition bias, and risk was unclear in a substantial number of studies and domains. Thus, evidence remains inconclusive about the impact of child and youth participatory on weight and healthy lifestyle outcomes. Nonetheless, we were able to characterize the types of approaches used

to engage children and youth in childhood obesity interventions, and identify important theoretical and study design considerations for future research.

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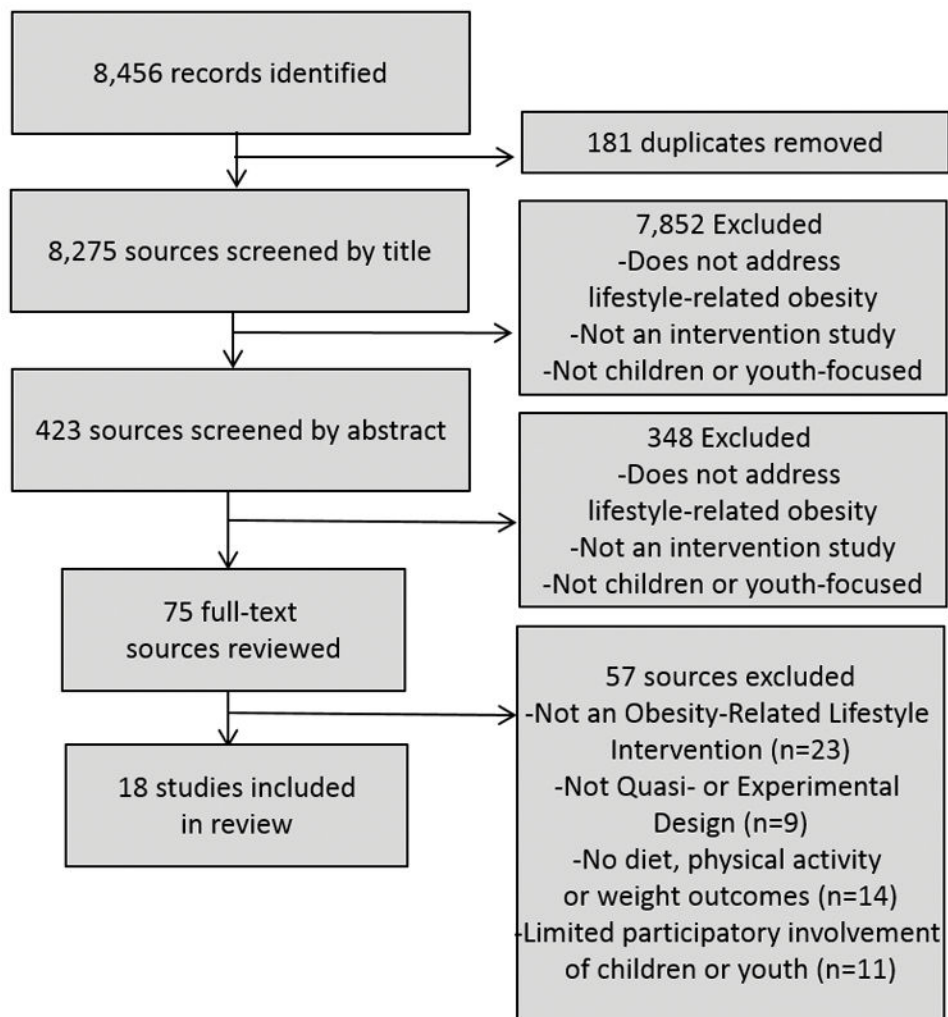


Figure 1.

Flowchart of study identification and selection

Flowchart of the numbers of articles identified, reviewed, and excluded at each stage of the systematic review process. A total of 8,456 were originally identified and 18 were eligible for and reviewed.

Table 1

Risk of bias in studies reviewed

Each row of the table provides the article reviewed and risk of bias score for all domains.

Citation	Selection Bias Random Sequence Generation (RCT and CRT)	Selection Bias Comparability of Groups (Non- Randomized)	Allocation Concealment (RCT and ClusterRT)	Detection Bias Blinding of Outcome Assessment	Attrition Bias Incomplete Outcome Data	Reporting Bias Selective Reporting	Instrumentation Bias Validity/Reliability of Outcome Assessment Methods*
Black <i>et al.</i> 2010 (27)	Unclear Risk	N/A	Unclear Risk	Low Risk	Low Risk	Low Risk	Medium Risk
Vivian <i>et al.</i> 2011 (28)	Unclear Risk	N/A	Unclear Risk	Unclear Risk	Low Risk	Unclear Risk	Low Risk
Smith <i>et al.</i> 2011 (38)	Low Risk	N/A	Low Risk	Unclear Risk	High Risk	Low Risk	Low Risk
Smith <i>et al.</i> 2013 (46)	Low Risk	N/A	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Muth <i>et al.</i> 2008 (43)	Unclear Risk	N/A	Unclear Risk	Unclear Risk	Low Risk	Low Risk	Low Risk
Fomeris <i>et al.</i> 2010 (36)	Low Risk	N/A	Low Risk	Unclear Risk	High Risk	Low Risk	High Risk
Bell <i>et al.</i> 2014 (29)	Unclear Risk	N/A	Unclear Risk	Unclear Risk	Unclear Risk	Unclear Risk	Medium Risk
Santos <i>et al.</i> 2014 (41)	Low Risk	N/A	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Foster <i>et al.</i> 1985 (36)	N/A	Unclear Risk	N/A	Unclear Risk	Unclear Risk	Low Risk	Unclear Risk
Stock <i>et al.</i> 2007 (42)	N/A	Low Risk	N/A	Low Risk	High Risk	Low Risk	Low Risk
Ronsley <i>et al.</i> 2013 (40)	N/A	Low Risk	N/A	Unclear Risk	Low Risk	Unclear Risk	Medium Risk
Eskicioglu <i>et al.</i> 2014 (39)	N/A	High Risk	N/A	High Risk	High Risk	Low Risk	Low Risk
Bogart <i>et al.</i> 2014 (30)	Low Risk	N/A	Low Risk	Low Risk	Low Risk	Unclear	High Risk
Bogart <i>et al.</i> 2011 (31)	N/A	Low Risk	N/A	Unclear Risk	High Risk	Unclear	High Risk
French <i>et al.</i> 2004 (32)	Unclear Risk	N/A	Unclear Risk	Unclear Risk	High Risk	High Risk	High Risk
Dziewaltowski <i>et al.</i> 2009 (33)	Low Risk	N/A	Low Risk	Unclear Risk	Low Risk	Low Risk	High Risk
Utter <i>et al.</i> 2011 (35)	N/A	Low Risk	N/A	Unclear Risk	High Risk	Low Risk	High Risk
Jones <i>et al.</i> 2011 (34)	N/A	Unclear Risk	N/A	Unclear Risk	High Risk	High Risk	High Risk

* Criteria for low, medium, and high risk of instrumentation set as follows: low risk = objective measures of weight, activity or diet or clear description and high levels of validity/reliability of self-reported measures; medium risk = self-report measures of weight, activity or diet with clear description of adequate validity/reliability; high risk = self-report or other measures of weight, activity or diet without adequate description or acknowledgement of limited validity/reliability of measures.

Table 2

Characteristics of studies

The rows of this table provide a summary of major characteristics of each study reviewed including design, setting, orientation of the intervention, intervention recipient participants, intervention duration, sample size, and retention.

Citation	Study Design	Setting	Intervention Orientation ^a	Intervention Recipient Participants	Intervention Duration, Follow-Up (if applicable)	Sample Size	Retention (%)
Functional Participatory Approaches – Engaging and Training Youth to Implement Pre-Defined Strategies							
Black <i>et al.</i> 2010 ²⁷	RCT	Home/Community: Trial was based at an urban, university medical center. Participants resided in a low-income community. (USA)	Prevention	African American Adolescents, ages 11–16	11 months, 24 month	N= 235	78%
Vivian <i>et al.</i> 2013 ²⁸	RCT	Community: Ethnically diverse community (20% whites, 33% African Americans, 35% Hispanic/Latino Americans, 10% Asian Americans, and 2% American Indians and or Alaska Natives) implemented through community-based settings (USA)	Early Intervention	Children between the ages of 10–16 with 2 or more risk factors for type 2 diabetes	12 months	N=67	69%
Smith <i>et al.</i> 2011 ³⁸	RCT	School: Rural (Appalachia county) implemented through three elementary after school programs. (USA)	Prevention	Students in 3 rd and 4 th grade	8 weeks	N=72	89%
Smith <i>et al.</i> 2013 ⁴⁶	RCT	School: Rural (Appalachia county) implemented through four elementary school after-school programs.	Prevention	Students in 3 rd and 4 th grade	8 weeks	N=160	92%
Muth <i>et al.</i> 2008 ⁴³	CRT	School: One rural elementary school (USA)	Prevention	Students in 4 th grade	12 weeks	N=75	97%
Forneris <i>et al.</i> 2010 ³⁶	CRT	School: Twenty-three rural schools (USA)	Prevention	Students in 6 th grade	12 weeks, 12 months, and 24 months	N=2120	86% (post), 67% (12 months), 47% (24 months)
Bogart <i>et al.</i> 2014 ³⁰	CRT	School: Ten middle schools (>50% students	Prevention	Peers (7 th grade students)	5 weeks	N = 2,809	Retention not available

Citation	Study Design	Setting	Intervention Orientation ^a	Intervention Recipient Participants	Intervention Duration, Follow-Up (if applicable)	Sample Size	Retention (%)
		eligible for national school lunch program and <900 7 th graders) in an urban community (USA)					Response Rate = 70%
Bogart <i>et al.</i> 2011 ³¹	CBA	School: Two middle schools (77% students eligible for national school lunch program) in an urban community (USA)	Prevention	Peers (7 th grade students)	5 weeks	N = 425	94%
Bell <i>et al.</i> 2014 ²⁹	CRT	School: Six co-educational comprehensive schools (UK)	Prevention	Peers (Year 8 students)	7 months	N=928 N=614 with accelerometry; 444 post	Unclear
Santos <i>et al.</i> 2014 ⁴¹	CRT	School: 19 elementary schools – urban and rural. (CAN)	Prevention	Kindergarten-6 th grade	10 months	N=647	90%
Foster <i>et al.</i> 1985 ³⁷	CBA	School: Catholic elementary school (USA)	Prevention	Students in 2 nd -5 th grade	12 weeks	N=89	90%
Stock <i>et al.</i> 2007 ⁴²	CBA	School: Two elementary schools, majority White, middle class communities (CAN)	Prevention	Students in Kindergarten-3 rd grade	10 months	N=383	Unclear
Ronsley <i>et al.</i> 2013 ⁴⁰	CBA	School: Three schools in a First Nations community. (CAN)	Prevention	Kindergarten-12	10 months	N=179	100%
Eskicioglu <i>et al.</i> 2014 ³⁹	CBA	School: School in a First Nations community (CAN)	Prevention	Students in 4 th Grade	5 months	N=180	84%

Interactive Participatory Approaches – Engaging youth to design, implement, and evaluate interventions

French <i>et al.</i> 2004 ³²	CRT	School: Twenty high schools, wide range of SES status and racial diversity (USA)	Prevention	Peers (High School)	2 years	N=750 (random sample of 75 students per school)	Survey Response rates: 75% and 77%
Dzewaltowski <i>et al.</i> 2009 ³³	CRT	School: Sixteen middle schools, strata included majority White and diverse populations (USA)	Prevention	Peers (7 th and 8 th grade students)	2 years	N =2211	72%

Citation	Study Design	Setting	Intervention Orientation ^a	Intervention Recipient Participants	Intervention Duration, Follow-Up (if applicable)	Sample Size	Retention (%)
Utter <i>et al.</i> 2011 ³⁵	CBA	School: Four secondary schools in ethnically diverse, predominantly Pacific Islander communities (New Zealand)	Prevention	Peers (students ages 15–18)	3 years	N=1634	Unclear. Response Rate was 66%; used independent cross-sectional design with 9 and 10 th grade removed.
Jones <i>et al.</i> 2011 ³⁴	CBA	School: Five rural elementary schools (USA)	Prevention	Peers (4 th grade students)	2 years	N=256	38%*

Notes: RCT = Randomized Controlled Trial; CRT = Cluster Randomized Controlled Trial; CBA = Controlled Before and After Study.

^a Intervention orientation was defined by the target population for the intervention. Prevention = no weight or risk criteria were defined for the target population; Early Intervention = behavioral and health metric criteria were used to define target population as at risk for developing obesity or related health co-morbidities; Treatment = weight-related metrics were used to define target population as children or youth who already were overweight or had developed obesity.

* The low retention was due to funding constraints that limited data collection at post-intervention. A random sample of participants was selected (n=180), of which n=98 had complete data.

Table 3

Intervention arms, theories, characteristics of and strategies to involve youth, and outcome results. The rows of this table provide a description of important aspects of each study reviewed including the intervention strategies, theory and frameworks used, characteristics of the engaged children or youth, recruitment and training techniques of the engaged youth, and outcomes reported. The outcomes are divided by activity, diet, and weight measures and indicate statistically significant outcomes with an asterisk.

Citation	Intervention Arms and Strategies	Theory and Frameworks	Number and Characteristics of Children/Youth in Participatory Roles	Identification and Training Strategies for Children/Youth in Participatory Roles	Statistical Improvement in Outcomes/ Measurement Method Measures		
					Activity	Diet	Body Weight/BMI
Functional Participatory Approaches – Engaging and Training Youth to Implement Pre-Defined Strategies							
Black et al. 2010 (27)	<i>Intervention:</i> Following a curricula, college enrolled or recent graduates (ages 19–25) paired by sex and race with African American children (ages 11–16) to motivate healthy eating and physical activity. Strategies of goal-setting and experiential learning techniques from SCT were used in the intervention. <i>Control:</i> Measurement only	Social Cognitive Theory	College enrolled or recent graduates (ages 19–25), paired with intervention participants (mentees) by gender and race	Identification not specified. Mentors received 40 hours of training, including motivational interviewing.	<i>Accel</i> Play Equiv. PA (+)	<i>HEO</i> Calories (+) FV (–) Snacks (+)*	<i>Obj</i> zBMI (+) %OW/OB (+)*
Vivian et al. 2011 (28)	<i>Intervention:</i> In addition to exercise sessions (physical activity classes 3x/wk) and family events, youth mentors (ages 12–16) provided other youth (ages 10–16) individual support and counseling on healthy lifestyles. <i>Control:</i> Mailed educational materials each month	Not specified	Seven adolescents with pre-diabetes and two with type 2 diabetes (ages 12–16)	Resided in the community and active in neighborhood activities. Training sessions provided by research team members.			<i>Obj</i> zBMI(+) WC(+)
Smith et al. 2011 (38)	<i>Intervention:</i> Structured after-school mentorship program on healthy eating and physical activity delivered by high school students to 3–4 th grade students. Teen mentoring strategies to improve child perceived autonomy support and to improve child self-efficacy were drawn from SDT and SCT, respectively. Informed by TPB, mentoring strategies hypothesized a direct influence on child attitudes and perceived	Theory of Planned Behavior (TPB), Self-Determination Theory (SDT), and Social Cognitive Theory (SCT)	Thirteen 10th and 11th Grade students from two local high schools chosen by principals.	High school students identified by principal and honor society advisors. 6 hours of training conducted over 2 days by research team members			<i>Obj</i> BMI Percentile(+)

Citation	Intervention Arms and Strategies	Theory and Frameworks	Number and Characteristics of Children/Youth in Participatory Roles	Identification and Training Strategies for Children/Youth in Participatory Roles	Statistical Improvement in Outcomes ¹ Measurement Method		
					Activity	Diet	Body Weight/BMI
	behavioral capacity and an indirect influence on behavioral intentions. <i>Control:</i> Structured after-school programming delivered by high school students on other topics (personal hygiene, bike safety, arts and crafts, and tobacco cessation).						
Smith <i>et al.</i> 2013 (46)	<i>Intervention:</i> Structured after-school programming on healthy eating and physical activity delivered by high school students to 3–4 th grade students. See Smith 2011. <i>Control:</i> Structured after-school programming on healthy eating and physical activity delivered by adult school staff.	Theory of Planned Behavior, Self-Determination Theory, and Social Cognitive Theory	Thirty-two 10 th and 11 th grade students, normal weight, interested in health and of high academic standing	All local high school students eligible, but priority given to those identified by an after-school network. Mentors provided training and an instructor's guide.	PAQ Score(+)*	HEQ Score(+)*	Obj BMI(+)
Muth <i>et al.</i> 2008 (43)	<i>Intervention:</i> High school and middle school students taught a healthy eating and physical activity curricula to younger (4 th grade). Informed by SCT, the strategies were hypothesized to result in reciprocal influences between environment and behavior change; whereby, students would gain new knowledge and skills in the school environment, change their behaviors, and, in return, model healthy behaviors to their peers in the school environment. <i>Control:</i> Standard school health education materials.	Social Cognitive Theory	Nine high school students interested in health education and ten medical student volunteers.	High school students in a health occupations class with interest in health education of younger students. Medical students with interest in community service. 15 hours of training on the curriculum by research team members.	PAQ Score(+)	HEQ FV(+)* SSB(-) Snacks(-)	
Forness <i>et al.</i> 2010 (36)	<i>Intervention:</i> High school students taught a healthy eating curricula to middle school (6 th grade) students. Informed by LDI, the curricula strategies focused on emphasizing life skills such as self- and goal-directed change that are thought to enable individuals to succeed in different environments (school, home, neighborhood). <i>Control:</i> Measurement only.	Life Development Intervention (LDI) Framework	One hundred forty four high school students chosen by school administrators for their academic performance, leadership qualities, and extracurricular involvement.	High school students chosen by school administrators for academic performance, leadership qualities, and extracurricular involvement.		HEQ Fat(-) Fiber(-) FV(-)	

Citation	Intervention Arms and Strategies	Theory and Frameworks	Number and Characteristics of Children/Youth in Participatory Roles	Identification and Training Strategies for Children/Youth in Participatory Roles	Statistical Improvement in Outcomes ¹ Measurement Method Measures		
					Activity	Diet	Body Weight/BMI
Bell <i>et al.</i> 2014 (29)	Intervention: Year 8 students are trained to informally diffuse health messages to their peers. Informed by Diffusion of Innovations, strategies focused on enabling students to informally and formally model healthy behaviors to their peers in order to diffuse such behaviors through social networks. Control: Measurement only.	Diffusion of Innovations Theory	Year 8 students	Student body nominates influential students who are recruited as peer supporters. Peer supporters receive knowledge and skills-based training from specialized trainers.	Accel/ MVPA(-) Sed(-)*	HEQ F(+) V(-)	
Santos <i>et al.</i> 2014 (41)	<i>Intervention:</i> "Healthy Buddies"; Older elementary/middle school students (4 th -7 th) teach healthy eating and physical activity lessons to younger elementary school students (K-3 rd). <i>Control:</i> Standard school curricula.	Not specified		"Older" classes are decided on by school administrators. "Older" students taught concepts by their teachers.	PEP "Older" steps/day (-) "Younger" steps/day (+)		Obj "Older" zBMI(+) "Younger" zBMI(-) "Older" WC(+)* "Younger" WC(+)*
Bogart <i>et al.</i> 2014 (30)	<i>Intervention:</i> "SNAX"; 7 th grade students trained to conduct healthy eating and physical activity promotion activities and promote healthy eating to their 7 th grade peers. Informed by SCT, strategies recognized that attitudes, norms, and self-efficacy lead to behavior change and are constrained/facilitated by the environment. Peer leaders were trained to promote and model healthy behaviors and changes were made in the school cafeteria to offer healthier options. <i>Control:</i> Measurement only.	Social Cognitive Theory (SCT)	Four hundred fifty-four 7 th grade students	Recruited via in-class presentations and informational tables for a peer-leader club. Peer leaders recruited additional peers to participate in training. Training involved sessions with adult facilitators who provided training on different topics each week and motivational interviewing.		Cafeteria Records F(+) V(+) F(+) V(-) Snacks(+)* HEQ Water(+)*	
Foster <i>et al.</i> 1985 (37)	<i>Intervention:</i> Peer counselors (8 th grade) provided social support and encouraged healthy eating and physical activity to younger children (grades 2-4 th). <i>Comparison:</i> Children in a nearby elementary school	Not Specified	Students in 8 th grade selected by the principal and teachers	Well-liked by principal and teachers. Received 3 one-hour training sessions.			Obj Weight(+)*

Citation	Intervention Arms and Strategies	Theory and Frameworks	Number and Characteristics of Children/Youth in Participatory Roles	Identification and Training Strategies for Children/Youth in Participatory Roles	Statistical Improvement in Outcomes ¹ Measurement Method Measures		
					Activity	Diet	Body Weight/BMI
Stock et al. 2007 (42)	<i>Intervention: "Healthy Buddies";</i> Older elementary/middle (4 th -7 th) school students teach healthy eating and physical activity lessons to younger (K-3 rd) elementary school students. Evidence from peer-teaching models were used to guide intervention strategies, i.e., education of young people by young people. <i>Comparison:</i> Measurement Only.	Peer-teaching Model	"Older" classes in a Kindergarten-12 setting - designation of "older" classes by school administrators.	"Older" classes are decided on by school administrators. "Older" students taught concepts by their teachers.			<i>Obj</i> K-2 Weight(+) BMI(+) 4-7 Weight(+)* BMI(+)*
Ronsley et al. 2013 (40)	<i>Intervention: "Healthy Buddies";</i> Older elementary/middle school students (4 th -7 th) teach healthy eating and physical activity lessons to younger elementary school students (K-3 rd). <i>Comparison:</i> Measurement only.	Not specified	"Older" classes (4 th -6 th Grades) designated by school administrators.	"Older" classes are decided on by school administrators. "Older" students taught concepts by their teachers.	<i>PAQ</i> Score(+)	<i>HEQ</i> SSB(+)	<i>Obj</i> zBMI(+)* WC(+) %OW/OB(+)*
Bogart et al. 2011 (31)	<i>Intervention: "SNAAX";</i> 7 th grade students trained to conduct healthy eating and physical activity promotion activities and promote healthy eating to their 7 th grade peers. Informed by SCT, strategies recognized that attitudes, norms, and self-efficacy lead to behavior change and are constrained/facilitated by the environment. Peer leaders were trained to promote and model healthy behaviors and changes were made in the school cafeteria to offer healthier options. <i>Comparison:</i> Cafeteria data collected only.	Social Cognitive Theory	One hundred forty 7 th grade students	Recruited via in-class presentations and informational tables for a peer-leader club. Peer leaders recruited additional peers to participate in training. Training involved sessions with adult facilitators who provided training on different topics each week and motivational interviewing.		<i>Cafeteria Records</i> F(+)* Healthy Entrées(+)*	
Eskicioglu et al. 2014 (39)	<i>Intervention:</i> High school mentors (grades 7-12) delivered culturally tailored healthy eating and physical activity curricula to younger students (grade 4) during after school program. Informed by the Circle of Courage model, strategies built on the strengths of Aboriginal	Circle of Courage and the Four R's model	Students in a nearby high school (Grades 7-12)	All high school students were invited, only criteria were regular class attendance. Training information not specified.			<i>Obj</i> zBMI(+)* WC(+)*

Citation	Intervention Arms and Strategies	Theory and Frameworks	Number and Characteristics of Children/Youth in Participatory Roles	Identification and Training Strategies for Children/Youth in Participatory Roles	Statistical Improvement in Outcomes ¹ Measurement Method Measures		
					Activity	Diet	Body Weight/BMI
	<p>youth and facilitating them to play leadership roles in their community. Drawing on the 4 R's model, four different areas of well-being were also incorporated: healthy food, healthy play, education, and healthy relationships. <i>Comparison:</i> Measurement only.</p>						
Interactive Participatory Approaches – Engaging youth to design, implement, and evaluate interventions							
French <i>et al.</i> 2004 (32)	<p><i>Intervention:</i> In addition to changes in cafeteria options, high school students were trained to and conducted activities to promote healthy eating among peers. Informed by SCT, strategies included observational learning (i.e., promotion of behavior change through peer-led activities that provides modelling of healthy behaviors) and improving self-efficacy by giving adolescent peer leaders decision-making powers and responsibilities. <i>Control:</i> Measurement only</p>	Social Cognitive Theory (SCT)	High School (unspecified number of students from 20 secondary schools)	Students were recruited via school staff, fliers, and presentations to student groups, classes, etc. Research staff and school advisors trained and worked with students to plan and implement activities.		<p><i>Cafeteria Records</i> Healthy a la carte sales (+) HEQ FV(+)</p>	
Dzewaltowski <i>et al.</i> 2009 (33)	<p><i>Intervention:</i> School adult coordinators facilitated youth advocacy groups (6th-8th grades) who designed and implemented environmental changes to promote healthy eating and physical activity. The reciprocal influences between an individual, behavior, and the environment was used as a framework to target both individual factors (e.g., self-efficacy) and environment. Ecological models were used to focus strategies on place and environment in order to provide contexts that allow individuals to demonstrate and master individual-level skills for health behavior change. <i>Control:</i> Measurement only.</p>	Social Cognitive Theory, Diffusion of Innovations, and Ecological Models	7 th and 8 th grade students (~15% of student body)	Identification of 'key youth' unclear. Curricula included lessons on planning, implementing and evaluating environmental change for healthy eating and physical activity promotion.	PAQ MVPA(+)*	HEQ FV(+)	

Citation	Intervention Arms and Strategies	Theory and Frameworks	Number and Characteristics of Children/Youth in Participatory Roles	Identification and Training Strategies for Children/Youth in Participatory Roles	Statistical Improvement in Outcomes ¹ Measurement Method Measures		
					Activity	Diet	Body Weight/BMI
Utter <i>et al.</i> 2011 (35)	<i>Intervention:</i> High school students (ages 15–18) participated in student health councils which designed and implemented activities to promote healthy eating and physical activity each year. Informed by positive youth development principles, the strategies focused on allowing youth full and active participation throughout the process, building quality relationships, drawing on youth strengths, and engaging them to consider broader community policies and programs in their work. <i>Comparison:</i> Measurement only.	Positive Youth Development Principles	Ten to fifteen students (ages 15–18) per school each year.	All students invited, participation was open and voluntary. Students received training in nutrition, activity, and health and opportunities for building leadership skills and planning intervention activities.	PAQ Screen Time(+)	HEQ SSB(+)	zBMI(-) Weight(-) BF%(-) %OB/OW(-)
Jones <i>et al.</i> 2011 (34)	<i>Intervention:</i> Elementary (4 th grade) students receiving training including planning and implementation of environmental changes for healthy eating. Strategies were not described in relation to SCT, but environmental, behavioral, and attitude outcomes assessed with based on SCT. <i>Comparison:</i> Standard classroom nutrition education.	Social Cognitive Theory	Nine-Ten 4 th grade students in each school.	Teachers identified the potential peer leaders for recruitment. Research staff and school advisors trained and worked with students to plan and implement activities.		HEQ School 1 Calories(-) F(+) V(-) School 2 Calories(-) F(-) V(-) *	

¹ Interpretation of outcome results: Outcomes reported are for between group differences unless denoted; a plus sign (+) indicates a treatment minus control difference in the desired direction and a minus sign (-) indicates a difference opposite to the desired direction.

* Indicates a statistically significant difference at a level of $P < 0.05$.

Note: Measurement Method: Accel = Accelerometer, PAQ = Physical Activity Questionnaire, PED = Pedometers, Obj = Objective measurement of weight and height via calibrated scale and stadiometer. Measures: Play Equiv. PA = Play Equivalent Physical Activity, F = Fruit Servings, V = Vegetable Servings, BF% = Body Fat Percent, %OW/OB = Percent overweight and obese, WC = waist circumference, SSB = Sugar sweetened beverage servings, MVPA = Moderate to Vigorous Physical Activity, Sed = Sedentary Activity.