

A Community Guide Systematic Review: School Dietary and Physical Activity Interventions



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Context: Schools can play an important role in supporting a healthy lifestyle by offering nutritious foods and beverages and providing opportunities for physical activity. A healthy diet and regular physical activity may reduce the risk of obesity. This manuscript reports on a Community Guide systematic review examining the effectiveness of interventions in schools combining school meal or fruit and vegetable snack programs and physical activity.

Evidence Acquisition: Studies meeting the intervention definition were identified from a literature search (search period: January 1990–November 2019). Community Guide systematic review methods were used to assess effectiveness as measured by dietary behavior, physical activity, and weight changes; analyses were conducted in 2020.

Evidence Synthesis: Interventions ($n=24$ studies) were considered effective for increasing physical activity (median increase=21.8 minutes/day; interquartile interval= -0.8 to 27.4 minutes/day), modestly increasing fruit and vegetable intake (median relative increase=12.1%; interquartile interval= -4.6% , 73.4%), and decreasing the prevalence of overweight and obesity (median decrease=2.5 percentage points; interquartile interval= -8.1 , -1.6 percentage points) among elementary school students through sixth grade. There were not enough studies to determine the effectiveness of interventions for middle- and high-school students.

Conclusions: School meal or fruit and vegetable snack interventions combined with physical activity were effective in increasing physical activity, with modest effects for improving fruit and vegetable consumption and reducing the prevalence of overweight and obesity among elementary students. These results may inform researchers and school administrators about healthy eating and physical activity interventions. *Am J Prev Med 2023;64(3):441–451. Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine.*

CONTEXT

Consuming a healthy diet and participating in regular physical activity during childhood can build stronger bones and muscles and reduce the risk of developing disease conditions such as obesity, type 2 diabetes, high blood pressure and heart disease, and osteoporosis.^{1,2} In 2018, about 35% of American children and adolescents aged 2–19 years experienced overweight or obesity.³ More specifically, the prevalence of obesity among children aged 6–11 years was 19.3%, and that in adolescents aged 12–19 years was 20.9%, with Mexican American populations and Black or African American populations having higher prevalence.⁴

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There are many causes of excess weight gain, such as diet, physical activity, genetics, and community factors.⁵ Schools can play an important role in providing an environment that supports 2 of these factors: healthy eating and physical activity. Schools are an ideal setting because most children in the U.S. attend school 6 hours a day during the school year and consume as much as half their daily calories at school.^{6,7} A healthy school nutrition and physical activity environment can support healthier choices by increasing the availability of nutritious foods and beverages and increasing opportunities for accumulating the recommended guidelines of 60 minutes or more of moderate- to vigorous-intensity physical activity daily for children and adolescents.^{2,7} Healthier foods and beverages include fruits; vegetables; whole grains; low-fat or fat-free dairy products; lean meats; beans; eggs; nuts; and items that are low in saturated fats, salt, and added sugars and that have no trans fats.¹

The Guide to Community Preventive Services serves as a respected source of information about effective interventions to address public health issues, including obesity prevention and control.⁸ A number of Community Guide reviews of intervention approaches to prevent and control obesity in schools have been conducted. This review contributes to the existing literature by assessing school meals or fruit and vegetable (FV) snack interventions combined with physical activity interventions and will be referred to as school meal, FV snack, and physical activity interventions in the remaining part of this paper. The purpose of this review was to examine the effectiveness of dietary habits, physical activity behavior, or weight status and the applicability of findings to various U.S. populations using Community Guide methods and to provide an evidence-based recommendation.

Conceptual Approach and Analytic Framework

School meal, FV snack, and physical activity interventions aim to improve students' health behaviors and overall health by increasing the availability of healthier foods and beverages and providing opportunities for physical activity. School meal, FV snack, and physical activity interventions include school meal policies that ensure that school breakfasts or lunches meet specific nutrition requirements (e.g., School Breakfast Program,⁹ National School Lunch Program¹⁰) or FV programs that provide fresh FV to students during lunch or snack. Physical activity interventions include physical education classes that engage students in physical activity or school policies or practices that provide opportunities for physical activity during the school day (e.g., physical activities for students such as recess and active classroom breaks).

Interventions also may include additional strategies such as healthy food and beverage marketing strategies (e.g., posters of healthier options); educational programs that address nutrition or build knowledge and skills needed to maintain physically active lifestyles; large-scale infrastructure changes that provide or improve space, facilities, or equipment to make physical activity easy and appealing (e.g., renovating a school playground); addition of small-scale equipment to promote physical activity (e.g., jump ropes, balls, cones, team vests); staff training; or family and community engagement.

The analytic framework (Figure 1) illustrates hypothesized pathways in which school meal, FV snack, and physical activity interventions lead to improved dietary, physical activity, and weight-related outcomes. These interventions may improve the school environment by increasing the availability of healthier foods and non-sugar-sweetened beverages (SSBs) and opportunities for physical activity. These interventions may also lead to increased knowledge, awareness, motivation, or skills, which may improve psychosocial outcomes, including self-efficacy. This may support improvement in the recommendation outcomes of dietary intake¹¹ and physical activity,¹¹ which may lead to improved weight-related and clinical outcomes. In addition, interventions may lead to additional benefits such as increased health-related quality of life and improved academic performance, whereas potential harms may include negative effects on body image. Potential effect modifiers include intervention intensity and duration of exposure to healthier meals, FV snacks, and physical activity; study population characteristics (such as sex, baseline weight status, and race/ethnicity); and peer influence.

EVIDENCE ACQUISITION

Detailed systematic review methods used by The Community Guide are published elsewhere.¹² For this review, the team comprised subject-matter experts in obesity, nutrition, and physical activity from multiple government agencies (e.g., Centers for Disease Control and Prevention [CDC], NIH, and universities) along with systematic review experts from the Community Guide Office at CDC. The team worked in collaboration with the independent, nonfederal, unpaid Community Preventive Services Task Force (CPSTF).

Search for Evidence

The search for evidence was conducted in CINAHL, Cochrane, Embase (Ovid), PsycINFO (Ovid), and PubMed and included peer-reviewed journal articles, books, and the gray literature of theses and dissertations

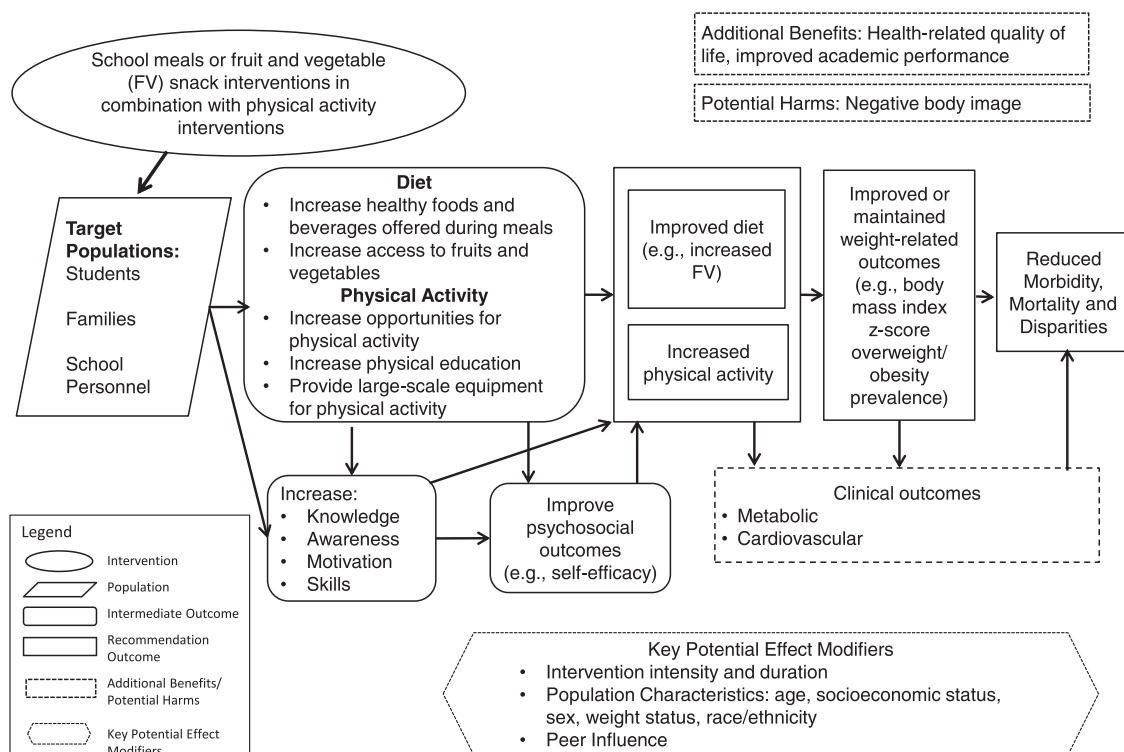


Figure 1. Analytic framework of school meal, FV snack, and physical activity interventions. FV, fruit and vegetable.

(search period was January 1, 1990–November 7, 2019). Reference lists in retrieved articles also were reviewed. The search strategy, found at <https://www.thecommunityguide.org/findings/obesity-prevention-control-meal-fruit-vegetable-snack-interventions-combined-physical-activity-interventions-schools.html>, combined terms related to school dietary and physical activity interventions and dietary, physical activity, and weight-related outcomes.

Inclusion and Exclusion Criteria

Studies were included if schools (kindergarten through high school) were the primary setting; they evaluated intervention programs or policies aimed at school meals or FV snack programs or both and the intervention included physical education classes or programs or policies aimed at providing increased opportunities for physical activity; they reported a diet, physical activity, or weight-related outcome measured at least 6 months after the intervention program or policy began; they were controlled trials or a quasi-experimental design that included a comparison group, time series, before–after study, or post-only studies with a comparison group; they were conducted in a very high Human Development Index country (for comparability with U. S. populations and settings)¹³; and they were published

in English. Weight loss–specific interventions were excluded as were studies that only recruited participants with overweight or obesity or other chronic diseases or conditions (e.g., eating disorders) so that findings are generalizable to the whole student population.

Data Abstraction and Quality Assessment

Included studies were independently abstracted by 2 review team members. The suitability of each study design was rated as greatest, moderate, or least, depending on the degree to which the design protected against threats to validity.¹² Abstraction was based on a standardized abstraction form that included information on study quality, intervention components, participant demographics, and outcomes.¹⁴ Disagreements were reconciled by consensus between reviewers. Threats to validity were used to characterize studies as having good (0–1 limitation), fair (2–4), or limited (5 or more) quality of execution.¹² Internal and external threats to validity included poor description of the intervention, population, or sampling frame; poor measurement of exposure or outcome; poor reporting of analytic methods; loss to follow-up; or intervention and comparison groups not being comparable at baseline. Studies with limited quality of execution were excluded from the analyses.

Outcomes of Interest

Effectiveness for outcomes of interest was assessed by the most reported measures that were relevant to the intervention. For dietary effectiveness, these included a total daily intake of at least 1 of the following: FV, beverages with added sugars (referred to as SSBs¹), low-nutrient foods (e.g., foods with too much sodium, saturated fat, and sugar), water, and composite healthy eating measures. The team considered increases in FV intake, water consumption, and composite healthy eating measures (i.e., higher number) and decreases in SSBs and low-nutrient food intake as favorable. Physical activity effectiveness was assessed by cardiorespiratory fitness (i.e., 1 mile run/walk and timed run) or time spent in physical activity. Improved cardiorespiratory fitness and increased time spent in physical activity were considered favorable.

Effectiveness for weight-related outcomes was assessed using BMI *z*-score or overweight or obesity prevalence. A decrease in BMI *z*-score, overweight, or obesity prevalence was considered favorable. Given national trends showing modest increases in obesity prevalence among children,¹⁵ the team considered studies without a control group that reported a decrease or no change in weight-related outcomes as favorable, regardless of statistical significance, because this showed potential for a decreased rate of change in BMI *z*-score, overweight, or obesity prevalence.

This body of evidence includes both objective and self-reported measures. Most physical activity and height and weight variables were objectively measured. Nearly all dietary consumption outcomes were self-reported using various, validated food and beverage intake instruments; some reported frequency of consumption, whereas others reported the quantity or volume consumed.

Calculation of Effect Estimates for Qualifying Studies

Effect estimates were calculated when the adjusted change was not provided; otherwise, the adjusted values provided in the publication were used. The formula for calculating effect estimates was carried out using 1 of 3 methods, depending on the study design and variability of the outcome. The preferred method included non-treated comparison (C) and intervention (I) group—the basic unit for the calculation—with measurements made before and after the intervention. For studies with a comparison group, the team calculated the difference between the intervention group and comparison group¹⁴ as follows:

$$(I_{\text{post}} - I_{\text{pre}}) - (C_{\text{post}} - C_{\text{pre}})$$

Where I_{post} is the post-test for the group of participants receiving the intervention (for studies with multiple measurement points, the time point closest to the conclusion of the intervention was used), I_{pre} is the pre-test for the group receiving the intervention, C_{post} is the post-test for the comparison group, and C_{pre} is the pre-test for the comparison group. In addition, when studies used various measures to assess the same outcome, relative percentage change was calculated as the difference in the relative change in the intervention group and comparison group¹⁴ as follows:

$$\left\{ \left[\frac{I_{\text{post}} - I_{\text{pre}}}{I_{\text{pre}}} \right] - \left[\frac{C_{\text{post}} - C_{\text{pre}}}{C_{\text{pre}}} \right] \right\} * 100$$

When studies did not include a comparison group, the team calculated the difference between postintervention and preintervention¹⁴ as follows:

$$I_{\text{post}} - I_{\text{pre}}$$

When possible, for each primary outcome measure, the median effect estimates from individual studies were reported, along with the interquartile interval (IQI), which represents the middle 50%, or the range between the first and third quartiles.

EVIDENCE SYNTHESIS

Search Yield

Figure 2 summarizes the search process. The search identified 24,086 records. After removing duplicates, 23,412 titles and abstracts were screened. Two review team members independently screened the full text of 250 potentially relevant articles, identifying 24 included studies in 30^{16–45} publications. Table 1^{16–46} includes the list of interventions and their linked publications used in this review.

Quality of Execution Assessment

Regarding study design, 17 studies had a comparison group (greatest suitability of study design),^{16–31,34–40} 1 study was a repeat cross-sectional with comparison (moderate suitability of study design),⁴¹ and 6 studies were pre–post studies (least suitability of study design).^{42–45} Appendix Figure 1 (available online) displays the study limitations on the basis of the quality assessment from included studies.¹² The most limitations were sampling approaches that were prone to bias ($n=15$), such as schools self-selecting to implement the intervention, and follow-up rates <80% ($n=9$). On the basis of the quality assessment, 7 studies had a good quality of

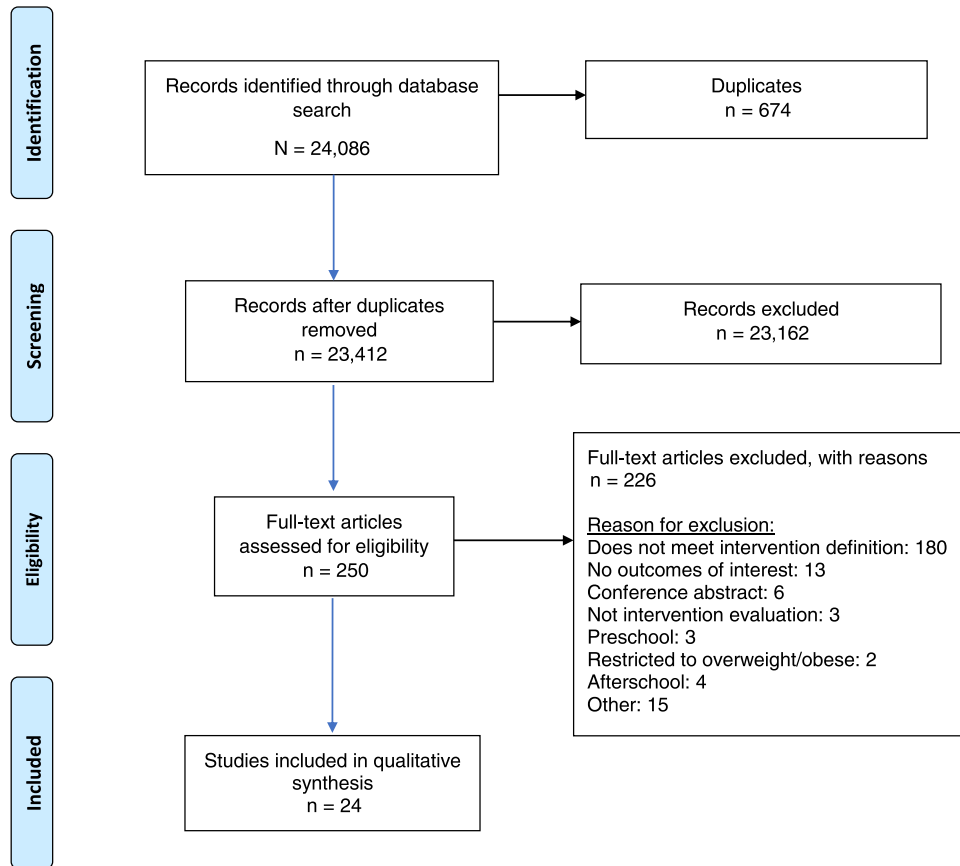


Figure 2. PRISMA flowchart of school meal, fruit and vegetable snack, and physical activity interventions.

execution,^{16,20,21,38–40,42} and the remaining studies had a fair quality of execution.^{17–19,22–31,34–37,41,44,45}

Study and Intervention Characteristics

Appendix Table 1 (available online) displays study characteristics, including country, degree of urbanization, setting, school level, and intervention components. Studies took place primarily in the U.S. (14 studies) and in urban areas (10 studies). Summary evidence tables for all included studies can be found at <https://www.thecommunityguide.org/sites/default/files/assets/SET-Obesity-School-Meals-PA.pdf>. Most studies (17 studies) were implemented in kindergarten through fifth grade, whereas 5 studies were implemented in elementary and middle combined, 1 was implemented in middle school, and 1 was implemented in middle and high school combined. Intervention duration ranged from 9 months to 42 months, with a median of 24 months.

Most studies (17 studies) included intervention components outside of the school setting. These additional components may include activities such as distributing newsletters encouraging families to make changes at home, activity packets, or family fun night; community

involvement by providing access to sports or offering children’s menus at restaurants; before or after school activities such as walk or bike to school; and afterschool activities. The most common dietary intervention component was school meal changes (17 studies), whereas the most common physical activity components were the combination of increasing time spent engaged in physical activity during physical education classes and providing opportunities for physical activity during the school day (e.g., physical activity during classroom breaks) (10 studies).

Demographic Characteristics of Participants in Included Studies

Study participants had a mean age of 8.8 years, with roughly equal numbers of males and females. Thirteen studies reported on SES, with 9 interventions implemented among low-income (e.g., proportion qualifying for free or reduced school meals, author-reported disadvantaged population) student populations and 4 being implemented in mixed or middle-income student populations.

Table 1. Interventions and Associated Publications by Study Design

Intervention names	Associated publications used in this review
Group RCT	
Aventuras Para Niños Study	Crespo (2012) ¹⁶
Child and Adolescent Trial for Cardiovascular Health (CATCH), multistate	Luepker (1996), ¹⁷ Nader (1999) ⁴⁶
Lifestyle of 7–9 Year-Old Study	Hrafinkelsson (2014), ¹⁸ Kristjansdottir (2010) ¹⁹
The CHILDREN Study	Angelopoulos (2009) ²⁰
The Energy Balance 4 Kids with Play	Madsen (2015) ²¹
The HEalth in Adolescents (HEIA) Study	Bjelland (2015), ²² Grydeland (2013), ²³ Grydeland (2014) ²⁴
The Heart Smart Program	Arbeit (1992) ²⁵
The Pathways Study	Caballero (2003) ²⁶
Wise Mind Healthy Eating and Exercise, 2007	Williamson (2007) ²⁸ Williamson (2013) ²⁷
Prospective cohort	
Know Your Body Program	Resnicow (1992) ²⁹
Other design with concurrent comparison	
Coordinated Approach to Child Health (CATCH) El Paso	Coleman (2005) ³⁰
Go For Health Program	Simons Morton (1991) ³¹
Healthy Primary School of the Future	Bartelink (2019), ³² Bartelink (2019), ³³
Kahnawake Schools Diabetes Prevention Project	Paradis (2005) ³⁴
Group non-randomized trial	
APPLE New Zealand (a pilot program for lifestyle and exercise)	Taylor (2006), ³⁵ Taylor (2008), ³⁶ Taylor (2007) ³⁷
Healthier Options for Public School-children (HOPS)	Hollar (2010), ³⁸ Hollar (2010) ³⁹
The Copenhagen School Child Intervention Study	Bugge (2012) ⁴⁰
Repeat cross-sectional with comparison	
Living 4 Life	Utter (2011) ⁴¹
Single group before–after	
CATCH BasicPlus (BP)	Hoelscher (2010) ⁴²
CATCH BasicPlus Community (BPC)	Hoelscher (2010) ⁴²
CATCH Midwest	Vogeltanz-Holm (2018) ⁴³
Healthy Children in Sound Communities – Germany	Naul (2012) ⁴⁴
Healthy Children in Sound Communities – The Netherlands	Naul (2012) ⁴⁴
Wise Mind Healthy Eating and Exercise, 2010	Newton (2010) ⁴⁵

Fourteen U.S. studies reported on racial and ethnic distributions, with 4 interventions implemented among students of a predominant race/ethnicity: American Indian/Alaska Native (100%; 1 study), Black or African American (100%; 1 study), and Hispanic or Latino (93% and >70%; 2 studies). Of the remaining 10 studies, populations were composed of students in the following groups: White (median=58%; 8 studies), Black or African American (median=14%; 9 studies), Hispanic or Latino (median=52%; 9 studies), and Asian (mean=9%; 2 studies).

Outcomes

Details of outcomes that are included within the CPSTF recommendation statement are described below. Additional outcomes assessed are in [Appendix Table 2](#) (available online).

Changes in dietary outcomes. Ten studies reported FV intake ([Table 2](#)^{16–18,20–23,25,26,28–30,32,}

^{34–37,40–46}). Four studies^{16,18,20,37} reported a median relative increase of 12.1% (range= –4.6%, 73.4%) for FV intake for the total day. Five studies in 4 publications^{22,29,34,42} reported a median relative increase of 3.0% (IQR=2.5%, 9.1%) for frequency of FV intake for the total day. One study²¹ reported no change in FV intake at lunch.

Six studies reported SSB intake ([Appendix Table 2](#), available online). Three studies^{18,22,37} reported a median relative decrease of 13.3% (range= –29.2%, –4.0%) in SSB intake per day. Three studies in 2 publications^{21,42} reported a median relative increase of 7.1% (range= –9.0%, 15.4%) in the frequency of SSB intake. Information on other dietary behaviors, including water and indices of low-nutrient food intake and healthy eating, is in [Appendix Table 2](#) (available online).

Changes in physical activity outcomes. Physical activity was reported using several different outcome

Table 2. Recommended Dietary and Physical Activity Outcomes and Overweight and Obesity Prevalence

Outcomes	Results
Dietary outcomes	
Fruit and vegetable	
Number of interventions	10
Median change (IQR or range)	Relative change in amount/d: Increase=12.1% (range= -4.6%, 73.4%) ^{16,18,20,37} Relative change in frequency/d: Increase=3.0% (IQR)=2.5%, 9.1%) ^{22,29,34,42} Lunchtime intake: no change ²¹
Physical activity	
Cardiorespiratory fitness	
1 mile run/walk time	
Number of interventions	3
Change (range)	Decrease=0.20 min (-1.1, 2.2 min) ^{21,25,34}
Timed run	
Number of interventions	4
Change	Timed run: increase=16 yards ¹⁷ 9 min run: boys increase=15 yards; girls increase=9 yards ³⁰ 6 min run: range: increase=44.4, 74.4 yards ⁴⁴
Number of interventions	2
Change	Max ergometer test: increase=0.29 watts/kg ¹⁸ VO ₂ peak (treadmill): Increase=0.46 mL/kg/min ⁴⁰
Counts per minute	
Number of interventions	2
Change	Accelerometer: Range: increase=0.18, 20.4 counts/min ^{26,32}
Time spent in physical activity	
Minutes per day	
Number of interventions	6
Change (IQR)	Increase=21.8 min/d (-0.8, 27.4 min/d) ^{20,23,28,35,45,46}
Changes in weight-related prevalence	
Overweight and obesity prevalence	
Number of interventions	9
Median change (IQR)	Decrease=2.5 PCT pts (-8.1, -1.6 PCT pts) ^{16,26,30,36,42-44}
Obesity prevalence only	
Number of interventions	1
Change	Increase=1.1 PCT pts ⁴¹

d, day; IQR, interquartile interval; min, minute; no., number; NR, not reported; PCT pt, percentage point.

measures. Studies were grouped into cardiorespiratory fitness outcome measures and time spent in physical activity. Results of cardiorespiratory fitness and time spent in physical activity favored the intervention. Eleven studies reported on cardiorespiratory fitness outcome measures (Table 2^{16-18,20-23,25,26,28-30,32,34-37,}

⁴⁰⁻⁴⁶). Three of these studies^{21,25,34} reported a median decrease of 0.20 minutes (range= -1.1, 2.2 minutes) in the 1-mile run/walk; 4 studies in 3 publications^{17,30,44} reported an increase in distance covered during a timed run; 2 studies^{18,40} reported no change in cardiorespiratory fitness measured by a treadmill maximal oxygen uptake test or a maximum ergometer test; and 2 studies reported accelerometer increases of 20.4 counts²⁶ and 0.18 counts per minute, respectively.³² Six studies^{20,23,28,35,45,46} reported on time spent in physical activity. The median increase was 21.8 minutes (IQR= -0.8, 27.4 minutes) of physical activity per day. Information on physical activity during the school day is in Appendix Table 2 (available online).

Changes in weight-related outcomes. Nine studies in 7 publications^{16,26,30,36,42-44} reported change in overweight and obesity prevalence combined following CDC or German definitions.⁴⁴ Results were favorable for the intervention. The baseline median overweight and obesity prevalence combined for these studies was 38.4%, with a reported decrease of 2.5 percentage points (IQR= -8.1, -1.6 percentage points) (Table 2^{16-18,20-23,25,26,28-30,32,34-37,40-46}). One additional study⁴¹ following the WHO definition⁴⁷ assessed only obesity prevalence and reported an increase of 1.1 percentage points (Table 2^{16-18,20-23,25,26,28-30,32,34-37,40-46}).

Twelve studies reported BMI z-score; 10 studies^{20,21,24,33,36,39-41,43,45} were able to be combined to calculate a median effect, which was a decrease of 0.07 (IQR= -0.19, -0.02). Two studies reported BMI z that could not be combined with the other 10: 1 study²⁷ reported no significant effects related to the comparison group, and 1 study¹⁶ reported a beta decrease of 0.019 (p=0.54) (Appendix Table 2, available online). Information on other weight-related outcomes is in Appendix Table 2 (available online).

Additional benefits and potential harms. Studies did not report outcomes the CPSTF postulated as additional benefits or potential harms.

DISCUSSION

On the basis of these findings, the CPSTF recommends school meal, FV snack, and physical activity interventions for elementary students. This is based on evidence of increasing physical activity by providing opportunities for physical activity, modestly increasing FV consumption through school meals and/or snacks, and decreasing the prevalence of overweight and obesity among students up to and including sixth grade. Most studies included additional components outside the school setting to reinforce the content of the intervention. Too few studies took place among middle- and high-school

students to support a recommendation. The CPSTF recommendation for elementary students and this systematic review on which it was based provide evidentiary support for and underscore the value of CDC's Comprehensive Framework for addressing the School Nutrition Environment Framework and Services⁴⁸ and the Increasing Physical Education and Physical Activity: A Framework for Schools,⁴⁹ which address school-based approaches to improve dietary intake and physical education and physical activity, respectively. In turn, these frameworks provide information, tools, and resources that schools and communities can use to implement such interventions.

Findings from this review are applicable to students in the U.S. and other high human development index countries for kindergarten through sixth grade. However, gaps remain, including the need to assess the effectiveness of these interventions among middle- and high-school students. In addition, results were generally favorable among studies that included racial and ethnic minority groups, but the available information limited the ability to explore potential between-group differences more closely. Few studies conducted subpopulation analyses; future studies may consider stratifying results by racial and ethnic groups such as Black or African American, Hispanic or Latino, Asian, American Indian/Alaska Native, and Native Hawaiian/other Pacific Islander students.

Future studies may consider examining whether these interventions offer cobenefits such as improvements in academic achievement, which would meet both educational and public health goals and may provide a stronger motivation for schools and communities to adopt these interventions. One included study among elementary students from families with lower income reported that significantly more children maintained a healthy weight and achieved improvements in math scores and higher, although not significant, reading scores.³⁸ In addition, studies may consider examining these interventions among middle- and high-school students.

Studies may also examine considerations for implementation, which include what amount and types of training are needed by faculty and school staff to implement these interventions, whether effects differ on the basis of the level of implementation (e.g., district-wide, school, specific grade level, classroom), whether schools implement these interventions with fidelity, and to what extent the programs are sustained. Studies may also consider identifying barriers (e.g., cost, lack of resources, potential burden on school staff) to implementing interventions that provide meals or FV snacks and physical activity and information on whether there were differences across schools with a majority lower-income families.

Even though most studies in this review (85%) lasted longer than a school year, seasonal effects were unable to be examined. Assessing whether benefits are lost over the summer is an important future research area for interventions that span multiple school years. This is an important consideration because physical fitness can decline,⁵⁰ and weight gain during elementary school years may occur primarily during summer break.⁵¹

Finally, studies may consider examining the potential harms of these interventions on development of weight or body dissatisfaction or unhealthy weight-control behaviors. No included study reported on these types of outcomes, perhaps because the included studies were primarily among elementary students. The American Academy of Pediatrics cautions that obesity prevention programs may trigger unhealthy weight-control behaviors among children aged ≥ 12 years.⁵² It may thus be important for future studies to modify interventions to reduce the potential for weight or body dissatisfaction or unhealthy weight-control behaviors among students of all ages.

Limitations

There were several limitations to this body of evidence. First, most articles were from peer-reviewed literature, and there is a potential publication bias. However, not all studies published positive effects. The team attempted to address publication bias further by searching gray literature, but no dissertations or other nonpeer-reviewed reports met the inclusion criteria. Second, a formal meta-analysis was not possible owing to varied study designs, few studies reporting CIs or SEs, and reported measures being heterogeneous. The team addressed this by grouping measures for relative percentage change to provide summary statistics when possible. Finally, the maintenance of dietary and weight-related outcomes is unknown because too few studies reported long-term effects.

CONCLUSIONS

Schools can be an important setting for addressing childhood obesity because of the number of hours children spend in schools and because of the role played by schools in providing meals or FV snacks and opportunities for physical activity. Interventions that combine healthy school meals or FV snacks in combination with opportunities for increasing physical activity are an effective way for children to improve FV intake, increase physical activity, and maintain weight status. Findings from this review can inform researchers, school administrators, and public health decision makers about effective strategies to improve students' dietary behavior and

physical activity levels and positively affect weight outcomes.

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SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at <https://doi.org/10.1016/j.amepre.2022.10.003>.

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