HHS Public Access

Author manuscript

Am J Clin Nutr. Author manuscript; available in PMC 2026 January 01.

Published in final edited form as:

Am J Clin Nutr. 2025 January ; 121(1): 167–173. doi:10.1016/j.ajcnut.2024.11.006.

School-based nutrition education programs alone are not cost-effective for preventing childhood obesity: A microsimulation study

Erica L. Kenney[1,2], **Mary Kathryn Poole**[1], **Stephanie M. McCulloch**[2], **Jessica L. Barrett**[2], **Kyla Tucker**[3], **Zachary J. Ward**[4], **Steven L. Gortmaker**[2]

[1]Department of Nutrition, Harvard T.H. Chan School of Public Health

[2]Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health

[3]Office of Student Wellbeing, Massachusetts Institute of Technology

[4]Center for Health Decision Science, Harvard T.H. Chan School of Public Health

Abstract

Background.—Although interventions to change nutrition policies, systems, and environments (PSE) for children are generally cost-effective for preventing childhood obesity, existing evidence suggests that nutrition education curricula, without accompanying PSE changes, are more commonly implemented.

Objective.—Estimate the societal costs and potential for cost-effectiveness of three nutrition education curricula frequently implemented in U.S. public schools for childhood obesity prevention.

Methods.—In 2021, we searched for nutrition education curricula in the SNAP-Ed Toolkit, a catalogue of interventions for obesity prevention coordinated by the federal government. Standard costing methodologies estimated the societal costs from 2023–2032 of nationwide implementation of each identified curriculum. Using the Childhood Obesity Intervention Cost-Effectiveness Study (CHOICES) microsimulation model, which projects the costs, healthcare costs saved, and cases of obesity prevented for childhood obesity prevention interventions, we conducted threshold analyses for each curriculum, estimating the cost per quality-adjusted life year (QALY) for a range of

Address correspondence to: Erica L. Kenney, Department of Nutrition, Harvard T.H. Chan School of Public Health, 667 Huntington Ave., Boston, MA 02115, ekenney@hsph.harvard.edu.

Authorship Contributions.

EK, MKP, JLB, ZW, and SG designed the research. EK, MKP, and KT conducted the research. JLB and SM analyzed the data. EK, MKP, JLB, and SG wrote the paper. EK had primary responsibility for final content. All authors have read and approved the final manuscript.

Conflict of interest disclosures: The authors have no conflicts to disclose.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

hypothetical effects on child body mass index (BMI) to determine how large of an effect each curriculum would need to have to meet a cost-effectiveness threshold of $150,000 per QALY.

Results.—Three nutrition education curricula without PSE were identified from SNAP-Ed; none had evidence of an impact on obesity risk. From 2023 to 2032, the estimated implementation costs of the curricula nationwide ranged from $1.80 billion (95% UI: $1.79-$1.82 billion) to $3.48 billion (95% UI: $3.44-$3.51 billion). Each curriculum would have to reduce average child BMI by 0.10 kg/m^2 or more—an effect size that has not been reported by any of the three curricula, or by more comprehensive existing prevention programs—to be considered cost-effective at this threshold.

Conclusions.—SNAP-Ed-endorsed nutrition education curricula alone are unlikely to be cost-effective for preventing childhood obesity. Continued efforts to implement interventions with strong evidence for effectiveness, including PSE approaches, are needed.

Keywords

Childhood obesity; Nutrition Education; schools; prevention; cost-effectiveness analysis; threshold analysis

Introduction

Nutrition education, especially for children, has been frequently implemented as a chronic disease prevention strategy, especially as a strategy for preventing obesity by modifying individual behaviors.(1) As the prevalence of childhood obesity has grown, so too have calls to implement more robust nutrition education curricula in K-12 school settings.(2–4) The Centers for Disease Control and Prevention promotes nutrition education as a chronic disease prevention strategy,(5) and $464 million of funding for the Supplemental Nutrition Assistance Program (SNAP), the largest social safety net program in the U.S., was set aside in 2022 for SNAP-Ed,(6) a program that promotes nutrition education for SNAP recipients and obesity prevention.(7) Yet education is typically much less effective at producing clinically meaningful and lasting change than public health interventions that modify contexts and environments using policy or systems changes.(8) While SNAP-Ed has, in recent years, also adopted “policies, systems and environment,” or PSE, strategies per requirements of the Healthy, Hunger-Free Kids Act of 2010,(7) its primary activity remains delivering direct nutrition education.(9,10)

It is unknown, however, whether direct nutrition education is a cost-effective strategy for population health. Although nutrition education may be a more palatable public health intervention for policymakers and politicians,(1) existing evidence suggests that, consistent with theoretical models proposing that education-only has limited impact compared to more robust, structural public health interventions,(8) nutrition education alone may have limited impact in supporting sustained behavior change with regards to eating and physical activity.(11–13) Meanwhile, school-based PSE strategies have been found to reduce childhood obesity risk (such as changes to school nutrition standards,(14) eliminating the sale of sugary beverages and other unhealthy snacks,(15) providing water on school lunch lines,(16) and incorporating more robust physical activity programs(17)). With the lack of evidence for

effectiveness at reducing excess weight gain in children, it is not possible to directly estimate the cost-effectiveness of nutrition education curricula for childhood obesity prevention. Yet, given that nutrition education is widely promoted and adopted in U.S. schools as an obesity prevention strategy, it is important to understand its potential for cost-effectiveness, and whether the current widespread adoption of this strategy is a prudent use of existing school and public health funds.

The first aim of this study was to identify evidence-based nutrition education curricula that are currently promoted for youth obesity prevention in U.S. school settings and to estimate the implementation costs of these nutrition education curricula if they were scaled to reach students nationally. The second aim was to assess the potential for the nutrition education curricula to be cost-effective for childhood obesity prevention, by estimating how large of an average effect on children's body mass index (BMI) each curriculum would need to have in order for it to meet a standard cost-effectiveness threshold.

Methods

Intervention Selection

This analysis was conducted after engaging a group of advisory partners, consisting of federal, state, and local public health practitioners, policymakers and researchers with expertise in childhood obesity prevention, as part of the Childhood Obesity Intervention Cost-Effectiveness Study (CHOICES). The advisory group requested that CHOICES explore the cost-effectiveness of strategies that are frequently implemented, and specifically cited a need for evidence of the cost-effectiveness of school-based nutrition education.
To identify specific nutrition education curricula for modeling, between May and June 2021, we searched the online SNAP-Ed Toolkit(18) for school-based interventions (see Supplementary Figure 1 for flow diagram). The toolkit, a catalogue maintained by the federal government, features obesity prevention interventions developed by practitioners and/or researchers that meet criteria of the SNAP-Ed Evaluation Framework. We chose to select interventions from SNAP-Ed given its wide reach and given that the included interventions undergo a quality review. Fifty-one (96%) of the 53 interventions from our search had a nutrition education component. From this list, we eliminated 29 interventions with multiple intervention components beyond nutrition education (such as modifying school meals or increasing physical activity opportunities), as these would not allow us to isolate the impact of nutrition education alone. Additionally, we excluded four interventions that were not designed to be implemented at school, and one intervention for changing teachers' nutrition knowledge only. For the remaining 17 SNAP-Ed Toolkit interventions, we then conducted targeted literature searches using PubMed, Google Scholar, the SNAP-Ed Toolkit, program sites when available, and the Google search engine to locate research studies evaluating their effectiveness at changing behaviors and/or weight outcomes. Thirteen of these interventions (72%) had at least one relevant peer-reviewed publication or publicly-available evaluation report with *any* outcome (not necessarily nutrition- or weight-related). For these 13 interventions, we searched available literature to determine whether they have actually been implemented outside of a research or pilot evaluation context; most (10 of the 13) showed no evidence of being in use, but three were found to

have been implemented across multiple states. We thus arrived at three nutrition education interventions:(18)

1. **Pick a Better Snack:** Eight lessons delivered by a nutrition educator for grades Kindergarten to 3, eight supplemental lessons led by classroom teachers, and take-home family newsletters;(19)
2. **Harvest of the Month:** Six nutrition lessons featuring a fruit or vegetable with taste tests for grades 4 to 6, plus take-home resources for families;(20) and
3. **Choose Health: Food, Fun and Fitness:** Six nutrition lessons for grades 3 to 6 with take-home family newsletters and activities.(21)

Because schools could use a wide variety of different programs, with different activities, costs and outcomes, we chose to include all three of the interventions in our study to reflect the variation in programs implemented rather than selecting a single program.

Intervention Reach

We assumed that 70.6% of students in the grade levels targeted by each intervention would participate in the interventions in public schools across 50 states plus the District of Columbia (Supplementary Tables 1–3). This assumption mirrors a similar estimate from the School Health Policies and Practices Study of 2016 which estimated the percentage of school districts with a policy requiring schools to deliver nutrition education to students.(22)

Intervention costs

We collected information on costs needed to implement each nutrition education program using a standard cost-estimation protocol with a modified societal perspective.(23,24) We enumerated implementation costs including labor (including both paid and unpaid labor) and materials (i.e., brochure printing costs, food costs), as well as payers, using estimates from peer-reviewed articles of the interventions, implementation manuals when available or from personal communications with intervention developers. Hours of labor were converted to costs using estimates for hourly wages for various job roles from the Bureau of Labor Statistics.(25) Costs are discounted at 3% annually, adjusted for inflation, and reported in 2019 U.S. dollars; 3% is the standard reference case for discounting in the U.S.(26,27) More detailed information on cost estimation can be found in Supplementary Tables 1–3.

Intervention effects

To estimate the potential impact on childhood obesity from implementing the three nutrition education programs in schools, we reviewed the evidence identified from our targeted literature search of scientific journals and grey literature described above including 3 studies for Pick a Better Snack,(19,28,29) 6 studies or evaluation reports for Harvest of the Month,(20,30–34) and 2 studies for Choose Health, Food, Fun, and Fitness.(21,35) No studies reported associations with body weight (i.e., BMI) or behavioral outcomes for which there is evidence of impact on child weight (i.e., calorie intake, intake of sugary drinks, minutes of physical activity, or hours of television watched). Therefore, in the absence of evidence of the effects of the three selected nutrition education curricula on body weight or BMI, we modeled one-way sensitivity analyses for each curriculum using five hypothetical

BMI effects: −0.01, −0.05, −0.1, −0.2, and −0.3 kg/m^2. These effect sizes were chosen based on the range of BMI effects previously estimated through the CHOICES study for effective childhood obesity prevention interventions in school, early care and education, and community and government settings.(17,24,36–38) These effect sizes were estimated based on implementation of policy, systems, and environmental strategies, including school-based physical activity promotion (e.g., active physical education −0.01 kg/m^2 BMI effect), state sugary drink excise taxes of 1 cent per ounce (−0.13 kg/m^2 BMI effect), improved early care and education policies and practices (−0.21 kg/m^2 BMI effect), and healthy afterschool programs (−0.29 kg/m^2 BMI effect).

This study was approved as non-human subjects research by the Harvard T.H. Chan School of Public Health Institutional Review Board.

Statistical Analyses

With these estimates of reach, cost, and effect gathered above, we then used the CHOICES microsimulation model(23,24) (Figure 1) to estimate both the total costs to implement each of the three nutrition education curricula from 2023–2032 as well as the potential net costs per quality adjusted life year (QALY) gained associated with each curriculum under the range of hypothetical effects on child BMI, compared with projections with no intervention. The microsimulation model leverages detailed data from multiple nationally representative datasets to simulate the experiences of individuals in the U.S. population related to height/weight trajectories and health, accounting for demographic characteristics and projected population growth. The model estimates healthcare costs associated with increasing BMI using age- and sex-specific estimates derived from the Medical Expenditure Panel Survey.(39) The healthcare cost savings associated with implementing a strategy that reduces excess weight gain are combined with the strategy's implementation costs to estimate net costs of the strategy. QALYs gained from implementing a strategy were estimated using health-related quality of life weights associated with three BMI categories (under/normal weight, overweight, obesity) by sex and age group.(23,40,41) A 10-year period was used to align with budget planning timelines for policymakers.(42) The model allows for the estimation of various outcomes, including: the *number of people reached* by the intervention over 10 years; the *annual intervention cost* in U.S. dollars (including private and government expenses); the *intervention cost per person; healthcare costs related to excess weight gain* saved over 10 years; the projected *number of childhood obesity cases prevented* in thousands in the year 2032; and the intervention's costs per QALY. To account for uncertainty in model inputs, we calculated 95% uncertainty intervals (UI), using 1,000 Monte Carlo iterations for a simulated nationally representative population of one million individuals. The model is programmed in Java (v1.8.0, Oracle Corporation, Redwood Shores, CA, USA), and R (v4.1.1, R Foundation for Statistical Computing, Vienna, Austria) was used to summarize results. Further details on the CHOICES microsimulation model are available elsewhere.(23,24)

Using the five hypothetical effects on child BMI, we conducted a threshold analysis to identify how large of an effect each curriculum would need to have on children's weight to meet a threshold for cost-effectiveness. For each curriculum, we calculated the incremental

cost-effectiveness ratio in terms of cost per QALY gained, given the curriculum's reach and costs, for the five hypothetical BMI effects specified above. We identified the magnitude of the BMI effect at which the cost per QALY fell below a willingness-to-pay threshold of $150,000, a threshold commonly and increasingly used in economic evaluation to reflect the value of health improvements.(43,44) We then compared the estimated effect needed to similar childhood obesity prevention interventions to assess whether that impact would be plausible. To gauge the plausibility of the BMI effects, we then qualitatively compared estimated effects needed to similar and more intensive childhood obesity prevention interventions we could identify that had evaluated impacts on BMI.

Results

The three direct nutrition education interventions included in this study–Pick a Better Snack, Harvest of the Month, and Choose Health: Food, Fun and Fitness– were projected to reach a large number of children. Over ten years, implementation of such nutrition education curricula would be estimated to reach between 31.7 million (95% UI: 31.0 million to 32.2 million) young children for Harvest of the Month to 34.0 million (95% UI: 33.5 million to 34.7 million) for Choose Health: Food, Fun, and Fitness (Table 1). Variations in projected reach were largely due to some interventions pertaining to smaller ranges of grade levels than others.

The interventions ranged widely in estimated total implementation costs. Harvest of the Month was estimated to cost $1.80 billion (95% UI: $1.79 billion to $1.82 billion) over ten years if implemented nationwide, with an annual cost per child of $18.70 ($18.50 to $18.90), while Choose Health, Fun, Food, and Fitness would cost $1.92 billion total (95% UI: $1.92 billion to $1.92 billion), with an annual cost per child of $15.90 ($15.60 to $16.20). Meanwhile, Pick a Better Snack, which involved more materials for more frequent lessons and more labor time for nutrition educators and school teachers(45) was estimated to have the highest implementation costs, at $3.48 billion (95% UI: $3.44 billion to $3.51 billion) over ten years and an annual cost per child of $30.50 ($30.20 to $30.90) (Table 1). Most of these implementation costs would be borne by state government agencies, with smaller costs borne by schools themselves, if the interventions were implemented with the same structures described in available evidence (Table 2).

When the curricula were assumed to have a BMI effect of −0.01 kg/m^2, the costs per QALY gained for each were well above a cost-effectiveness threshold of $150,000 per QALY ($1,430,000 per QALY for Pick a Better Snack, $1,060,000 per QALY for Harvest of the Month, and $950,000 per QALY for Choose Health, Fun, Food, and Fitness). Costs per QALY gained were still estimated to be higher than $150,000 for all curricula when a larger BMI effect of −0.05 kg/m^2 was assumed, and only met this threshold when a BMI effect of −0.1 kg/m^2 was used (Figure 2).

Discussion

In this cost-effectiveness analysis of nutrition education curricula without any accompanying changes to policies, systems, or environments that were selected from the SNAP-Ed Toolkit

for obesity prevention, we found that such curricula are unlikely to be cost-effective for preventing childhood obesity at a cost-effectiveness threshold of $150,000 per QALY. In order to be considered cost-effective, these interventions, which currently lack published evidence of having an effect on weight status, would need to have implausibly large effects on children's BMI. We estimated that the effects of the curricula on students' BMI would have to be greater than −0.05 kg/m^2, and at least −0.1 kg/m^2 for Pick a Better Snack, the curriculum with the highest estimated per person implementation cost, for the curricula to be cost-effective at $150,000 per QALY gained. In comparison, the Texas Sprouts intervention, which involved both school-based nutrition education and gardening, was associated with a nonsignificant BMI change of −0.02 kg/m^2.(46) Achieving a BMI effect two and a half to five times larger than that found by the Texas Sprouts intervention by implementing nutrition education alone is not likely to be plausible. While school-based nutrition education curricula may appear to be more feasible or politically palatable compared to more effective obesity prevention interventions that directly influence nutrition environments for children, and while nutrition education curricula may improve knowledge, the results of this study suggest that only implementing such curricula without accompanying PSE changes is likely not an efficient use of resources if obesity prevention is the goal.(8)

These findings highlight an area of public health nutrition practice that needs refinement. Public health agencies have scarce resources, experiencing regular budget cuts(47) and limited funds at state and local levels,(48) and local health departments across the US, for example, spend an average of roughly $50 per capita per year across all public health initiatives.(48) State public health departments and schools, which would likely bear a substantial portion of implementation costs, are also chronically under-resourced. In this context, it is even more essential for these entities to spend such limited resources wisely if the goal is measurable impacts in improving child weight status and reducing chronic disease burden. Cost-effectiveness analyses of school-based or afterschool-based obesity prevention programs that do involve the implementation of other components, such as Planet Health,(49) the Coordinated Approach to Child Health,(50) and the FitKid Project,(51) as well as analyses of school-based programs that solely focus on policy and environmental changes and do not incorporate nutrition education, like stronger standards for school meals,(24) and the provision of water dispensers on school lunch lines,(37) suggest that these approaches are simply more cost-effective. Nutrition professionals involved in supporting school-based efforts to promote healthy weight should consider selecting programs that focus on policy, systems, and environmental changes.

Of note, the modeled programs were identified via the SNAP-Ed toolkit, which serves as a mechanism for disseminating obesity prevention interventions to low income communities. In 2022, the federal government allocated $464 million to deliver SNAP-Ed in income-eligible communities nationwide,(6) much of which occurs in educational settings.(9) Prior evidence suggests more states are partnering with schools for PSE interventions(9) though barriers to implementation remain.(10,52–54) Our results suggest that if these school-based lessons involved the utilization of direct nutrition education-only programs, and do not make continued progress on PSE interventions, this approach may not be an investment with good value for money if childhood obesity prevention is the goal. This is of particular concern given that SNAP-Ed is meant to focus on low income communities;

spending scarce financial resources on programs that are unlikely to impact obesity may inadvertently contribute to health inequities by diverting needed resources away from potentially effective programs instead. While school-based nutrition education alone may be helpful for improving students' nutrition knowledge,(55) especially when multi-component interventions are implemented,(56,57) and for contributing to students' development of general knowledge more broadly, such increases in knowledge may not be sufficient to translate to sustained behavioral change, particularly enough to bring about the significant dietary changes that may be necessary to prevent obesity in childhood.(58,59)

These results also further highlight the inadequacy of current efforts to translate the evidence base for childhood obesity into effective practice. Effective interventions have been identified,(60) and the cost-effectiveness of several school-based interventions in the U.S. has also been evaluated;(37,49–51) in other words, evidence does exist that could be used to help inform strategic choices that maximize the utilization of limited public health and educational expenditures for the most population health impact. Yet existing data suggests that such evidence is not being widely accessed in school settings.(61) More work to effectively disseminate research findings to practitioners in a usable, practical format is needed, as is work to help train practitioners in the skills needed for utilizing evidence-based interventions specific to their targeted health outcomes. Resources like the SNAP-Ed Toolkit Literature Review Database released in 2022(18) (now available in the SNAP-Ed Library(62)) may further assist practitioners with accessing evidence for dietary and obesity outcomes. More work may also be needed to ensure the implementation of multiple evidence-based interventions in schools as no single strategy or intervention will adequately prevent childhood obesity—careful consideration of cost-effectiveness is key to maximizing impact with available resources.

This study has several limitations. First, we were not able to directly estimate the cost-effectiveness of each of the curricula, since there were no published studies evaluating their effects on children's weight status. Our threshold analysis assesses the plausibility of the interventions being cost-effective, but it is possible that the true, unstudied effect of the interventions are unexpectedly higher than what has been seen in similar interventions with larger doses and more intervention activities. Second, the nutrition education curricula assessed here have demonstrated effects on other behavioral outcomes (e.g. fruit and vegetable intake) for which there is no evidence of impact for childhood obesity/weight outcomes but may have other benefits for population health. Additionally, there are likely a multitude of other nutrition education curricula in use nationwide—some evidence-based, and some developed ad hoc—so the three curricula modeled here may not be representative of all programs in place at the moment. However, given that the three curricula modeled here were rigorously and carefully developed by experts in the field, and promoted by SNAP-Ed, it is unlikely that curricula developed ad hoc or with a less rigorous process would be more effective at preventing obesity than what was modeled.

Conclusions

By themselves, nutrition education curricula—even those endorsed by SNAP-Ed—are not likely to be cost-effective strategies for preventing childhood obesity. To be considered cost-

effective at standard thresholds, each of these evidence-based nutrition education curricula would have to have implausibly large impacts on child BMI. While nutrition education can support improved knowledge and skills, it cannot be thought of as a stand-alone solution for addressing cardiometabolic disease risk in children. Efforts to better translate research findings on effective and cost-effective programs for childhood obesity prevention into public health practice are needed.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding/support:

This study was supported by Healthy Eating Research, a national program of the Robert Wood Johnson Foundation (2833590), The JPB Foundation, the National Heart, Lung, and Blood Institute (NHLBI) (5T32HL098048, R01HL146625, and 1F31HL162250), the National Institute of Diabetes and Digestive and Kidney Diseases (K01DK125278), and the Centers for Disease Control and Prevention (U48DP006376). The content is solely the responsibility of the authors and does not necessarily represent the official views of these agencies.

Data Share Statement:

Data used in the model are available from published literature and publicly available data sources cited in the manuscript.

Abbreviations:

PSE	Policy, Systems, and Environment
CHOICES	Childhood Obesity Intervention Cost-Effectiveness Study
QALY	Quality-adjusted Life Year
SNAP	Supplemental Nutrition Assistance Program
BMI	body mass index

References

1. Chrisman M, Hampton N. Preferred child obesity message frames and their perceived strength among state policymakers. Child Obes. 2021 Apr;17(3):169–75. [PubMed: 33601951]
2. Youdim A Lack of health education leads to a rise in obesity rates. The Hill [Internet]. 2016 Oct 18 [cited 2023 Nov 30]; Available from: https://thehill.com/blogs/pundits-blog/healthcare/301581-lack-of-health-education-leads-to-a-rise-in-obesity-rates/
3. Dunleavy BP. CDC: Schools aren't doing enough to teach kids about nutrition. UPI [Internet]. 2019 Dec 5 [cited 2023 Nov 30]; Available from: https://www.upi.com/Health_News/2019/12/05/CDC-Schools-arent-doing-enough-to-teach-kids-about-nutrition/9491574879196/
4. Food and Nutrition Board, Board on Children, Youth, and Families, Institute of Medicine. Nutrition Education in the K-12 Curriculum: The Role of National Standards: Workshop Summary [Internet]. Washington (DC): National Academies Press (US); 2013 [cited 2023 Nov 30]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK202128/
5. Centers for Disease Control and Prevention [Internet]. 2023 [cited 2023 Oct 18]. Healthy eating learning opportunities and nutrition education. Available from: https://www.cdc.gov/healthyschools/nutrition/school_nutrition_education.htm

6. Food and Nutrition Service (FNS), USDA. USDA.gov. [cited 2023 Oct 18]. SNAP-Ed Final Allocations for FY 2022. Available from: https://snaped.fns.usda.gov/sites/default/files/documents/FY_22_SNAP-Ed_Allocations.pdf
7. Supplemental Nutrition Assistance Program: Nutrition Education and Obesity Prevention Grant Program [Internet]. Mar 31, 2016 p. 18447. Available from: https://snaped.fns.usda.gov/sites/default/files/documents/81FR18447.pdf
8. Frieden TR. A framework for public health action: the health impact pyramid. Am J Public Health. 2010 Apr;100(4):590–5. [PubMed: 20167880]
9. Burke MP, Gleason S, Singh A, Wilkin MK. Policy, systems, and environmental change strategies in the Supplemental Nutrition Assistance Program-Education (SNAP-Ed). J Nutr Educ Behav 2022 Apr 1;54(4):320–6. [PubMed: 35027308]
10. Draper CL, Younginer N. Readiness of SNAP-Ed implementers to incorporate policy, systems, and environmental approaches into programming. J Nutr Educ Behav 2021 Sep;53(9):751–8. [PubMed: 34233861]
11. Cullerton K, Donnet T, Lee A, Gallegos D. Playing the policy game: a review of the barriers to and enablers of nutrition policy change. Public Health Nutr 2016 Oct;19(14):2643–53. [PubMed: 27034196]
12. Mozaffarian D, Angell SY, Lang T, Rivera JA. Role of government policy in nutrition— barriers to and opportunities for healthier eating. BMJ. 2018 Jun 13;361:k2426. [PubMed: 29898890]
13. Story MT, Duffy E. Supporting Healthy Eating: Synergistic Effects of Nutrition Education Paired with Policy, Systems, and Environmental Changes. In: Black MM, Delichatsios HK, Story MT, editors. Nestlé Nutrition Institute Workshop Series [Internet]. S. Karger AG; 2020 [cited 2022 Sep 28]. p. 69–81. Available from: https://www.karger.com/Article/FullText/499549
14. Kenney EL, Barrett JL, Bleich SN, Ward ZJ, Cradock AL, Gortmaker SL. Impact of the Healthy, Hunger-Free Kids Act on obesity trends. Health Aff (Millwood). 2020 Jul 1;39(7):1122–9. [PubMed: 32634356]
15. Ickovics JR, Duffany KO, Shebl FM, Peters SM, Read MA, Gilstad-Hayden KR, et al. Implementing school-based policies to prevent obesity: cluster randomized trial. Am J Prev Med 2019 Jan;56(1):e1–11. [PubMed: 30573151]
16. Schwartz AE, Leardo M, Aneja S, Elbel B. Effect of a school-based water intervention on child body mass index and obesity. JAMA Pediatr 2016 Mar;170(3):220–6. [PubMed: 26784336]
17. Cradock AL, Barrett JL, Kenney EL, Giles CM, Ward ZJ, Long MW, et al. Using cost-effectiveness analysis to prioritize policy and programmatic approaches to physical activity promotion and obesity prevention in childhood. Prev Med 2017 Feb 1;95:S17–27. [PubMed: 27773710]
18. SNAP-Ed Toolkit [Internet]. [cited 2023 Oct 19]. Search the Database. Available from: https://snapedtoolkit.org/literature-review/find/
19. Blitstein JL, Cates SC, Hersey J, Montgomery D, Shelley M, Hradek C, et al. Adding a social marketing campaign to a school-based nutrition education program improves children's dietary intake: a quasi-experimental study. J Acad Nutr Diet 2016 Aug;116(8):1285–94. [PubMed: 26857870]
20. Strochlic R, Woodward-Lopez G, Hewawitharana S, Streng K, Richardson J, Whetstone L, et al. A Harvest of the Month curriculum increases fruit and vegetable intake among 4th-6th grade students. J Sch Health. 2021;91(9):750–60. [PubMed: 34291460]
21. Wolfe WS, Dollahite J. Evaluation of the Choose Health: Food, Fun, and Fitness 3rd- to 6th-grade curriculum: changes in obesity-related behaviors. J Sch Health. 2021 Jan;91(1):9–18. [PubMed: 33152803]
22. Division of Adolescent and School Health, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention. Results from the School Health Policies and Practices Study 2016 [Internet]. Atlanta, GA: Centers for Disease Control and Prevention; 2017 [cited 2021 Jun 9]. Available from: https://www.cdc.gov/healthyyouth/data/shpps/pdf/shpps-results_2016.pdf
23. Ward ZJ, Barrett JL, Cradock AL, Dupuis R, Lee MM, Long MW, et al. Childhood Obesity Intervention Cost-Effectiveness Study (CHOICES) Microsimulation Model Technical Documentation: Details on Model Parameters (CHOICES v4.6.1) [Internet]. CHOICES Project

Team at the Harvard T.H. Chan School of Public Health; 2023 Mar [cited 2023 Feb 27]. Available from: https://choicesproject.org/methods/choices-model-technical-documentation/

24. Gortmaker SL, Wang YC, Long MW, Giles CM, Ward ZJ, Barrett JL, et al. Three interventions that reduce childhood obesity are projected to save more than they cost to implement. Health Aff (Millwood). 2015 Nov;34(11):1932–9. [PubMed: 26526252]
25. U.S. Bureau of Labor Statistics. May 2020 national occupational employment and wage estimates [Internet]. [cited 2021 Jun 28]. Available from: https://www.bls.gov/oes/current/oes_nat.htm
26. Sanders GD, Neumann PJ, Basu A, Brock DW, Feeny D, Krahn M, et al. Recommendations for Conduct, Methodological Practices, and Reporting of Cost-effectiveness Analyses: Second Panel on Cost-Effectiveness in Health and Medicine. JAMA. 2016 Sep 13;316(10):1093–103. [PubMed: 27623463]
27. Neumann PJ, Ganiats TG, Russell LB, Sanders GD, Siegel JE. Cost-Effectiveness in Health and Medicine. 2nd ed. Oxford University Press; 2016.
28. Inebnit K, Gonzales D, Rodibaugh R, Hakkak R. Evaluation of attitudes and knowledge of fruit and vegetable consumption among second graders: the Pick a Better Snack and Act Program. The FASEB Journal. 2011;25(S1):597.1–597.1.
29. Frishman N, Shelley MC, Montgomery D. Investigation of the effects of nutrition education on the lifestyles of third-grade children and their parents. Social Thought & Research. 2013;32:47–69.
30. LaChausse RG. A clustered randomized controlled trial to determine impacts of the Harvest of the Month program. Health Educ Res 2017 Oct 1;32(5):375–83. [PubMed: 28931166]
31. Margolin A, Goto K, Wolff C, Bianco S. Let's talk food: elementary school students' perceptions of school and home food environment and the impact of the Harvest of the Month program on their dietary attitudes and behaviors. Int J Child Youth Fa 2017;8(3/4):154–67.
32. McCarthy E, Wolff C, Bianco-Simeral S, Crozier J, Goto K. The effects of a school-based nutrition intervention on fruit and vegetable preferences, self-efficacy, and consumption among low-income, Hispanic and white middle-school students. JCN&M. 2012;36(2).
33. Evans K, Goto K, Wolff C, Frigaard M, Bianco-Simeral S. Teachers' perceptions indicate success for Harvest of the Month nutrition education program. Calif J Health Promot 2012 Jun 1;10(1):105–16.
34. Strochlic R, Hewawitharana S, Streng K, Richardson J, Gorshow D, Hecht K, et al. Evaluation of the Harvest of the Month 4–6 Grade Curriculum, 2017 [Internet]. Nutrition Policy Institute; 2018 [cited 2021 Jun 10]. Available from: http://npi.ucanr.edu/files/294033.pdf
35. Wolfe WS, Scott-Pierce M, Dollahite J. Choose Health: Food, Fun, and Fitness youth curriculum promotes positive behaviors. J Nutr Educ Behav 2018 Oct 1;50(9):924–30. [PubMed: 29170056]
36. Sharifi M, Franz C, Horan CM, Giles CM, Long MW, Ward ZJ, et al. Cost-effectiveness of a clinical childhood obesity intervention. Pediatrics. 2017 Nov;140(5):e20162998. [PubMed: 29089403]
37. Kenney EL, Cradock AL, Long MW, Barrett JL, Giles CM, Ward ZJ, et al. Cost-effectiveness of water promotion strategies in schools for preventing childhood obesity and increasing water intake. Obesity. 2019;27(12):2037–45. [PubMed: 31746555]
38. Kenney EL, Lee MM, Barrett JL, Ward ZJ, Long MW, Cradock AL, et al. Cost-effectiveness of improved WIC food package for preventing childhood obesity. Pediatrics. 2024 Jan 1;153(2):e2023063182. [PubMed: 38258385]
39. Ward ZJ, Bleich SN, Long MW, Gortmaker SL. Association of body mass index with health care expenditures in the United States by age and sex. PLoS One. 2021 Mar 24;16(3):e0247307. [PubMed: 33760880]
40. Muennig P, Lubetkin E, Jia H, Franks P. Gender and the burden of disease attributable to obesity. Am J Public Health. 2006 Sep;96(9):1662–8. [PubMed: 16873748]
41. Kwon J, Kim SW, Ungar WJ, Tsiplova K, Madan J, Petrou S. A systematic review and meta-analysis of childhood health utilities. Med Decis Making. 2018 Apr;38(3):277–305. [PubMed: 28990449]
42. Congressional Budget Office [Internet]. [cited 2023 Jan 26]. Budget and economic data. Available from: https://www.cbo.gov/data/budget-economic-data#4

43. Neumann PJ, Kim DD. Cost-effectiveness thresholds used by study authors, 1990–2021. JAMA. 2023 Apr 18;329(15):1312–4. [PubMed: 37071104]
44. Neumann PJ, Cohen JT, Weinstein MC. Updating cost-effectiveness--the curious resilience of the $50,000-per-QALY threshold. N Engl J Med 2014 Aug 28;371(9):796–7. [PubMed: 25162885]
45. Long V, Cates S, Blitstein J, Fantacone J, Kosa K, Bell L, et al. Iowa Nutrition Network's Building and Strengthening Iowa Community Support (BASICS) for Nutrition and Physical Activity Program [Internet]. Washington, DC: United States Department of Agriculture; 2013 Dec [cited 2021 Jul 27]. (Supplemental Nutrition Assistance Program Education and Evaluation Study (Wave II)). Report No.: Volume 1. Available from: https://idph.iowa.gov/Portals/1/Files/INN/SNAPEDWaveII_IowaVol1.pdf
46. Davis JN, Pérez A, Asigbee FM, Landry MJ, Vandyousefi S, Ghaddar R, et al. School-based gardening, cooking and nutrition intervention increased vegetable intake but did not reduce BMI: Texas sprouts - a cluster randomized controlled trial. Int J Behav Nutr Phys Act 2021 Jan 23;18(1):18. [PubMed: 33485354]
47. McKillop G, Ilakkuvan V. The impact of chronic underfunding on America's public health system: Trends, risks and recommendations [Internet]. Washington, D.C.: Trust for America's Health; 2019 p. 32. Available from: https://www.tfah.org/report-details/publichealthfunding2020/
48. Leider JP, Resnick B, Bishai D, Scutchfield FD. How much do we spend? Creating historical estimates of public health expenditures in the United States at the federal, state, and local levels. Annu Rev Public Health. 2018;39(1):471–87. [PubMed: 29346058]
49. Wang LY, Yang Q, Lowry R, Wechsler H. Economic analysis of a school-based obesity prevention program. Obes Res 2003 Nov;11(11):1313–24. [PubMed: 14627751]
50. Brown HS, Pérez A, Li YP, Hoelscher DM, Kelder SH, Rivera R. The cost-effectiveness of a school-based overweight program. Int J Behav Nutr Phys Act 2007 Oct 1;4:47. [PubMed: 17908315]
51. Wang LY, Gutin B, Barbeau P, Moore JB, Hanes J, Johnson MH, et al. Cost-effectiveness of a school-based obesity prevention program. J Sch Health. 2008 Dec;78(12):619–24. [PubMed: 19000237]
52. Younginer NA, Draper CL. Capacity, communication, and coordination are key to successful implementation of policy, systems, and environmental strategies at SNAP-Ed partner sites in one Southeastern US state: a qualitative approach. J Acad Nutr Diet 2024 Feb 1;124(2):169–80. [PubMed: 37482267]
53. Naja-Riese A, Keller KJM, Bruno P, Foerster SB, Puma J, Whetstone L, et al. The SNAP-Ed Evaluation Framework: demonstrating the impact of a national framework for obesity prevention in low-income populations. Transl Behav Med 2019 Oct 1;9(5):970–9. [PubMed: 31570929]
54. Washburn L, Norman-Burgdolf H, Jones N, Kennedy LE, Jarvandi S. Exploring extension agent capacity and readiness to adopt policy, systems and environmental change approaches. Front Public Health [Internet]. 2022 May 26 [cited 2024 Jun 8];10. Available from: https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2022.856788/full
55. Cotton W, Dudley D, Peralta L, Werkhoven T. The effect of teacher-delivered nutrition education programs on elementary-aged students: an updated systematic review and meta-analysis. Prev Med Rep 2020 Aug 13;20:101178. [PubMed: 32944494]
56. Murimi MW, Moyeda-Carabaza AF, Nguyen B, Saha S, Amin R, Njike V. Factors that contribute to effective nutrition education interventions in children: a systematic review. Nutr Rev 2018 Aug 1;76(8):553–80. [PubMed: 29800311]
57. Meiklejohn S, Ryan L, Palermo C. A systematic review of the impact of multi-strategy nutrition education programs on health and nutrition of adolescents. J Nutr Educ Behav 2016 Oct;48(9):631–646.e1. [PubMed: 27720105]
58. Hall KD, Gortmaker SL, Lott M, Wang YC. From calories to weight change in children and adults: The state of the science [Internet]. Durham, NC: Healthy Eating Research; 2016 [cited 2023 Oct 18]. Available from: https://healthyeatingresearch.org/wp-content/uploads/2016/06/her_weight_change-FINAL-2.pdf

59. Hall KD, Butte NF, Swinburn BA, Chow CC. Dynamics of childhood growth and obesity: development and validation of a quantitative mathematical model. Lancet Diabetes Endocrinol 2013 Oct;1(2):97–105. [PubMed: 24349967]

60. Brown T, Moore TH, Hooper L, Gao Y, Zayegh A, Ijaz S, et al. Interventions for preventing obesity in children. Cochrane Database Syst Rev [Internet]. 2019 Jul 23 [cited 2021 Feb 12];2019(7). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6646867/

61. Kenney EL, Wintner S, Lee RM, Austin SB. Obesity prevention interventions in US public schools: are schools using programs that promote weight stigma? Prev Chronic Dis [Internet]. 2017 Dec 28 [cited 2020 Nov 12];14. Available from: http://www.cdc.gov/pcd/issues/2017/16_0605.htm

62. SNAP-Ed Connection [Internet]. [cited 2024 Jun 9]. SNAP-Ed Library. Available from: https://snaped.fns.usda.gov/library/materials?lib%5B0%5D=archived%3ANo

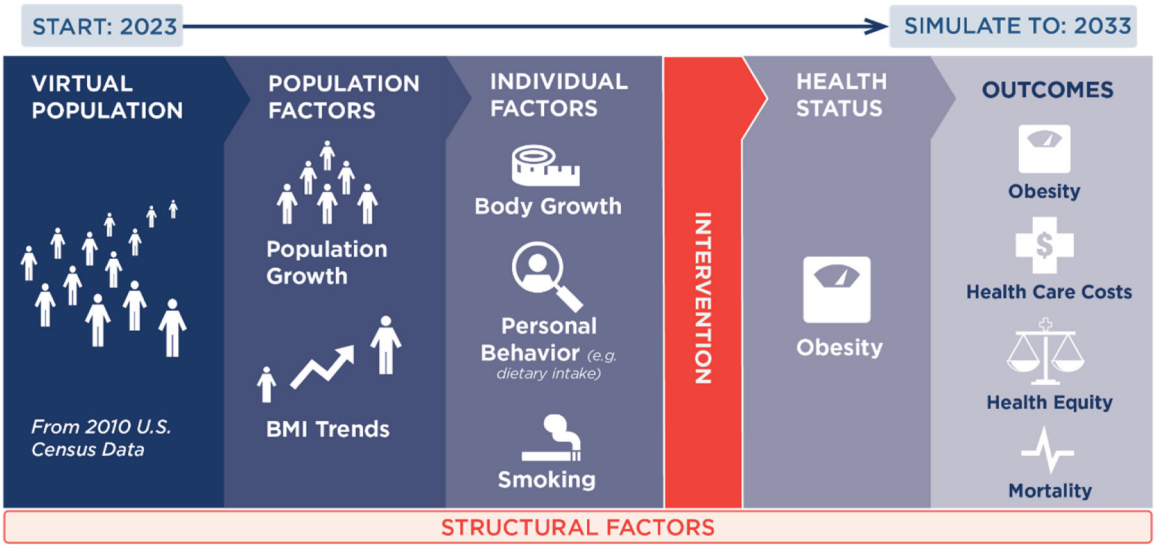

Figure 1.

Visual representation of the CHOICES microsimulation model for the cost-effectiveness of childhood obesity interventions.

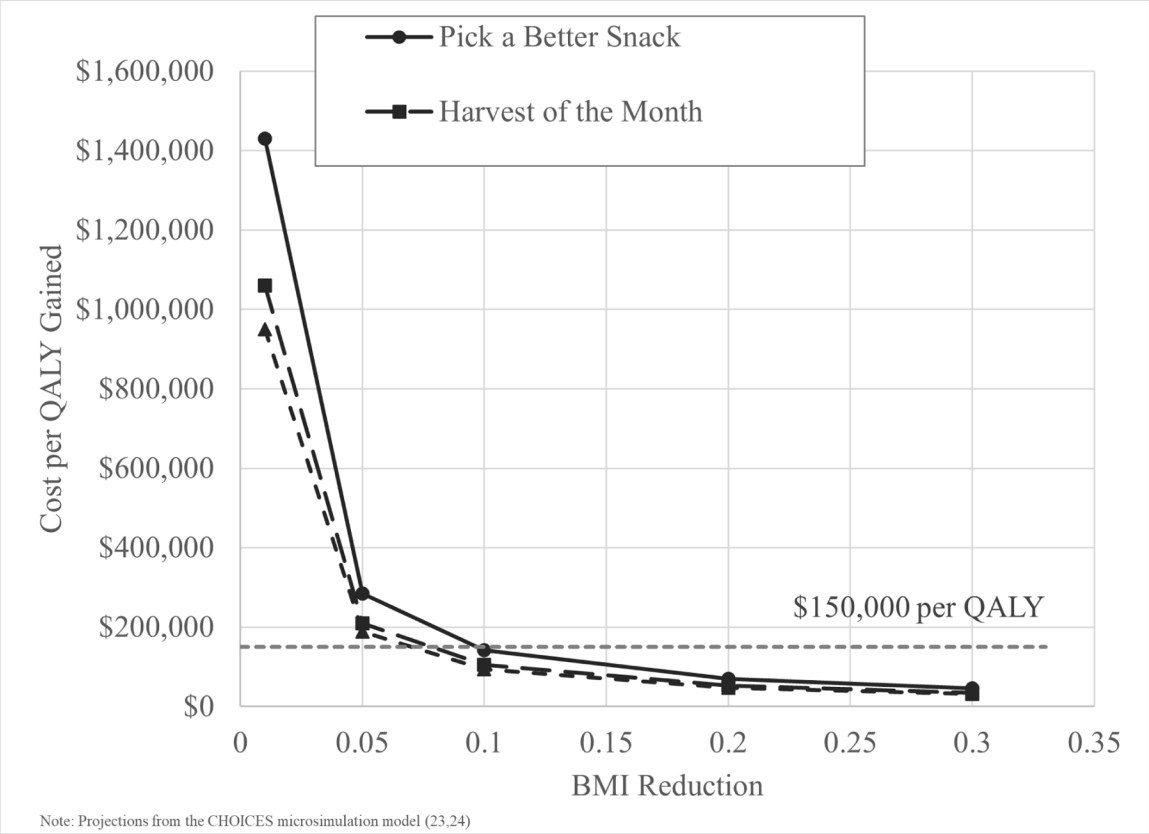

Figure 2.
Estimated costs per quality-adjusted life year (QALY) expected for three nutrition education curricula at a range of assumed effects on child body mass index (BMI).

Table 1.

Estimated reach and implementation costs of three nutrition education curricula if implemented in U.S. public schools nationwide for obesity prevention over 10 years (2023–2032)

Outcome	Mean (95% UI)
Number of children reached over 10 years	
Pick a Better Snack	33.2 M (32.5 M to 33.9 M)
Harvest of the Month	31.7 M (31.0 M to 32.2 M)
Choose Health: Food, Fun, and Fitness	34.0 M (33.5 M to 34.7 M)
Annual implementation cost per benefitting child	
Pick a Better Snack	$30.50 ($30.20 to $30.90)
Harvest of the Month	$18.70 ($18.50 to $18.90)
Choose Health: Food, Fun, and Fitness	$15.90 ($15.60 to $16.20)
Annual implementation cost	
Pick a Better Snack	$344 M ($348 M to $351 M)
Harvest of the Month	$180 M ($179 M to $182 M)
Choose Health: Food, Fun, and Fitness	$192 M ($192 M to $192 M)
10-year implementation costs	
Pick a Better Snack	$3.48 B ($3.44 B to $3.51 B)
Harvest of the Month	$1.80 B ($1.79 B to $1.82 B)
Choose Health: Food, Fun, and Fitness	$1.92 B ($1.92 B to $1.92 B)

Notes: B = billion. M = million. UI = uncertainty interval.

Projections from the CHOICES microsimulation model.

The 95% uncertainty interval is a central range in which 95 percent of model results fell when the model was run 1,000 times, taking into account uncertainty from data sources and population projections

Table 2.

Summary of estimated 10-year implementation costs of three nutrition education curricula if implemented in U.S. public schools nationwide for obesity prevention by category and payer (2023–2032)

Intervention	Estimated amount in U.S. dollars $ (% of total implementation costs)	Payer[1]
Pick a Better Snack		
Labor	$230 M (6%)	State government
	$1.33 B (38%)	Schools
Materials	$1.95 B (56%)	State government
Harvest of the Month		
Labor	$10,000 (<1%)	State government
	$930 M (51%)	School
Materials	$880 M (49%)	School
Choose Health: Food, Fun and Fitness		
Labor	$850 M (44%)	State government
Materials	$1.06 B (55%)	State government
Equipment	$11.5 M (1%)	State government

Notes: Projections from the CHOICES microsimulation model(23,24).

[1]Payers were estimated based on available peer-reviewed evidence and program reports. B = billion. M = million.