Appendix E-2.29a: Evidence Portfolio

Part D. Chapter 4: Food Environment and Settings

What is the impact of school-based approaches on the dietary intake, quality, behaviors and/or preferences of school-aged children?

Conclusion Statement: Moderate evidence indicates that multi-component school-based approaches can increase daily vegetable and fruit consumption in children in grades kindergarten through 8th. Sufficient school-based studies have not been conducted with youth in grades 9 to 12. Vegetable and fruit consumption individually, as well as in combination, can be targeted with specific school-based approaches.

DGAC Grade: Moderate

Key Findings

- This evidence portfolio includes three systematic reviews (Evans, 2012; Jensen, 2011; Langellotto and Gupta, 2012); two of which included meta-analyses (Evans, 2012; Langellotto and Gupta, 2012), which collectively evaluated 75 studies published between 1985 and 2011. Forty-nine studies were conducted in the United States and the remaining studies were completed in other highly developed countries. The systematic reviews examined the impact of school-based approaches targeting the dietary intake, quality, behaviors and/or preferences of school-aged children.
- The studies used a variety of intervention strategies targeting behaviors related to dietary intake. Some approaches were multi-component, with a combination of interventions targeting children, their parents, and/or the school environment. The primary dietary outcome of interest was fruit and vegetable intake.
- In the body of evidence available, the school-based approaches were diverse, making comparison across studies challenging. Despite this variability, multi-component interventions, and in particular those that engage both children and their families were more effective than single-component interventions for eliciting significant dietary improvements. Broadly, school-based intervention programs moderately increase total daily fruit and vegetable intakes and fruit (with and without fruit juice) intake alone. Furthermore, school-based economic incentive programs can effectively increase fruit and vegetable consumption and reduce consumption of low-nutrient-dense foods while children are at school. Nutrition education programs that include gardening effectively increase the consumption of vegetables in school-aged children, along with small, but significant increases in fruit intake.
- The evidence base includes three reviews evaluating several studies by independent investigators with sufficient sample sizes. Some inconsistency is evident across studies and may be explained by differences in the populations sampled, outcome measures, duration or exposure of intervention and follow-up periods. Although findings indicate that school-based approaches effectively increase the combined intake of fruit and vegetables, the magnitude of the effect as well as the public health significance is difficult to assess because of different measures and methodology.

Description of the Evidence

This evidence portfolio includes 3 systematic reviews/meta-analyses published between 2011 and 2012 (Evans, 2012; Jensen, 2011; Langellotto and Gupta, 2012). Collectively, the reviews included a total of 75 studies published between the years 1985 to 2011, with no overlap of studies between reviews. Study designs included randomized controlled trials

(RCTs), non-randomized controlled trials, cross-sectional studies, modeling studies, and simulation studies. Evans *et al* reviewed 27 controlled trials; 21 were included in the meta-analysis. Jensen *et al* reviewed 28 studies, from 30 publications, consisting of the following: 4 RCTs, 10 quasi-experimental studies, 4 price simulation experiments, 4 cafeteria sales incentives, and 6 cross-sectional studies. Langellotto and Gupta reviewed 20 studies, consisting of the following: 2 RCTs, 12 quasi-experimental studies with a control group, and 6 quasi-experimental studies without a control group.

The systematic reviews/meta-analyses had relatively low risk of bias, as evidenced by AMSTAR scores, ranging from 8 points out of a possible 11 to 11 out of 11. Evans *et al* evaluated the quality of the studies included in their meta-analysis based on the following 3 criteria: reporting of sequence generation criteria, allocation concealment, and blinding of participants, personnel, or outcome assessors. Trials were considered to be at high risk of bias if none of the criteria were met (n=11), at medium risk of bias if one or two of the criteria were met (n=10), or at low risk of bias if all three of the criteria were met (n=1). The other two reviews did not assess the risk of bias of the included studies.

The sample sizes reported for individual studies ranged from 6 to 3,382 children. The Evans *et al* meta-analysis presented pooled results for 26,361 subjects with a mean of 909 children per study and a median of 486 children per study.

Population

The studies examined generally healthy children in kindergarten through 12th grade, with the majority of findings pertaining to children aged 5 to 12 years. Of the 75 studies included in the three reviews, 49 were conducted in the United States, while 26 were conducted in other highly developed countries. The reviews did not review or present results by gender or race/ethnicity (refer to the Overview Table for review-specific details).

Exposures

The studies included in the reviews examined a variety of school-based approaches for targeting the dietary intake of children and their behaviors related to nutrition, including educational programs, social marketing, changes to the environment, and economic incentives. The majority of the programs were multi-component, with many of the interventions targeting daily fruit and/or vegetable intake. The studies included in the Jensen *et al* review evaluated economic incentives focused on physical, social, and political environmental factors to promote healthier eating. Some incentives directly targeted students' selection of specific foods by reducing or eliminating the cost of fruits and vegetables available during the school day. The Langellotto and Gupta review examined the impact of programs that included hands-on gardening experiences versus nutrition education programs without a gardening component.

Outcomes

The Jensen *et al* review reported various outcome data regarding food and beverage intake of school-aged children, including food choice observations from controlled experiments (representing intake), self-reported intake with changed economic incentives, observed sales data (a measurement of intake in schools), and intake data measured directly by researchers. The Evans *et al* review reported the difference in portions (total weight in grams per 80 grams) of fruit and vegetables, separately and combined, consumed daily, excluding potatoes, between intervention and control groups. Trials that included fruit juice together with fruit and vegetables were analyzed separately. Langellotto and Gupta evaluated children's nutrition knowledge, preference for fruit and vegetables, and/or consumption of fruit and vegetables.

Evidence Synthesis

Findings from the Evans *et al* review and meta-analysis of (primarily multi-component) school-based programs designed to increase daily fruit and/or vegetable intake in children consistently demonstrated moderate effectiveness for increased

total fruit and vegetable intake. Improvements in dietary intake, specifically fruit and vegetable consumption, were primarily attributable to fruit intake which increased 1/4 to 1/3 of a portion (equivalent to a 20–30-g daily increase). Although most programs aimed to improve intake of both fruit and vegetables, most schemes failed to increase vegetable intake by a meaningful amount. Studies that included fruit juice when assessing fruit and vegetable consumption tended to have higher intakes at baseline and greater increases as a result of the intervention. The exclusion of fruit juice, which is not strongly associated with health outcomes, attenuated the impact of programs on daily fruit and vegetable intake. Multi-component school-based programs designed to improve child and family eating behaviors tended to be more effective than single-component programs. However, due to a paucity of data strong conclusions could not be made regarding single-component interventions, which primarily involved distributing free or subsidized fruits and vegetables to children in the school setting.

Jensen *et al* reviewed studies that aimed to improve the diets of children using economic incentives. Consistent with Evans *et al*, school-based approaches effectively increased consumption of fruit and vegetables. Specifically, programs to reduce or eliminate the cost of fruit and vegetables effectively increased consumption, especially when the program focused on the cost and availability directly to the student. Additionally, findings indicate that economic incentives can be used to simultaneously increase fruit and vegetable intakes while reducing the intakes of foods low in nutrient density (e.g., soda/candy/chips). Limited information suggested that economic incentives focused on physical, social, and political environmental factors also may promote healthier eating behaviors of students, but effectiveness was not clearly documented. The multitude of approaches assessed in this systematic review made it difficult to draw strong conclusions; and the lack of a meta-analysis precluded quantifying the magnitude of dietary behavior responses. In summary, Jensen *et al* concluded that manipulating the cost of foods can impact dietary intake and behaviors (i.e., food purchases) among school-aged children.

The review and quantitative analysis assessing the impact of garden-based nutrition education programs on children's nutrition knowledge, preference for fruit and vegetables, and/or consumption of fruit and vegetables by Langellotto and Gupta was limited by the small number of studies that reported the full suite of descriptive statistics needed to conduct a meta-analysis. Nonetheless, gardening was associated with increased consumption of fruit and vegetables; while nutrition education programs significantly increased nutrition knowledge. Neither gardening nor nutrition education programs significantly improved preferences for fruit and/or vegetables.

Despite the variability in school-based approaches (i.e., programs and interventions) targeting dietary intake and eating behaviors among school-aged children, multi-component approaches effectively increase daily fruit and vegetable consumption in children grades kindergarten through 8th; yet data are lacking among youth in grades 9th through 12th. Fruit and vegetable consumption individually, as well as in combination, can be targeted through a variety of school-based approaches, including educational programs, changes to the environment, economic incentives, and gardening programs.

Overview Table

Summary of systematic review examining the impact of school-based approaches on the dietary intake, quality, behaviors and/or preferences of school-aged children			
Author, Year Study Design AMSTAR Score* Number of Included Studies	**Purpose of Review Subject Population Location of Included Studies**	**Independent Variable Outcomes**	**Results**
Evans, 2012 Systematic review/meta-analysis AMSTAR Score: 11/11	To quantify the impact of school-based interventions on fruit and vegetable (FV) intake in children aged 5-12 y Total N = 26,361 (mean of	**Independent variables:** intervention elements included: school lessons, communications with parents, students, teachers, food provision such as the availability of	School-based interventions of all types were estimated to improve daily FV consumption by an average of one-quarter to one-third of a portion (equivalent to a 20–30-g daily increase).

27 randomized controlled trials or controlled trials 21 studies used in meta-analysis	909 children/study) **Location:** 12 studies in the US 5 studies in the UK 4 studies in the Netherlands 3 studies in Norway 1 each in Canada, Denmark, New Zealand	FV at lunchtime, free FV distribution, food marketing, point-of-purchase incentives, food preparation or tasting during school, home-based projects or homework, improvements in school environment, and community, supermarket, or industry involvement **Outcomes:** difference in portions (total weight in g/80 g) of FV, separately and combined, consumed daily, excluding potatoes	**Daily difference in FV consumption, excluding fruit juice** = 0.25 portions (95% CI: 0.06, 0.43; P <0.01) **Daily difference in FV consumption, including fruit juice** = 0.32 portions (95%CI: 0.14, 0.50; P < 0.01) **Daily difference in fruit consumption, excluding fruit juice** = 0.24 portions (95% CI: 0.05, 0.43; P <0.01); Egger's test for asymmetry was significant (P = 0.02) **Daily difference in fruit consumption, including fruit juice** = 0.28 portions (95% CI: 0.12, 0.44; P <0.01) **Daily difference in vegetable consumption** = 0.07 portions (95% CI: 20.03, 0.16; NS)
Jensen, 2011 Systematic review AMSTAR Score: 8/11 28 studies (30 publications): • 4 randomized controlled trials • 10 quasi-experimental • 4 price simulation experiments • 4 cafeteria sales incentives • 6 cross-sectional	Focused on interventions that aimed to improve the diets of children aged 10-12 y using various types of economic incentives. Non-obese children **Location:** 17 studies the US 3 studies in Norway 1 each in Ireland, UK, Australia 5 not identified	**Independent variables:** economic incentives designed to influence dietary behavior – measured as intake of relevant foods, beverages, and snacks – or the availability of healthy foods and beverages in schools **Outcomes:** food choice observations (representing intake), self-reported intake with changed economic incentives, observed sales, and intake data measured directly by researchers	In general, the review supports the hypothesis that the choice of foods, snacks, and beverages by schoolchildren can be influenced by economic incentives. Overall, studies of price incentives in schools suggested that incentives are effective for increasing FV consumption in schools in the short term and, to some extent, in the long term. Two crucial determinants for the effectiveness of price instruments were identified: 1) foods or beverages are offered (for sale) at the schools, and 2) 10–12-year-old children bring money to school to buy some of these items.
Langellotto, 2012 Systematic review/meta-analysis AMSTAR Score: 8/11 20 studies reported 66 observations: • 2 randomized controlled trials • 12 quasi-experimental with control 6 quasi-experimental without control	Meta-analysis examined the efficacy of garden-based nutrition education programs for increasing children's nutrition knowledge, preference for fruit and vegetables, and/or consumption of fruit and vegetables. Children from kindergarten through 8th grade. (search was for K-12th grade) **Location:** US	**Independent variables:** three categories of interventions: nutrition education with garden component, nutrition education without garden component, or control with no formal nutrition education program **Outcomes:** nutrition knowledge, fruit and vegetable preference, and/or fruit and vegetable	**Change in FV preferences** • Gardening treatment Fruit: E^{++} = –0.02; CI: –0.20, 0.01, df = 3; NS Vegetables: E^{++}= 0.10; CI: 0.01, 0.19, df = 1; Significant • Nutrition education treatment: insufficient observations to quantify changes in FV preferences • Control Fruit: E^{++} = –0.01; CI: –0.01, 0.00, df = 1; NS Vegetables: E^{++} = –0.01; CI: –0.05, 0.11; df = 2; NS **Change in fruit intake** • Garden-based program: E^{++} = 0.08; CI:

		consumption	0.02, 0.12; df = 1; Significant • Nutrition education treatment: E^{++} = –0.02; CI: –0.14, –0.002; df = 2; Negative effect • Control: E^{++} = –0.04; CI: –0.24, 0.003; df = 3; NS **Change in vegetable intake** • Garden treatment: E^{++} = 0.42; CI: 0.07, 2.07; df = 3; fail-safe number = 50.5; Significant • Nutrition education treatment: E^{++} = –0.002; CI: –0.0073, 0.04; df = 2; fail-safe number = 0; NS • Control: E^{++} = –0.03; CI: –0.14, –0.01; df = 5; fail-safe number = 0; NS **Qualitative analysis of the vote counting:** Pre- vs. posttest comparisons revealed that the majority of the outcomes (26 out of 39) were non-significant in the control and nutrition education groups, but positive and significant for the gardening group.
*Quality assessed by AMSTAR (Shea, 2007: http://www.ncbi.nlm.nih.gov/pubmed/17302989)			

Assessment of the Body of Evidence

Quality and Quantity: Collectively, the evidence base includes 75 independent studies with 43 controlled studies evaluated in three rigorous systematic reviews, two of which include a quantitative meta-analysis. The reviews/meta-analyses are of high-quality with AMSTAR scores of 8 to 11 out of 11 possible points.

Consistency: Across individual studies and reviews, school-based approaches consistently increased fruit and vegetable intake. In particular, the utility of economic incentives to promote fruit and vegetable intake consumption was evident across reviews (Evans, 2012; Jensen, 2011). Additionally, findings from Langellotto and Gupta support the effectiveness of school-based programs that include hands-on gardening experiences to increase the consumption of vegetables. All three reviews indicate that multi-component programs are more effective than single-component programs.

Impact: Daily total fruit and vegetable intakes increased by 1/4 to 1/3 of a portion, but the potential health impact of this change was not evaluated in these reports. For reference, the *Dietary Guidelines for Americans* recommend between 1 to 1½ cups of fruit and 1½ to 2 cups of vegetables per day for most school-aged children.

Generalizability: Collectively, the studies included in the reviews were geographically diverse (both nationally and internationally), but information on the characteristics of the participating children was very limited. Thus, the generalizability of the findings is not known with confidence.

Limitations: While the included reviews were of high quality, the authors of the individual reviews commented that the quality of the studies included in their assessments varied, with some studies having a high risk for bias. Evans *et al* included controlled studies with and without randomization and reporting of results was not consistent across studies. Additionally, the authors noted that successful programs may not have been included in the analysis because of a lack of suitable published data on improvements in fruit and vegetable intake over the whole day. Jensen *et al* noted the problem of separating the effects of economic incentives from those of other intervention strategies for the studies they reviewed

as well as a paucity of relevant studies. Furthermore, many of the significant improvements in fruit and vegetable consumption reported by Langellotto and Gupta with regard to school-garden programs were small in magnitude.

Implications*

Existing evidence indicates that school-based programs designed to improve the food environment and support healthy behaviors may effectively promote improved dietary intake and weight status of school-aged children. Programs that emphasize multicomponent, multidimensional approaches (including increased physical activity) are important to changing behavior and need to be reinforced within the home environment, as well as the community, including neighborhood food retail outlets that surround schools. Policies should strive to support effective programs that increase availability, accessibility, and consumption of healthy foods and beverages, while reducing less healthy competitive foods and beverages. The combination of economic incentives along with specific policies can increase the likelihood that specific approaches will be effective.

The recently updated USDA nutrition standards for school meals and snacks and beverages sold in schools will ensure that students throughout the U.S. will have healthier school meals and snack and beverage options, but schools need support and active engagement from students, parents, teachers, administrators, community members, and their districts and states to successfully implement and sustain them.

Research Recommendations*

1. New research is needed to document the types and quantities of foods and beverages students consume both at school and daily before, during and after school-based healthy eating approaches and policies are implemented.

   Rationale: Effective school-based approaches and policies to improve the availability, accessibility, and consumption of healthy foods and beverages, and reduce competition from unhealthy offerings, are central to improving the weight status and health of children and adolescents. Accurate quantification of the types and quantities of foods and beverages students consume before, during, and after approaches and policies are implemented is fundamental to assessing effectiveness. However, many of the studies included in the systematic reviews and meta-analyses used by the 2015 DGAC to address this issue did not comprehensively measure or report dietary information. While the USDA/FNS-sponsored School Nutrition Dietary Assessment (SNDA) series collects student dietary intake data every 10 years, the DGAC recommends more frequent and consistent data collection, especially before and periodically after implementation of school-based nutrition and physical activity policy and program changes.

2. Improvements are needed in the quality of research studies designed to assess the effects of school-based approaches and policies on dietary behaviors and body weight control to reduce the risk of bias, with an emphasis on randomized control trials.

   Rationale: While the methodological quality of the systematic reviews and meta-analyses used by the 2015 DGAC to evaluate school-based approaches and policies on dietary intake and body weight outcomes was high, the authors of these reviews commented that the scientific quality of individual studies was generally poor and the risk of bias high. Many of the studies were done using quasi-experimental (with or without control), pre-post intervention, or cross-sectional designs. Future research should prioritize using prospective, repeated measures, randomized control trial experimental designs, with randomization at the individual, classroom, school, or school district level. Feasibility studies may also be helpful to more quickly identify promising novel approaches to improve dietary intake and weight control outcomes.

3. Post-program follow-up assessments lasting >1 year are needed to determine the longer-term retention of changed nutrition behaviors as well as the usefulness of continuing to offer the programs while children advance in school grade. Also, more research is needed in adolescents (grades 9-12).

   Rationale: Literature supports that eating and physical activity behaviors and body weight status of children are predictive of changes over time as they progress into adolescence and adulthood. Ideally, improvements in dietary intake and weight status achieved due to a given school-based approach or policy would be sustained over time and progressive improvements would occur long-term. The vast majority of published research focuses on children in grades K-8, or ages 4-12 years, and new and improved data are needed on adolescents and the transition from childhood to adolescence.

4. A wider variety of innovative school-based approaches and policies are needed to increase vegetable intakes.

   Rationale: Consumption of non-potato vegetables is below 2010 Dietary Guidelines for Americans recommendations in both children and adolescents. Published research indicates that school-based approaches and policies designed to increase fruit and vegetable intakes are generally more effective at increasing fruit intake – the documented exceptions being school gardens and economic incentives, which increase vegetable intake among school-aged children. Some past public policies (e.g. the Basic 4) treated fruits and vegetables as a single food group, which props the need for new research using prospective, repeated measures, randomized control trial experimental designs specifically targeting increased consumption of healthy vegetables.

*Because the schools questions are complementary, the Dietary Guidelines Advisory Committee chose to develop only one implication statement for the four questions along with collective research recommendations.

References

1. Evans CE, Christian MS, et al. Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12 y. Am J Clin Nutr 2013;96(4):889-901. PMID:22952187 http://www.ncbi.nlm.nih.gov/pubmed/22952187
2. Jensen JD, Hartmann H, et al. Economic incentives and nutritional behavior of children in the school setting: a systematic review. Nutr Rev 2011;69(11):660-74. PMID:22029832. http://www.ncbi.nlm.nih.gov/pubmed/22029832
3. Langellotto GA and Gupta A. Gardening increases vegetable consumption in school-aged children: a meta-analytical synthesis. Horttechnology 2012;22(4):430-445. http://horttech.ashspublications.org/content/22/4/430.abstract