

Obesity Prevention and Control: Interventions to Support Healthier Foods and Beverages in Schools

Community Preventive Services Task Force Finding and Rationale Statement Ratified December 2016

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Community Preventive Services Task Force Finding and Rationale Statement

Context

Healthy eating during childhood is important for optimal growth, helps prevent high cholesterol and high blood pressure, and helps reduce one's risk for developing osteoporosis, iron deficiency, dental caries, and obesity (Centers for Disease Control and Prevention, 1998; Dietary Guidelines Advisory Committee, 2010). With an estimated one in three school-aged children and adolescents being overweight or obese (Ogden et al., 2014), promoting healthier dietary habits during childhood is critical. Schools can play an important role in preventing obesity because most U.S. children attend school six hours a day and consume as much as half of their daily calories at school (Centers for Disease Control and Prevention, 2016a). Schools can provide nutritious and appealing foods and beverages in all venues accessible to students, including cafeterias, vending machines, school stores, and concession stands (CDC, 2011).

Interventions Definition

These interventions aim to provide healthier foods and beverages that will be consumed by students, limit access to less healthy foods and beverages, or both. 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.

Approaches to support healthier foods and beverages in schools must include one of the following:

1. **Meal or fruit and vegetable snack interventions to increase healthier foods and beverages provided by schools.** These interventions must include one 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. **Interventions supporting healthier snack foods and beverages sold or offered as a reward in schools** must include one of the following components:
 - Food and beverage policies that require foods and beverages sold during the school day, outside of school meal programs, meet established nutritional standards or guidelines. These foods and beverages are often referred to as “competitive foods and beverages” as they are sold in competition with school meal programs, and include in-school fundraisers, a la carte foods, vending machines, school stores, and snack bars.
 - Celebration and reward rules or policies that encourage healthy foods and beverages be served during classroom celebrations, parties, and special events or encourage rewards of nonfood items for academic achievement.
3. **Multicomponent interventions to increase availability of healthier foods and beverages in schools** must include one component from each of the interventions described above (1. **meal or fruit and vegetable snack interventions** in combination with 2. **healthier snack foods and beverages**).

4. **Interventions to increase water access in schools** ensure students have access to safe, free drinking water during the school day. Interventions may include one or more of the following components aimed at increasing students' water intake:
 - Procedures to ensure water fountains are clean and maintained
 - Availability of water fountains and hydration stations throughout the school
 - Policies allowing students to have water bottles in class

Each intervention may also include one or more of the following:

- Healthy food and beverage marketing strategies:
 - Placing healthier foods and beverages where they are easy for students to select
 - Pricing healthier foods and beverages at a lower cost
 - Setting up attractive displays of fruits and vegetables
 - Offering taste tests of new menu items
 - Posting signs or verbal prompts to promote healthier foods and beverages and new menu items
- Healthy eating learning opportunities such as nutrition education and other strategies that give children knowledge and skills to help choose and consume healthier foods and beverages.

CPSTF Findings (December 2016)

The Community Preventive Services Task Force issued separate findings for four types of interventions to increase the availability of healthier meals, snacks, and beverages in schools.

- The Community Preventive Services Task Force recommends **meal interventions and fruit and vegetable snack interventions to increase the availability of healthier foods and beverages provided by schools** based on sufficient evidence of effectiveness for increasing fruit and vegetable consumption and reducing or not changing the prevalence of obesity or overweight. Evidence was favorable for fruit and vegetable consumption primarily due to fruit and vegetable programs. Economic evidence shows that meal interventions and fruit and vegetable snack interventions are cost-effective.
- The Community Preventive Services Task Force finds insufficient evidence to determine the effectiveness of **interventions supporting healthier snack foods and beverages sold or offered as a reward in schools**. Evidence is considered insufficient based on inconsistent findings for sugar-sweetened beverage consumption outcomes and too few studies for weight and other dietary outcomes.
- The Community Preventive Services Task Force recommends **multicomponent interventions to increase availability of healthier foods and beverages in schools (i.e., meal or fruit and vegetable snack interventions in combination with healthier snack foods and beverages)** on the basis of sufficient evidence of effectiveness for reducing or not changing the prevalence of obesity or overweight.
- The Community Preventive Services Task Force finds insufficient evidence to determine the effectiveness of **interventions to increase water access in schools**. Evidence is considered insufficient because there were too few studies.

Rationale

Basis of Finding

In 2013, the Agency for Healthcare Research and Quality (AHRQ) conducted a meta-analysis on the effectiveness of childhood obesity prevention programs implemented in six intervention settings and reported moderate evidence of effectiveness in school settings (Wang et al., 2013). The CPSTF findings are based on a subset of studies from the AHRQ review that focused on dietary-only approaches in schools (Wang et al., 2013; 15 studies, search period through August 2012) combined with more recent evidence (20 additional studies, search period August 2012 through March 8, 2016). The 4 intervention approaches in this review align with the Center for Disease Control and Prevention's Comprehensive Framework for Addressing the School Nutrition Environment and Services (CDC, 2016b): meal interventions and fruit and vegetable snack interventions to increase the availability of healthier foods and beverages provided by schools (25 studies); interventions supporting healthier snack foods and beverages sold or offered as a reward in schools (13 studies); multicomponent interventions to increase availability of healthier foods and beverages in schools (i.e., meal or fruit and vegetable snack interventions in combination with healthier snack foods and beverages; 11 studies); and interventions to increase water access in schools (2 studies).

Dietary outcomes included intake of energy, sugar-sweetened beverages (SSB), low nutrient foods, fruits and vegetables, milk and alternatives to dairy products, water, or 100% fruit juice, and overall diet quality indices.

For energy intake, a favorable direction is dependent on age, length of follow-up, and baseline obesity prevalence. Decreases in SSB and low nutrient food intake were considered favorable. Increases in fruit and vegetable, milk or dairy alternatives, water, and 100% fruit juice intake were considered favorable. Diet quality indices are composite measures of diet quality that include aspects of diet adequacy, variety, balance, and moderation. For the indices reported in this review, a higher score indicates better diet quality.

Weight outcomes were assessed by overweight/obesity prevalence and BMI z-score. When studies did not have control groups, then no changes or minimal decreases in weight outcomes were considered favorable as this demonstrated potential for a decreased rate of change in obesity prevalence.

Results of the intervention effect on weight-related and diet-related outcomes are shown in Table 1. It was not possible to calculate summary effect estimates due to the variability of outcome measures. However, an overall direction for each outcome is provided. Study design is provided for weight-related outcomes in order to show whether a control group was used and whether no change was favorable.

Table 1. Intervention Effect on Weight-related and Diet-related Outcomes

	Meal or Fruit and Vegetable Snack Interventions to Increase Healthier Foods and Beverages Provided by Schools	Interventions Supporting Healthier Snack Foods and Beverages Sold or Rewarded in Schools	Multicomponent Interventions to Increase Availability of Healthier Foods and Beverages in Schools	Interventions to Increase Water Access in Schools
Overweight/Obesity Prevalence	<p>Obesity Prevalence: Decrease of 7.7 percentage point, NS (1 study; post only with comparison)</p> <p>Overweight/Obesity Prevalence: Median decrease of 9.6, IQI -10.7 to -1.6 (5 studies; 1 repeat cross sectional, 2 before after, 2 post only with comparison)</p> <p><i>Summary: Favorable Effect</i></p>	<p>Obesity Prevalence: Strong Law Arm: Beta 0.0, NS (1 study; before-after)</p> <p>Elementary School ≥4 strong laws: Odds Ratio: 0.57 (0.34, 0.97) 2-3 strong laws: Odds Ratio: 0.57 (0.36, 0.90)</p> <p>Middle & High School ≥4 strong laws: No change 2-3 strong laws: No change (1 study; repeat cross-section; reference group: state with no school laws or only 1 non-competitive food & beverage law)</p> <p>Overweight Prevalence: Strong Law Arm: decrease of 2.8, p=0.04 (1 study; before-after)</p> <p>Elementary School ≥4 strong laws: Odds Ratio: 1.04 (0.59,1.84) 2-3 strong laws: Odds Ratio: 0.97 (0.61,1.52)</p> <p>Middle School ≥4 strong laws: Odds Ratio: 0.76 (0.57,0.99)</p>	<p>Obesity Prevalence: Decrease of 1.0 percentage point (1 study; group RCT)</p> <p>Odds of Obesity: 0.85 (1 study; post-only with comparison)</p> <p>Overweight Prevalence: Odds of Overweight: 0.92 (1 study; post-only with comparison)</p> <p>Obesity/Overweight Prevalence: Decrease of 0.01%, NS (1 study; group RCT)</p> <p>Increase of 0.6 percentage points (significance not reported)* (1 study; repeat cross-sectional)</p> <p><i>Summary: Favorable Effect</i></p>	<p>Obesity Prevalence: Girls: decrease of 0.2 percentage points, NS Boys: decrease of 0.5 percentage points, p=0.08 (1 study; repeat cross-sectional with comparison)</p> <p>Overweight/Obesity Prevalence: Girls: decrease of 0.6 percentage points, p=0.07 Boys: decrease of 1.2 percentage points; p<0.01 (1 study; repeat cross-sectional with comparison)</p> <p>Odds Ratio: 0.69, 95% CI: 0.48, 0.98 (1 study; group RCT)</p> <p><i>Summary: Too few studies; included studies favorable</i></p>

	Meal or Fruit and Vegetable Snack Interventions to Increase Healthier Foods and Beverages Provided by Schools	Interventions Supporting Healthier Snack Foods and Beverages Sold or Rewarded in Schools	Multicomponent Interventions to Increase Availability of Healthier Foods and Beverages in Schools	Interventions to Increase Water Access in Schools
		2-3 strong laws: Odds Ratio: 0.70 (0.5, 0.90) High School ≥4 strong laws: Odds Ratio: 1.11 (0.79, 1.55) 2-3 strong laws: Odds Ratio: 1.21 (0.90,1.60) (1 study; repeat cross-section; reference group: state with no school laws or only 1 non-competitive food & beverage law) Overweight/Obesity Prevalence: Strong law: Odds Ratio: 1.01 (0.8, 1.3) (1 study; post-test with comparison) <i>Summary: Too few studies; included studies favorable</i>		
BMI z-score	Median: 0.01; range -0.14 to 0.03 (3 studies; 1 RCT, 1 post only with comparison, 1 time series)	Strong Law Arm: decrease of 0.10, NS (1 study; before-after)	Decrease of 0.01 (1 study; group RCT) Increase in both groups in BMIz, $p < .001$ (1 study; group RCT)	Girls: decrease of 0.01; $p > 0.05$ Boys: decrease of 0.02; $p = 0.04$ (1 study; repeat cross-sectional with comparison) No intervention effect (1 study; group RCT)

	Meal or Fruit and Vegetable Snack Interventions to Increase Healthier Foods and Beverages Provided by Schools	Interventions Supporting Healthier Snack Foods and Beverages Sold or Rewarded in Schools	Multicomponent Interventions to Increase Availability of Healthier Foods and Beverages in Schools	Interventions to Increase Water Access in Schools
	<i>Summary: Too few studies; included studies mixed</i>	<i>Summary: Too few studies; included study favorable</i>	<i>Summary: Too few studies; included studies mixed</i>	<i>Summary: Too few studies; included studies no effect</i>
Energy Intake	<p>Median: decrease of 25.8 kilocalories per day (range -452.2 to 4.5 kilocalories per day) (4 studies)</p> <p>Decrease of 3.17 kilocalories at lunch, NS (1 study)</p> <p><i>Summary: Too few studies; included studies mixed</i></p>	<p>Adjusted difference: -157.8 kilocalories per day (1 study)</p> <p><i>Summary: Too few studies</i></p>	<p>Mean energy intake (kilocalories per day): Increase of 85 kilocalories per day, NS (1 study)</p> <p>Decrease of 248 kilocalories/day, p<0.001 (1 study)</p> <p>Mean energy intake at lunch Increase of 44 kcal at lunch (95% CI: 26.6, 62.0) (1 study)</p> <p><i>Summary: Too few studies; included studies mixed</i></p>	<i>Summary: No Studies</i>
Sugar Sweetened Beverage (SSB) Intake		<p>Range: -0.33 to 0.08 servings per day (3 studies; both studies reduced availability of SSB in schools)</p> <p>Sweet drinks at school: Decrease of 0.25, NS (1 to 4 scale) (1 study)</p>	<p>Decrease of 0.3 servings per day, p<0.05</p> <p>Decrease of 4.7 ounces at lunch, p<0.05 (1 study)</p> <p>Decrease of 0.20 servings per day (95% CI: -0.27, -0.12)</p>	No intervention effect 1 study

	Meal or Fruit and Vegetable Snack Interventions to Increase Healthier Foods and Beverages Provided by Schools	Interventions Supporting Healthier Snack Foods and Beverages Sold or Rewarded in Schools	Multicomponent Interventions to Increase Availability of Healthier Foods and Beverages in Schools	Interventions to Increase Water Access in Schools
	<i>Summary: No Studies</i>	<p>Child consumed ≥ 1 SSB/d in schools with SSB Adjusted Odds Ratio: 3.25, $p < 0.001$ (1 study)</p> <p>Ban soda: Prevalence difference 2.3, NS</p> <p>Ban all SSB: Prevalence difference 5.5 (0.6, 11.1) (1 study, 2 arms; reduced availability of soda or SSB in schools)</p> <p>Soda servings per week Soda banned (vending) increase of 0.2 servings per week (1 study)</p> <p>Soda consumption: Decreased soda consumption among African American students, but not total population (1 study)</p> <p><i>Summary: included studies mixed</i></p>	<p>Decrease of 0.09 cans or glasses of regular soda per day (95% CI: -0.11, -0.06) (1 study)</p> <p>Increase of 1 serving per SSB yesterday: OR 1.08, NS (1 study)</p> <p><i>Summary: Too few studies; included studies favorable</i></p>	<i>Summary: Too few studies; included study no effect</i>
Low-Nutrient Food Intake	Sweets: Decrease of 0.14 portions per day (95% CI: -0.53, 0.26 portions per day)	Sweet snacks: decrease of 0.10, NS Salty snacks: decrease of 0.20, NS	Odds of meeting recommended intake of low-nutrient dense food 2.14 (1.62, 2.82) (1 study)	

	Meal or Fruit and Vegetable Snack Interventions to Increase Healthier Foods and Beverages Provided by Schools	Interventions Supporting Healthier Snack Foods and Beverages Sold or Rewarded in Schools	Multicomponent Interventions to Increase Availability of Healthier Foods and Beverages in Schools	Interventions to Increase Water Access in Schools
	<p>Crisps: Decrease of 0.04 portions per day (95% CI:-0.25, 0.18 portions per day) (1 study)</p> <p>Soda/Candy/Chips: Decreases of 0.40 and 0.58 times per week (1 study, 2 arms)</p> <p>Intake of energy-dense, micronutrient-poor food or drink at breakfast: -2.3, p=0.02 (1 study)</p> <p><i>Summary: Too few studies; included studies favorable</i></p>	<p>(1 to 4 scale) 1 study</p> <p>Candy: In school: Odds Ratio 0.97, NS Out of school: Odds Ratio 0.99, NS</p> <p>Pastries: In school: Odd Ratio 0.44, p= 0.00 Out of School: Odds Ratio 1.4, p=0.06</p> <p>Chips: In school: Odds Ratio 0.87, NS Out of school: Odds Ratio 1.17, NS (1 study)</p> <p><i>Summary: Too few studies; included studies favorable</i></p>	<p><i>Summary: Too few studies; included study favorable</i></p>	<p><i>Summary: No Studies</i></p>
Fruit and Vegetable (FV) Intake	<p>Fruit and Vegetable: Relative median increase of 20.0%; IQI: 4.3% to 38.5% (8 studies, 9 arms)</p> <p>Decrease of 0.15 servings per day of fruit, NS</p>	<p>Fruit: In school: Odds Ratio 1.01, NS Out of school: Odds Ratio 1.21, p=0.09</p> <p>Vegetable: In school: Odds Ratio 1.08, NS Out of school:</p>	<p>Relative increase in consumption: 15 (range: 1.0, 45.0) (4 studies)</p> <p>Decrease of 0.08 servings per day, NS (1 study)</p>	

	Meal or Fruit and Vegetable Snack Interventions to Increase Healthier Foods and Beverages Provided by Schools	Interventions Supporting Healthier Snack Foods and Beverages Sold or Rewarded in Schools	Multicomponent Interventions to Increase Availability of Healthier Foods and Beverages in Schools	Interventions to Increase Water Access in Schools
	<p>Increase of 0.36 servings per day of vegetables, p=0.01 (1 study)</p> <p>Increase of 0.45 cups per day of fruit, (0.07, 0.84)</p> <p>Increase of 0.61 cups per day of vegetables, NS (1 study)</p> <p>Lunch intake Increase of 0.17 servings of fruit at lunch, p<0.05 Decrease of 0.06 servings of vegetables at lunch, NS (1 study)</p> <p>Increase 0.06 cups of fruit at lunch, NS Decrease 0.03 cups of vegetables at lunch, NS (1 study)</p> <p>Decrease of 0.06 cups of FV at lunch; p=0.01 (1 study)</p> <p>Breakfast intake</p>	<p>Odds Ratio 0.94, NS (1 study)</p> <p>Fruit intake: increase of 0.17 cups/day, (0.02, 0.32)</p> <p>Vegetable: decrease of 0.03 cups/day, NS (1 study)</p> <p><i>Summary: Too few studies; included studies no effect</i></p>	<p><i>Summary: Too few studies; included studies no effect</i></p>	<p><i>Summary: No Studies</i></p>

	Meal or Fruit and Vegetable Snack Interventions to Increase Healthier Foods and Beverages Provided by Schools	Interventions Supporting Healthier Snack Foods and Beverages Sold or Rewarded in Schools	Multicomponent Interventions to Increase Availability of Healthier Foods and Beverages in Schools	Interventions to Increase Water Access in Schools
	<p>Decrease of 0.41% of students reporting fruit intake at breakfast, NS (1 study)</p> <p>Snack intake FV at morning snack Arm 1 Increase of 0.81 of FV at snack, NR Arm 2 Increase of 0.56 of FV at snack, NR</p> <p>Other Increase in home consumption for 10 of 17 vegetables and fruit; NS (1 study)</p> <p>Eat > 1 fruit daily City and suburb: Odds Ratio: 1.00, NS Town and rural: odds Ratio: 1.19, p=0.04 Eat > 1 vegetable daily City and suburb: Odds Ratio: 1.07, NS Town and rural: odds Ratio: 1.24, p=0.01 (1 study)</p> <p>Fruit>1 time per day in</p>			

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	<p>preceding 7 days: increase of 18.8 percentage points, NS Vegetables >3 times per day in preceding 7 days: decrease of 0.9 percentage points, NS (1 study)</p> <p>Fruit: In school: increase of 0.06 servings per day, NS Whole day: increase of 0.09 servings per day, NS (1 study)</p> <p><i>Summary: Favorable Effect</i></p>			
Intake of Milk and Alternatives to Dairy Products	<p>Decrease of 0.05 servings per day, p=0.07 (1 study)</p> <p>Increase of 0.21 servings per day, p<0.001 (1 study)</p> <p>Increase of 8.7 percentage points at breakfast of students reporting any milk intake, NS (1 study)</p> <p>Increase of 3.7% milk at lunch, NS (1 study)</p>	<p>Milk: In school: Odds Ratio 0.97, NS Out of school: Odds Ratio 1.24, p=0.04 (1 study)</p>	<p>Increase of 4.1 ounces of milk at lunch, p<0.05 (1 study)</p> <p>Increase of 0.18 servings of milk and alternatives to dairy per day (95% CI: 0.80, 0.28) (1 study)</p> <p>Increase of 0.24 servings of milk/dairy products per day (95% CI: 0.18, 0.31) (1 study)</p>	<p><i>Summary: No Studies</i></p>

	Meal or Fruit and Vegetable Snack Interventions to Increase Healthier Foods and Beverages Provided by Schools	Interventions Supporting Healthier Snack Foods and Beverages Sold or Rewarded in Schools	Multicomponent Interventions to Increase Availability of Healthier Foods and Beverages in Schools	Interventions to Increase Water Access in Schools
	<p>Decrease of 0.46 oz of milk at lunch, NS (1 study)</p> <p><i>Summary: included studies mixed</i></p>	<p><i>Summary: Too few studies; included study favorable</i></p>	<p><i>Summary: Too few studies; included studies favorable</i></p>	
Water Intake	<p><i>Summary: No studies</i></p>	<p>Water (serv/wk) Soda banned (vending): increase of 0.7 serv/wk</p> <p>See next row: one study combined water and fruit juice.</p> <p><i>Summary: See next row</i></p>	<p><i>Summary: No studies</i></p>	<p>Increase of 1.1 glasses/day; p<0.001 (1 study)</p> <p><i>Summary: Too few studies; included study favorable</i></p>
Fruit Juice Intake	<p>Decrease of 0.01 servings at lunch, NS (1 study)</p> <p>Increase of 0.31% in percentage of students reporting fruit juice with breakfast, NS (1 study)</p> <p>Increase of 0.03 cups at lunch, NS (1 study)</p>	<p>In School: Odds Ratio 0.73, p<0.05</p> <p>Out of School: Odds Ratio 0.82, p=0.10 (1 study)</p> <p>Girls: decrease of 0.21 servings per day, p<0.05</p> <p>Boys: increase of 0.05 servings per day, NS (1 study)</p> <p>100% fruit juice (servings per week) Soda banned (vending)</p>		<p>Decrease of 0.1 glasses/day, NS 1 study</p>

	Meal or Fruit and Vegetable Snack Interventions to Increase Healthier Foods and Beverages Provided by Schools	Interventions Supporting Healthier Snack Foods and Beverages Sold or Rewarded in Schools	Multicomponent Interventions to Increase Availability of Healthier Foods and Beverages in Schools	Interventions to Increase Water Access in Schools
	<i>Summary: Too few studies; included studies no effect</i>	Increase of 0.4 servings per week, NS 100% Fruit Juice and Water (1 to 4 scale) At school: increase of 0.33, NS At home: decrease of 0.18, p<0.05 (1 study) <i>Summary: Too few studies; included studies mixed</i>	<i>Summary: No studies</i>	<i>Summary: Too few studies; included study no effect</i>
Diet Quality Indices	KIDMED (range -4 to 11): Increase of 0.05, NS (1 study) <i>Summary: Too few studies; included study no effect</i>	Total Diet Quality Index: 0.03, NS (range: -4 to 4) (1 study) <i>Summary: Too few studies; included study no effect</i>	Students 80% more likely to report better diet quality after intervention: increase in Prevalence Ratio of 1.8 (95% CI: 1.3, 2.3) (1 study) Total Diet Quality Index Increase: 0.03, NS (1 study) <i>Summary: Too few studies; included study favorable</i>	<i>Summary: No studies</i>

CI = confidence interval; IQI = interquartile interval NS = not significant; RCT = randomized control trial

Weak law arm = weak competitive food laws, rating of 1-2 (scale 0-6); Strong law arm = strong competitive food laws >2 (scale 0-6).

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

*Systematic review team calculated overweight and obesity prevalence combined.

Applicability and Generalizability Issues

Applicability and generalizability are only described for the two recommended interventions. Applicability is not assessed for the other two interventions because the CPSTF did not have enough information to determine if the interventions work.

Meal or Fruit and Vegetable Snack Interventions to Increase Healthier Foods and Beverages Provided by Schools

Included studies were conducted in the United States (12 studies), Canada (2 studies), Norway (3 studies), the United Kingdom (1 study), the Netherlands (1 studies), Spain (1 studies), Australia (1 study), Denmark (1 study), Taiwan (1 study), and Greece (1 study), and one study took place across three countries (Norway, the Netherlands, and Spain). Studies were conducted in schools alone (23 studies) or in schools plus one or more additional settings (2 studies). Fourteen studies reported information on urbanization; nine reported a mixed setting, two reported a rural setting, and three reported an urban setting. Interventions were effective across countries, intervention settings, and degree of urbanization.

Interventions were found to be effective among elementary and middle school students. Only two studies represented high school students only. Four studies included high school students with elementary school and middle school students. All studies demonstrated effectiveness among males and females and included studies had roughly equal numbers of males and females.

Twelve studies that reported racial and ethnic distributions showed intervention effectiveness across reported groups. Populations were comprised of students in the following reported groups: white (median 49%; 9 studies), black (median 2.1%; 8 studies), Hispanic (median 28.6%; 8 studies), and First Nation (100.0%; 2 studies). One study conducted in the Netherlands examined the effectiveness of interventions by race/ethnicity and reported the intervention significantly increased fruit intake among ethnically Dutch children and significantly increased vegetable intake among non-Western children.

Interventions were effective among primarily low-income populations (8 studies) or when targeted to low-income First Nation children (2 studies). One study of a program to increase fruit and vegetable intake reported parental education level was related to effectiveness, reporting that students from the low parental educational group consumed more soda, candy, and chips than did students in the high parental education group at the end of the study.

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.

Multicomponent Interventions to Increase Availability of Healthier Foods and Beverages in Schools

Included studies were conducted in the United States (6 studies), Canada (3 studies), and the United Kingdom (2 studies). Studies were conducted in schools alone (9 studies) or in schools plus one or more additional settings (2 studies). Nine studies reported information on urbanization; four reported a mixed setting, three reported an urban setting, one reported a rural setting, and one reported a suburban setting. Interventions were effective across countries, intervention settings, and degree of urbanization.

Interventions were found to be effective among elementary and middle school students. No studies represented high school students only. One study included high school students combined with middle school students. All studies demonstrated effectiveness among males and females and included studies had roughly equal numbers of males and females.

Five studies that reported racial and ethnic distributions showed intervention effectiveness across reported groups. Populations were comprised of students in the following reported groups: white (median 19%; 11 studies), black (median 19.0%; 9 studies), Hispanic (median 55.0%; 10 studies), and Other (10%; 10 studies). One study showed an intervention effect in low-income populations.

Data Quality Issues

Dietary outcomes were based primarily on self-reported data, and weight outcomes were typically measured by trained staff. Common limitations of self-reported dietary data include participants forgetting about consumption of specific foods or beverages, inaccurately estimating portion sizes, and accidentally or purposely failing to report specific items (Grandjean, 2012). Most studies addressed these limitations by using age-appropriate, validated instruments. More than 85% of the studies that provided weight outcomes reported measured height and weight.

It was often difficult to calculate an effect estimate because inconsistent measures were used for diet outcomes. In these instances, findings were summarized qualitatively.

Other Benefits and Harms

Included studies identified several additional benefits of these interventions. Children reported an increased liking for fruits and vegetables, and the majority of students and parents rated the fruit and vegetable program as very good. Children increased their intake of specific nutrients and significantly lowered their total cholesterol. One study found that two years after the program, participants reported an increase in vitamin A intake and a decrease in saturated fatty acid intake, and three years after the program they reported an increase in fiber, vitamins A and C, calcium, and sodium intake. Another study found students in the intervention group consumed more vitamin C and dietary fiber than did students in the control group. Yet another study found students reported higher intakes of vitamin C and folate after policies were implemented to improve school lunches in primary schools.

No harms of the intervention were identified. Included studies were reviewed for information about body dissatisfaction or dieting behaviors. One study reported no differences between intervention and control groups for weight perception, weight preference, or current dieting habits. Another study reported no difference between the proportion of participants in intervention and control groups who perceived themselves as too heavy.

Economic Evidence

Systematic reviews of the economic evidence were conducted for the two recommended interventions. Economic reviews were not done for the other two interventions because the CPSTF did not have enough information to determine if the interventions work.

Meal or Fruit and Vegetable Snack Interventions to Increase Healthier Foods and Beverages Provided by Schools

A systematic review of economic evidence found that meal or fruit and vegetable snack interventions are cost-effective.

The economic review included 7 studies (search period through May 2016). Studies were based in the United States (4 studies), Norway (1 study), the Netherlands (1 study), and Taiwan (1 study). Three studies were based in elementary schools, one study was conducted in elementary and middle schools, and three studies included students from all grades. All monetary values are reported in 2016 U.S. dollars.

Intervention Cost

The major drivers of intervention cost are costs associated with ingredients, labor for food preparation and service, infrastructure modifications, and staff time for curricular components. The median cost per student per year to

implement a fruit and vegetable snack intervention was \$50 (IQI: \$27 to \$77; 3 studies). Two studies estimated it would cost \$198 and \$624 per student per year to provide meals that met nutritional guidelines, and another study estimated an incremental cost of \$40 per student per year to do the same. An additional study found that the annual cost per student was reduced by \$3 for breakfast and by \$9 for lunch when providing healthier school meals.

Healthcare Cost

The change in patients' healthcare cost due to intervention was reported in three studies. Two fruit and vegetable snack interventions reported savings of \$28 and \$17 per student over the course of their lives, and a comprehensive intervention to improve the nutritional content of school meals reported savings of \$17 per student per year.

Total Cost

Total cost is measured as the sum of change in healthcare cost due to intervention and the cost of intervention. Hence, a negative value indicates averted healthcare cost exceeds the intervention cost. One study estimated total cost of a school meal intervention at \$23 per student per year.

Cost-Benefit

One study noted that the incremental fruit and vegetable intake achieved in the intervention was greater than the minimum necessary for economic benefit to exceed intervention cost, as identified in a Norwegian government report (Sælensminde, 2005).

Cost-Effectiveness

The cost per disability-adjusted life year (DALY) averted for two fruit and vegetable snack interventions in the Netherlands was estimated to be \$8,014 and \$14,934, both far less than the country's \$49,390 per capita income in 2016. Averted DALY and savings in healthcare cost were derived from modeling averted cases of heart disease, stroke, and cancer.

One study evaluated an intervention that improved school meals to meet or exceed USDA guidelines and used their results to model averted cases of childhood obesity for a cohort of all U.S. school children. The model assumed 25% and 50% of the effects in childhood would be sustained into adulthood. Averted obesity was then translated to quality-adjusted life year (QALY) gained using the following formula: one averted case of obesity = 5.8 QALY gained (Muennig et al., 2006). Cost per QALY gained over the lifetime was estimated at \$10,800 (assuming 50% of intervention effect) and \$21,500 (assuming 25% of intervention effect), with both estimates far below a benchmark of \$50,000.

In summary, the cost per DALY estimates and the cost per QALY estimates are based on sound epidemiologic and economic inputs, and extrapolations are based on validated and published models or formulae. All three estimates fall below conventional benchmarks for cost-effectiveness, indicating meal or fruit and vegetable snack interventions are cost-effective.

Multicomponent Interventions to Increase Availability of Healthier Foods and Beverages in Schools

A systematic review of economic evidence included 3 studies (search period through May 2016). Studies were based in the United States (2 studies) and the United Kingdom (1 study). One study each was conducted in elementary, middle, and high schools.

One study assessed increased fruit and vegetable snack availability within a multicomponent intervention. One study assessed the effect of improving the nutritional content of breakfast, lunch, and à la carte items chosen by students. One study surveyed high school food service directors to determine factors affecting student participation in school meal programs and factors influencing competitive food and beverage offerings. All monetary values are reported in 2016 U.S. dollars.

Intervention Cost

Two studies reported on intervention cost. The cost to implement an intervention aimed at increasing fruit and vegetable offerings within current meals was \$4.34 per student per year. The incremental cost to implement a more comprehensive intervention aimed at reducing fats and sugars and increasing fiber, vegetables, and fruits through foodservice staff training was \$15.26 per student per year.

Healthcare Cost

No studies estimated change in healthcare cost due to intervention.

Cost-Benefit

No studies estimated cost-benefit of the intervention.

Cost-effectiveness

No studies estimated cost-effectiveness of the intervention.

Considerations for Implementation

Important considerations include the different possible combinations of components, the levels at which changes are made (i.e., federal, state or provincial, district, or school), and the school capacity for implementing the intervention(s). Some intervention components (e.g., implementing National School Lunch Program guidelines) may be required if a school is participating in the National School Lunch program; other components may be selected. There was not enough evidence from the included studies to evaluate the different combinations of components.

Intervention success is likely to vary based on school characteristics and intervention components. Schools with greater resources are better able to implement interventions with high fidelity as compared with schools that have higher needs. Some school communities may be resistant to change. And interventions that include an educational component must compete with other educational demands in the school. Additionally, for interventions with an educational component, competing demands to meet education requirements during the school day is a consideration.

Evidence Gaps

Additional research and evaluation are needed to fill existing gaps in the evidence base. Evidence gaps are split into three groups: 1) evidence gaps for reviews where a recommendation was made; 2) evidence gaps related to reviews for which there was an insufficient evidence finding; 3) cross-cutting evidence gaps related to all four intervention approaches.

1. Evidence gaps for reviews where a recommendation was made:

Meal or Fruit and Vegetable Snack Interventions to Increase the Availability of Healthier Foods and Beverages Provided by Schools

- Additional studies in high school settings are needed to increase understanding of intervention effectiveness on older children.
- The majority of studies were conducted outside the United States; additional studies in the United States would further strengthen the evidence base for U.S. students.
- It would be useful for studies to better report on the inclusion of components used to estimate intervention cost and economic benefits.

- In addition, studies need to model long-term benefits of averted healthcare cost and productivity into adulthood for interventions shown to improve nutrition and avert obesity in childhood.

Multicomponent Interventions Combining Meal or Fruit and Vegetable Snack Interventions to Increase Availability of Healthier Foods and Beverages in Schools

- Future studies should examine which combinations of components are most effective and which components are critical to success.
- Studies evaluating the effectiveness of multicomponent interventions also need to assess intervention cost, economic benefits, and cost-effectiveness.

2. Evidence gaps related to reviews for which there was an insufficient evidence finding:

- Additional research is needed to move these interventions from an insufficient evidence finding to a recommendation for or against. Literature in this field should be monitored to determine when enough studies have been published to warrant further review.

Interventions Supporting Healthier Snack Foods and Beverages Sold or Rewarded in Schools

- Evidence about newer nutrition standards such as Smart Snack in Schools, was not captured in this review. It is unclear if those standards would have a larger effect.

Interventions to Increase Water Access in Schools

- Future research should consider different ways to increase access to water (e.g., adding water fountains, allowing water bottles in class) and determine which are more effective.

3. Cross-cutting evidence gaps related to all intervention approaches:

- Increased consensus about “best measures” for dietary intake outcomes would increase comparability and the ability to synthesize evidence.
- Studies are needed that examine whether children act as agents of change by discussing changes in the school environment with parents and whether parents incorporate healthier dietary habits at home.
- Future research could examine how often schools implement interventions with fidelity, and determine what amount of training is needed for faculty.
- While interventions should be applicable across school-aged populations, more research is needed on the varying effectiveness of interventions by age group, and among high school students in particular.
- Research should be done to show whether national, state, or local policies are more effective.
- Studies should assess the cumulative effects of adding intervention components or determine if a single component is equally effective.
- Approximately half of the studies reported on weight outcomes; future studies should report weight-related outcomes to increase understanding of intervention effectiveness.
- Studies should report the fat content of milk products and alternatives to dairy.
- Future research could examine if these interventions lead to other health benefits such as improvements in cholesterol or blood pressure.

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Disclaimer

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Document last updated April 29, 2019