

Obesity Prevention and Control: Meal or Fruit and Vegetable Snack Interventions Combined with Physical Activity Interventions in Schools

Community Preventive Services Task Force Finding and Rationale Statement Ratified April 2018

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CPSTF Finding and Rationale Statement

Context

Consuming a healthy diet and participating in regular physical activity can build stronger bones and muscles, help control weight, and reduce the risk of developing health conditions such as heart disease, type 2 diabetes, high blood pressure, and osteoporosis (U.S. Department of Health and Human Services and U.S. Department of Agriculture 2015; 2018 Physical Activity Guidelines Advisory Committee, 2018). In the United States, the percentage of children and adolescents affected by obesity has more than tripled in the past 40 years (Fryar et al., 2014). Data from 2015-2016 show that nearly 1 in 5 school age children and adolescents (6 to 19 years) in the United States has obesity (Hales et al., 2017).

Consuming more energy than the body needs for healthy functioning and growth can lead to excess weight gain (Hill et al., 2012). Many factors contribute to excess weight gain such as high-calorie, low-nutrient foods and beverages, inadequate physical activity, short sleep duration, genetics, and metabolism (U.S. Department of Health and Human Services 2016, U.S. Department of Health and Human Services 2018a). When addressing obesity, a comprehensive approach should be considered such as the [Whole School, Whole Community, Whole Child](https://www.cdc.gov/healthyyouth/wsc/) [https://www.cdc.gov/healthyyouth/wsc/] (WSCC) model, which involves schools, parents, caregivers, community organizations, and health care providers (U.S. Department of Health and Human Services 2018b; U.S. Department of Health and Human Services 2018c).

Schools can play an important role in supporting a healthy diet and physical activity. Most U.S. children ages 5 to 18 years attend school for an average of six to seven hours a day during the school year (National Center for Education Statistics, 2010). Schools can provide students nutritious and appealing foods and beverages. They can also provide opportunities for physical activity to help students accumulate the recommended 60 minutes of physical activity per day (CDC 2011; 2018 Physical Activity Guidelines Advisory Committee).

Intervention Definition

Healthy eating interventions combined with physical activity interventions in schools aim to improve student health by implementing (1) meal or fruit and vegetable snack interventions, with (2) physical activity interventions.

- 1) **Meal or fruit and vegetable snack interventions** are designed to provide healthier foods and beverages* that will be consumed by students, limit access to less healthy foods and beverages, or both. Interventions must include one or more of the following components:
 - School meal policies that ensure school breakfasts or lunches meet specific nutrition requirements (e.g., School Breakfast Program, National School Lunch Program)
 - Fresh fruit and vegetable programs that provide fresh fruits and vegetables to students during lunch or snack
- 2) **Physical activity interventions** engage students in physical activity each day. Interventions must include one of more of the following components:
 - Physical education classes that engage students in physical activity
 - School policies or practices that provide opportunities for physical activity during the school day (i.e., physical activities for students such as recess and classroom breaks)

- Large-scale environmental changes that provide or improve space, facilities, or equipment to make physical activity easy and appealing (e.g., renovating a school playground)

Interventions also may include one or more of the following:

- Healthy food and beverage marketing strategies
- Educational programs that address nutrition or build knowledge and skills needed to maintain physically active lifestyles
- Addition of small-scale equipment to promote physical activity (e.g., jump ropes, balls, cones, team vests, pedometers)
- Staff involvement
- Family and community engagement

*Healthier foods and beverages include fruits, vegetables, whole grains, low-fat or fat-free dairy, lean meats, beans, eggs, nuts, and items that are low in saturated fats, salt, and added sugars, and have no trans fats. Less-healthy foods and beverages include those with more added sugars, fats, and sodium.

CPSTF Finding (April 2018)

The Community Preventive Services Task Force (CPSTF) recommends elementary school-based interventions that combine meal or fruit and vegetable snack interventions that provide healthier foods and beverages that will be consumed by students, limit access to less healthy foods and beverages, or both, with physical activity interventions that get students moving every day. The finding is based on sufficient evidence of effectiveness that shows combined interventions increase physical activity, modestly increase fruit and vegetable consumption, and decrease the prevalence of overweight and obesity among elementary school students up to and including sixth grade.

There were too few studies to determine the effectiveness of these interventions among middle and high school students.

The CPSTF previously recommended [Meal or Fruit and Vegetable Snack Interventions to Increase Healthier Foods and Beverages Provided by Schools](https://www.thecommunityguide.org/findings/obesity-meal-fruit-vegetable-snack-interventions-increase-healthier-foods-beverages-schools) [https://www.thecommunityguide.org/findings/obesity-meal-fruit-vegetable-snack-interventions-increase-healthier-foods-beverages-schools]. Studies included in the current review of combined intervention approaches were not designed to examine the incremental effectiveness of adding physical activity interventions to meal or fruit vegetable snack interventions. Results of this review should not be compared with results from the previous review because the two reviews included different studies that had varying levels of program intensity.

Rationale

Basis of Finding

The CPSTF finding is based on evidence from a systematic review of 21 studies with 22 study arms (search period 1990–July 19, 2017). Of the 21 studies, 15 were conducted in elementary schools.

BMI z-scores and the combined prevalence of overweight/obesity were the most commonly reported weight outcomes. Other weight-related outcomes included overweight prevalence, obesity prevalence, skinfold thickness, and percent body fat. When included studies had a control group, decreases in weight-related outcomes among the intervention group were considered favorable. When included studies did not have a control group, results were considered

favorable if the overall population reported no change or decreases in weight-related outcomes. Based on national trends that show modest increases in obesity prevalence among children (Ogden et al., 2016), included studies without a control group demonstrated potential for a decreased rate of change in obesity prevalence.

Dietary outcomes included intake of fruits and vegetables, sugar-sweetened beverages (SSB), low nutrient foods, and water, and some studies measured outcomes using diet quality indices. Increases in fruit, vegetable, and water consumption were considered favorable. Decreases in SSB and low nutrient food intake were considered favorable. Diet quality indices are composite measures that include aspects of diet adequacy, variety, balance, and moderation. In this review, higher scores indicated better diet quality.

Physical activity outcomes included cardiorespiratory fitness, time spent in physical activity, and accelerometer counts. Cardio fitness was reported as one mile run/walk time, timed run, VO2 peak, or maximum score on cycle ergometer. Increases in the distance covered during a timed run, VO2 peak, maximum cycle ergometer score, time spent in physical activity, and accelerometer counts were considered favorable. Decreases in time for the one mile run/walk were considered favorable.

Interventions demonstrating effectiveness on weight, dietary, and physical activity outcomes are shown in Table 1. It was not always possible to calculate summary effect estimates due to the variability of reported outcome measures in the studies. In these instances, an overall direction for the outcome is provided. Study design indicates whether there was a control group.

Table 1: Weight-related, Diet-related, and Physical Activity-related Outcomes with Sufficient Evidence of Effectiveness

Outcome	Number of Studies	Key Study Findings
Weight-related		
Combined Overweight and Obesity Prevalence	7*	Percent with BMI-for-age and sex \geq 85 percentile: Decrease of 2.0 percentage points, IQI: -6.7 to -0.9 percentage points 7 studies: 3 group RCT, 1 group non-RCT, 3 before-after (no control)
BMI z-score	10*	Median BMI z-score decrease of 0.05, IQI: -0.13 to 0.01 8 studies: 3 group RCT, 3 group non-RCT, 1 repeat cross-sectional with comparison, 1 before-after (no control) BMI z-score: Decrease, NS 1 study: group RCT No statistically significant change 1 study arm: group RCT

Outcome	Number of Studies	Key Study Findings
Diet-related		
Fruit and Vegetable (FV) Intake	10	<p>Relative change in amount of FV consumption per day: Median increase of 12.1% per day, IQI: -4.6% to 73.4% 4 studies: 3 group RCT, 1 group non-RCT</p> <p>Relative change in frequency of FV consumption per day: Median increase of 3.0% per day; IQI: 2.5% to 9.1% 5 studies: 1 prospective cohort, 1 group RCT, 1 other study design with concurrent comparison, 2 before-after (no control)</p> <p>FV consumption during lunch: No change, NS 1 study: group RCT</p>
Physical activity-related		
Cardiorespiratory Fitness	8	<p>Time for 1 mile run/walk Median decrease of 0.20 min; range: -1.1 to 2.2 min 3 studies: 2 group RCT, 1 other study design with concurrent comparison</p> <p>Distance in 9 minute timed run: Boys increased 15 yards, p<0.05; girls increased 9 yards, p<0.05 1 study: other study design with concurrent comparison</p> <p>Increase of 16 yards, NS 1 study: group RCT</p> <p>Distance in 6 minute run: German students increased 74.4 yards; students in the Netherlands increased 44.4 yards; p = 0.001 1 study (2 arms): before-after (no control)</p> <p>Aerobic Power: Increase of 0.46 mL/kg/min; 95% CI: -3.29 to 2.37 mL/kg/min (measured VO₂ peak on treadmill) 1 study: group non-RCT</p> <p>Increase of 0.29 watts/kg, p=0.18 (measured by max cycle ergometer test) 1 study: group RCT</p>

Outcome	Number of Studies	Key Study Findings
Time Spent in Physical Activity	10	<p>Physical activity throughout day: Median increase of 21.8 min/d; IQI: -0.8 to 27.3 min/d 6 studies: 4 group RCT, 1 group non-RCT, 1 before-after (no control)</p> <p>Physical activity during school: Moderate to vigorous physical activity: increase of 9.9 minutes per PE class 1 study: other study design with concurrent comparison</p> <p>Percent of students who reported being active during lunch period: Increase of 4.9 percentage points, p=0.57 1 study: repeat cross-sectional with comparison</p> <p>Mean percent of PE class time spent in moderate to vigorous physical activity (direct observation): range increase of 4.1 to 5.5 percentage points, NS 2 studies: 2 before-after (no control)</p>

CI = confidence interval

IQI = interquartile interval

NS = not significant

RCT = randomized control trial

mL/kg/min = milliliters of oxygen per kilogram of body weight per minute

watts/kg = watts per kilogram

*Studies that report BMI z-score and prevalence data are represented in each outcome category.

Interventions with insufficient evidence of effectiveness on weight, dietary, and physical activity outcomes are shown in Table 2. Insufficient evidence was based on too few studies or inconsistent results. It was not always possible to calculate summary effect estimates due to the variability of reported outcome measures in the studies. In these instances, an overall direction for the outcome is provided. Study design indicates whether there was a control group.

Table 2: Weight-related, Diet-related, and Physical Activity-related Outcomes with Insufficient Evidence of Effectiveness

Outcome	Number of Studies	Key Study Findings	Summary
Weight-related Outcomes			
Obesity Prevalence	4*	<p>Percent with BMI-for-age and sex > 95 percentile: Median decrease of 0.4 percentage points; IQI: -3.6 to 1.1 percentage points 4 studies: 1 group RCT, 1 repeat cross-sectional with comparison, 2 before-after (no control)</p>	Too few studies to draw a conclusion about this outcome measure
Overweight Prevalence	3*	<p>Percent with BMI-for-age and sex \geq 85 percentile and < 95 percentile: Median increase of 0.6 percentage points; range -4.7 to 6.0 percentage points 3 studies: 1 group RCT, 2 before-after (no control)</p>	Too few studies to draw a conclusion about this outcome measure

Outcome	Number of Studies	Key Study Findings	Summary
Skinfold Measure	3	<p>Sum of four skinfolds: Increase of 1.5 millimeters, NS 1 study: group non-RCT</p> <p>Sum of triceps and subscapular skinfold thickness: Increase of 0.2 millimeters, NS 1 study: group RCT</p> <p>Decrease of 5.7 millimeters, p<0.01 1 study: other study design with concurrent comparison</p>	Inconsistent results for this outcome measure
Percent Body Fat	5	<p>Percent body fat: Median increase of 0.22 percentage points; range -0.8 to 1.1 4 studies: 2 group RCT, 1 repeat cross sectional with comparison, 1 before-after (no control)</p> <p>No statistically significant effects 1 study: group RCT</p>	Inconsistent results for this outcome measure
Diet-related Outcomes			
Sugar Sweetened Beverage (SSB) Intake	8	<p>Relative change in amount of SSB consumption per day: Median decrease of 13.3% per day; range: -29.2% to -4.0% 3 studies: 2 group RCT, 1 other design with concurrent comparison</p> <p>Relative change in frequency of SSB consumption per day: Median increase of 7.1% per day; range: -9.0 to 15.4% per day 3 studies: 1 group RCT, 2 before-after (no control)</p> <p>Number of servings of SSBs consumed per day: Non-significant decrease 1 study: group RCT</p> <p>Percent of students reporting soft drink consumption on all of the past 5 days: Decrease of 7.1%, NS 1 study: repeat cross-sectional with comparison</p>	Inconsistent results for this outcome measure

Outcome	Number of Studies	Key Study Findings	Summary
Low-Nutrient Food Intake	7	<p>Number of servings of sweets and beverages per day: Decrease of 1.0 servings per day, $p < 0.05$ 1 study: group RCT</p> <p>Number of servings of sweets/snacks/desserts consumed per day: Non-significant decrease 1 study: group RCT</p> <p>Biscuits/cakes, chips/fries, candy grams per day: Increase of 13.7 g/d, NS 1 study: group RCT</p> <p>Salty or sweet snacks per day: No change 1 study: group RCT</p> <p>Sugar Consumption Index: Increase of 0.11, NS 1 study: other design with concurrent comparison</p> <p>Unhealthy Foods Index: Increase of 0.7, $p < 0.05$ and 0.10, NS 2 studies: both before-after (no control)</p>	Inconsistent results for this outcome measure
Water Intake	2	<p>Child-reported total number of servings of water over a 3-day period: Increase of 0.7, $p = 0.07$ 1 study: group non-RCT</p> <p>Child-reported number of glasses of water per day in a typical week: Non-significant increase 1 study: group RCT</p>	Too few studies to draw a conclusion about this outcome measure
Diet Quality Indices	3	<p>Healthy eating indices: range: increase 0.3 to 2.60 3 studies: 1 group RCT, 2 before-after (no control)</p>	Too few studies to draw a conclusion about this outcome measure

Outcome	Number of Studies	Key Study Findings	Summary
Physical Activity-related Outcomes			
Additional Physical Activity Measures	2	Counts per min (accelerometer): Increase of 20.4, NS 1 study: group RCT Parent-report child participates in sports: Non-significant increase 1 study: group RCT	Too few studies to draw a conclusion about this outcome measure

CI = confidence interval

IQI = interquartile interval

NS = not significant

RCT = randomized control trial

*Studies that report BMI z-score and prevalence data are represented in each outcome category.

Applicability and Generalizability Issues

Included studies were conducted in the United States (13 studies), Canada (1 study), Denmark (1 study), Greece (1 study), Iceland (1 study), New Zealand (2 studies), and Norway (1 study); one study took place in two countries (Germany and the Netherlands). Studies were conducted in schools alone (7 studies) or in schools plus one or more settings (14 studies). Seventeen studies reported information about urbanization. Studies were conducted in urban (5 studies), suburban (1 study), rural (2 studies), and mixed settings (9 studies). Interventions were effective across countries, intervention settings, and degree of urbanization.

Interventions included children ages 6 to 13 years. Of the 21 studies included in the review, 15 studies (16 study arms) were conducted in schools K-5th grade, five were conducted in schools K-6th grade, and one was done with students ages 11-13 (U.S. equivalent of 6th-8th grade). No studies included only middle or high school students.

Included studies reported roughly equal numbers of males and females and showed similar effectiveness among both populations.

Fourteen U.S. studies that reported racial and ethnic distributions showed intervention effectiveness across reported groups. Populations were composed of students in the following groups: white (median 58%; 6 studies), black (median 13.9%; 8 studies), and Hispanic (median 54.9%; 8 studies). Four of the 14 studies were conducted with a predominant race/ethnicity: Native American (100.0%; 1 study), black (100%, 1 study), and predominantly Hispanic (2 studies).

Interventions were effective among primarily low-income populations in six of seven studies that reported outcomes for this population.

One study reported greater effects for weight-related outcomes among students who were obese at baseline when compared with students who were overweight or normal weight.

Data Quality Issues

Study designs included group randomized controlled trials (9 studies), non-randomized trials (3 studies), prospective cohorts (1 study), other designs with a concurrent comparison group (3 studies), repeated cross-sectionals with comparison (1 study), and single group before-after (4 studies).

Dietary outcomes were based primarily on self-reported data, and physical activity and weight-related outcomes were usually measured by trained staff. Common limitations of self-reported dietary data included participants forgetting about consumption of specific foods or beverages, inaccurately estimating portion sizes, and inadvertently or intentionally failing to report specific items (Grandjean, 2012). Most studies addressed these limitations by using age-appropriate, validated instruments. All studies that provided weight outcomes reported measured height and weight.

When it was not possible to calculate an effect estimate because inconsistent measures were reported, findings were summarized narratively.

Other Benefits and Harms

Other potential benefits of these interventions include improvements in cardiometabolic outcomes such as systolic blood pressure, diastolic blood pressure, and total cholesterol. Seven of the included studies measured these outcomes. They reported a median decrease in systolic blood pressure of 3.5 millimeters of mercury (mmHg; IQI: -4.5 to -1.5 mmHg; 7 studies), a median decrease in diastolic blood pressure of 2.8 mmHg (IQI: -3.0 to -1.0 mmHg; 5 studies), and a median decrease in total cholesterol of 0.4 milligrams/deciliter (mg/dL; range: -7.4 to 0.2 mg/dL; 3 studies). Because these interventions were implemented among general student populations, the meaningfulness of these outcomes in terms of cardiovascular disease risk and disease as adults is unknown.

Other potential benefits of these interventions include student enjoyment and development of taste preferences for fruits and vegetables. Programs may also contribute to improved academic performance and focus and fewer reports of behavioral problems. One included study reported results from a statewide achievement test (Hollar, 2010) and showed improvements in math and reading scores at 24 months.

While no potential harms of the intervention were identified within the included studies, postulated harms include body dissatisfaction or unhealthy dieting behavior and overexertion from physical activity.

Economic Evidence

A systematic review of economic evidence (search period 1990 through July 2017) included one study from the United States. All monetary values are reported in 2016 U.S. dollars.

The study evaluated an intervention that worked with four elementary schools to implement a curricula addressing healthy eating and physical activity; modify food services and meals; make small scale changes to the physical activity environment; and train teachers and food staff.

The study used observed reductions in students' weight to model quality-adjusted life years gained, healthcare cost averted, and productivity gains in adulthood. The intervention cost an estimated \$132 per person. This estimate was assessed to be fair in quality because it did not include important drivers of cost such as materials, supplies, and small scale improvements in infrastructure for food services and physical activity. Based on the model, averted healthcare costs would be \$109 per person, productivity improvements would be \$227 per person, and quality adjusted life-years (QALY) would be 0.02 per person. These estimates were assessed to be of good quality. The cost per QALY gained was \$1,143, and this estimate was assessed to be of fair quality.

The CPSTF did not issue an economic finding for this intervention because there were not enough studies.

Considerations for Implementation

Most of the included studies were aligned with evidence-based policies supported at the federal, state, and district levels to improve nutrition and increase physical activity in schools. Many of the included studies evaluated interventions that used existing guidelines such as the National School Lunch Program. To ensure interventions are high-quality, implementers should closely align them with national recommendations that are current and evidence-based.

Many of the included studies used interventions that lasted two school years. Schools implementing similar interventions should take the time commitment into account and consider what may be required to sustain change.

Implementers will need to decide which intervention components to emphasize. The most commonly used dietary component in the included studies was a school lunch intervention (16 studies). Some schools followed specified guidelines to ensure school meals met certain criteria for total energy and percent of total energy from fat. Others offered salad bars or employed a registered dietitian to teach a nutrition education curriculum. Physical activity interventions used in the included studies were more varied. Examples included increasing the amount of PE class dedicated to moderate or vigorous physical activity or offering physical activity breaks during class time.

Interventions in the included studies took place in elementary schools and varied in intensity. Some of the studies only implemented dietary and physical activity components that pertained to policy or environmental changes. More than half of the studies also included nutrition education and education about the importance of an active lifestyle and chronic disease prevention. Most of the included studies used existing staff (e.g., teachers, food service staff) to implement intervention changes; some also included additional professionals (e.g., registered dietitians).

The Community Guide review team performed stratified analyses to examine the influence of physical activity components on weight-related and physical activity outcomes. Interventions were split into four, mutually exclusive strata that combined the same dietary intervention with (1) physical education classes; (2) physical activity opportunities; (3) physical education classes and physical activity opportunities combined; and (4) large-scale environmental change. The first strata included five studies and showed favorable results for increased physical activity. The second strata included seven studies and demonstrated a small decrease in BMI z-scores and inconsistent results for dietary and physical activity behaviors. The third strata included seven studies and reported favorable results for overweight/obesity prevalence combined. The last strata included two studies and found mixed results for all outcomes.

Communities and schools looking to implement combined nutrition and physical activity interventions should consider efforts to promote adoption, training of appropriate staff, and necessary funding. Some groups may resist program implementation including teachers, staff, parents, or students.

CDC promotes the [School Nutrition Environment Framework](https://www.cdc.gov/healthyschools/nutrition/pdf/School_Nutrition_Framework_508tagged.pdf) [https://www.cdc.gov/healthyschools/nutrition/pdf/School_Nutrition_Framework_508tagged.pdf] and the [Comprehensive School Physical Activity Program Framework](https://www.cdc.gov/healthyschools/physicalactivity/pdf/17_278143-A_PE-PA-Framework_508.pdf) [https://www.cdc.gov/healthyschools/physicalactivity/pdf/17_278143-A_PE-PA-Framework_508.pdf], which address school-based dietary intake and physical education and physical activity, respectively.

Evidence Gaps

Additional research and evaluation are needed to answer the following questions and fill existing gaps in the evidence base.

- What are the best measures for dietary intake, physical activity, and weight-related outcomes? Increased consensus on definitions would improve comparability and the ability to synthesize evidence.
- Do these interventions lead to other benefits (e.g., academic achievement) or potential harms (e.g., body dissatisfaction)?
- Are schools implementing interventions with high fidelity?
- What amount of training is needed for faculty?
- Do effects differ based on the level of implementation (e.g., district-wide, school, specific grade level, classroom)?
- What is the effect of program duration on key outcomes? Would interventions less than one school year have similar results, or is a longer time period needed to change dietary and physical activity habits?
- When interventions span multiple school years, are benefits lost over the summer?
- Are interventions effective among middle and high school students?
- Are interventions equally effective among different racial and ethnic populations, especially black students? In this review, results were generally favorable among studies that included racial/ethnic minorities, but future studies should stratify results by race/ethnicity.
- Are interventions serving appealing foods and beverages that students are willing to eat, especially fresh fruits and vegetables?
- What is the incremental effectiveness of adding physical activity interventions to meal or fruit and vegetable snack interventions?
- How much does it cost to implement interventions? More economic evaluations are needed.
- Which components are used to estimate costs? Studies should itemize the components used to calculate cost estimates.

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Disclaimer

The findings and conclusions on this page are those of the Community Preventive Services Task Force and do not necessarily represent those of CDC. Task Force evidence-based recommendations are not mandates for compliance or spending. Instead, they provide information and options for decision makers and stakeholders to consider when determining which programs, services, and policies best meet the needs, preferences, available resources, and constraints of their constituents.

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