Cost-effectiveness of Improved WIC Food Package for Preventing Childhood Obesity

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abstract

BACKGROUND AND OBJECTIVES: The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) prevents food insecurity and supports nutrition for more than 3 million low-income young children. Our objectives were to determine the cost-effectiveness of changes to WIC's nutrition standards in 2009 for preventing obesity and to estimate impacts on socioeconomic and racial/ethnic inequities.

METHODS: We conducted a cost-effectiveness analysis to estimate impacts from 2010 through 2019 of the 2009 WIC food package change on obesity risk for children aged 2 to 4 years participating in WIC. Microsimulation models estimated the cases of obesity prevented in 2019 and costs per quality-adjusted-life year gained.

RESULTS: An estimated 14.0 million 2- to 4-year old US children (95% uncertainty interval (UI), 13.7–14.2 million) were reached by the updated WIC nutrition standards from 2010 through 2019. In 2019, an estimated 62 700 (95% UI, 53 900–71 100) cases of childhood obesity were prevented, entirely among children from households with low incomes, leading to improved health equity. The update was estimated to cost $10 600 per quality-adjusted-life year gained (95% UI, $9760–$11 700). If WIC had reached all eligible children, more than twice as many cases of childhood obesity would have been prevented.

CONCLUSIONS: Updates to WIC's nutrition standards for young children in 2009 were estimated to be highly cost-effective for preventing childhood obesity and contributed to reducing socioeconomic and racial/ethnic inequities in obesity prevalence. Improving nutrition policies for young children can be a sound public health investment; future research should explore how to improve access to them.

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Dr Kenney conceptualized the study, developed the analysis plan, supervised analysis, drafted the manuscript, and critically reviewed and revised the manuscript; Mr Lee and Ms Barrett conducted the analysis, contributed to drafting the manuscript, and critically reviewed and revised the manuscript; Dr Ward developed the microsimulation model and critically reviewed the manuscript; Dr Long contributed to the conceptualization of the study and critically reviewed the manuscript; Drs Cradock and Williams critically reviewed and revised the manuscript; Dr Gortmaker contributed to the conceptualization of the study and the development of the microsimulation model and critically reviewed and revised the manuscript; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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WHAT'S KNOWN ON THIS SUBJECT: Changes to the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) in 2009 improved diet quality for WIC participants and reduced the risk of obesity for 2- to 4-year-old participants.

WHAT THIS STUDY ADDS: We estimate the cost effectiveness of the 2009 changes for preventing childhood obesity and reducing racial/ethnic and socioeconomic disparities using a microsimulation model over 10 years; we also estimate the hypothetical impact of full WIC participation.

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During the period of rapid development in early childhood, ensuring children can access healthful foods, with the critical nutrients needed for healthy growth, is essential.[1] To protect infants and young children from the nutritional risks associated with poverty, the United States has used, since 1972, the Special Supplemental Nutrition for Women, Infants, and Children (WIC) program.[2] WIC provides nutritional assistance to pregnant, postpartum, and breastfeeding mothers and their children up to age 5 years; to be eligible, families must have household incomes at or below 185% of the federal poverty line (FPL) and be considered at nutritional risk.[3] An estimated 6.2 million people participate in WIC nationwide, approximately 3.4 million of whom are young children[4]; even so, the program is underused, reaching only half of those who are eligible, and participation among eligible individuals varies widely by state.[5] WIC has been associated with improved birth outcomes,[6] better child cognitive and academic outcomes,[7] and a reduced risk of food insecurity.[4,8]

Although WIC was developed in an era when inadequate nutrition was a primary concern, the children whose lower household incomes make them eligible for WIC have been disproportionately at risk for a relatively newer nutrition-related health threat: excess weight gain for healthy growth, or childhood obesity.[9,10] Traditionally, WIC's food package (the list of foods and beverages that could be obtained with WIC vouchers) had been designed to ensure basic nutritional adequacy for young children at low cost, not to prevent obesity. In 2009, however, the US Department of Agriculture (USDA), which administers WIC, modified the WIC food package to promote foods that would continue to support nutritional adequacy while also reducing future chronic disease risk.[11] As a result, the quantities of juice that could be purchased with WIC benefits were decreased, whole grain breads were required, and a cash-value voucher for purchasing fruits and vegetables was added. These changes to the food package led to increases in WIC recipients' fruit and vegetable consumption, reductions in juice consumption, and reductions in caloric intake,[12–16] and were also associated with reductions in childhood obesity risk.[17–19]

However, it is unclear whether these changes were cost-effective for preventing childhood obesity. As further food package changes are considered,[20] it is important to understand the cost-effectiveness of the initial changes, as well as their impact on socioeconomic and racial/ethnic disparities in obesity risk. Additionally, given the substantial declines in retention in WIC as children age and large differences in WIC coverage across states,[21] and the prioritization of addressing underparticipation as a policy goal,[22] it is also important to consider what impact these changes could have had if WIC fully reached all eligible children. This study aims to estimate the implementation costs of the 2009 WIC package change and the cost-effectiveness of the package change for preventing cases of childhood obesity among young children in households with low incomes.

METHODS

Study Design

This cost-effectiveness analysis study used the Childhood Obesity Intervention Cost Effectiveness Study (CHOICES) methodology, which has been applied to assess the cost-effectiveness of several childhood obesity prevention policies and programs.[23–26] The CHOICES approach involves: a key partner engagement process to identify policies and programs for modeling; a systematic evidence review process to identify model inputs for a given policy's or program's effects on child weight, costs to society, and population reach; and a microsimulation model to estimate potential impacts on childhood obesity, population reach, implementation costs, and healthcare cost savings over a 10-year period.

Intervention

Advisory partners suggested evaluating the cost-effectiveness of the 2009 WIC package changes for childhood obesity prevention. Specifically, we evaluated the changes to the WIC food package for 1- to 4-year-old children, which resulted in WIC benefits being directed toward less juice, cheese, and eggs and more whole grains, as well as a change to low-fat or nonfat milk and the addition of a cash value voucher for fruits and vegetables.[11]

Identification of Model Inputs

Effect

Although the food package targets 1- to 4-year olds, we focused on outcomes for 2- to 4-year-old children because obesity prevalence is not calculated by WIC in 1-year-old children. To project the impact of the package changes on childhood obesity risk, we used estimates from a natural experimental study, using an interrupted time series analysis that tested how the introduction of the 2009 package change was associated with changes in time trends in obesity.[17] This analysis found that, although before 2009 the prevalence of obesity among WIC-participating 2- to 4-year olds was increasing steadily (by 0.23 percentage points per year), after the package change was implemented the prevalence of obesity started significantly declining by an estimated −0.34 percentage points per year. These results are consistent with other localized evaluations of the impact of the package change on childhood obesity.[18] We used state-level estimates of the national impact on childhood obesity to account for strong state-by-state variation.

Reach

To estimate the population reached by the package change, we used estimates of the number of children who are eligible for WIC and the number and percentage of eligible children who participate in WIC in each state from administrative data released by USDA Food and Nutrition Services. Given that enrollment in WIC among eligible children varies substantially

by child age, race/ethnicity, and state, we used age-, race/ethnicity-, and state-stratified estimates of participation.[27–30] We assumed WIC eligibility among 2- to 4-year-old children based on household income eligibility (ie, children in households with incomes at or below 185% of the FPL were eligible) given that nearly all income-eligible children are classified as being at "nutritional risk."[21,31]

Costs

We used standard costing methodological approaches to estimate the incremental costs associated with implementation of the 2009 WIC food package change compared with no change.[32,33] We used a modified societal perspective, taking into account labor costs, opportunity costs, and equipment costs related to the food package changes. This involved accounting for costs at: (1) the federal level, where the program is partly administered; (2) state WIC agencies, which are largely responsible for implementing WIC policies and programs; and (3) WIC retailers (ie, supermarkets, grocery stores, corner stores, and pharmacies that are eligible to sell foods and beverage to WIC participants).[34] Of note, there was no estimated difference in the cost of the foods themselves for the WIC program given that the 2009 package change, which was designed to be cost-neutral, has not been found to increase the cost of the average recipient's food package.[35] Costs were derived from searches of administrative reports and from personal communications with WIC agency staff. Labor costs were estimated using data from the Bureau of Labor Statistics.[36,37] Costs are discounted at 3% annually, adjusted for inflation, and reported in 2019 US dollars. More details on model inputs can be found in the Supplemental Information.

Microsimulation Model

Using these data on the cost, population reach, and effectiveness of the WIC food package change, we then used the CHOICES microsimulation model to estimate outcomes related to childhood obesity for the US population from 2010 through 2019 associated with the package change, along with estimates of uncertainty for each outcome. The microsimulation model leverages detailed data from multiple nationally representative datasets to simulate the experiences of individuals in the US population related to height/weight trajectories and health, accounting for projected population growth.[38] The model assumes a 1-time effect from the intervention, and then calculates expected body mass index (BMI) trajectories moving forward in childhood from that initial BMI change. The model estimates health care costs associated with each unit change of BMI using age- and sex-specific estimates derived from the Medical Expenditure Panel Survey.[39] The model also estimates gains in quality-adjusted life years (QALYs), which are a measure of health benefit in terms of both quantity and quality of life lived. QALYs are used to estimate a cost-effectiveness metric, cost per QALY, and enable comparisons with the cost-effectiveness of other interventions. QALYs were estimated using published estimates of the relationship between weight category and health-related quality of life by sex and age group for children[40] and adults.[41,42] For children, a recent meta-analysis[40] calculated the decrement in health-related quality of life weights linked with overweight and obesity using a variety of measures. We also used published[13] adult weights, which use nationally representative health care expenditure data,[41] to calculate weights for children, making use of the strong relationship between child and adult weight status. When compared with the first set of weights, results were similar; thus, we chose to use the weights based on more representative data. More details on the calculation of QALYs can be found elsewhere[43] and in the Supplemental Information. To account for uncertainty in model inputs, we calculated 95% uncertainty intervals (UI), using 1000 Monte Carlo iterations for a simulated nationally representative population of 1 million individuals. Further details on the CHOICES microsimulation model are available in the Supplemental Information.

We used the microsimulation model to estimate 10-year population reach, implementation costs, QALYs gained, health care costs saved per dollar invested, cost-per-QALY, and the number of cases of childhood obesity prevented just in the year 2019, under 2 scenarios: (1) "historical" implementation, in which the benefits of the WIC package change would only accrue to children who actually participated (primary scenario); and (2) "full" implementation, in which we estimated what benefits society could have seen if all eligible children had participated in WIC (secondary scenario). We also projected whether the WIC program might have impacted socioeconomic and income-related racial/ethnic disparities in childhood obesity by comparing the percentage point differences in obesity prevalence between (1) children in poverty and children with household income at or above 350% FPL and (2) non-Hispanic white children compared with non-Hispanic Black and Hispanic children that would have been expected with and without the package change.

RESULTS

Primary Scenario

From 2010 through 2019, the model estimated that 14.0 million 2- to 4-year-old children (95% UI, 13.7–14.2 million), all from households with low income, were reached by the WIC package change (Table 1). The WIC package change is estimated to have prevented 62 700 cases of childhood obesity in the year 2019 alone (95% UI. 53 900–71 100). Combining data on implementation costs with health care cost savings attributable to the prevented cases of childhood obesity, the WIC 2009 package change is estimated to have saved $0.27 in health care costs per dollar invested

TABLE 1 Projected 10-Year Cost-Effectiveness Outcomes (Mean and 95% Uncertainty Intervals) of the 2009 WIC Food Package Change, 2010–2019		
	Historical Model	Full Participation Model
Children reached by the intervention (million)[a]	14.0 (13.7–14.2)	29.6 (29.0–30.0)
Implementation costs (million)	$248 ($247–$248)	$248 ($247–$248)
Implementation cost per child reached by the intervention	$17.70 ($17.40–$18.10)	$8.36 ($8.24–$8.52)
Healthcare costs saved (million)	$67.6 ($65.7–$69.6)	$161 ($157–$165)
Health care cost savings per dollar invested	$0.27 ($0.27–$0.28)	$0.65 ($0.63–$0.67)
Net costs (million)	$180 ($178–$182)	$86.8 ($82.7–$90.6)
Total cases of childhood obesity prevented in the year 2019 alone[a]	62 700 (53 900–71 100)	145 000 (125 000–166 000)
Cost per quality-adjusted life year gained	$10 600 ($9760–$11 700)	$2180 ($1980–$2430)

All costs and health outcomes are discounted at 3% annually unless otherwise noted; costs are reported in 2019 US dollars.
[a] Not discounted.

(95% UI, $0.27–$0.28) and cost $10 600 per QALY gained (95% UI, $9760–$11 700).

The WIC 2009 package change is also estimated to have narrowed income-related disparities in childhood obesity prevalence (Fig 1). Because the program is targeted only to children from households with low incomes, the cases of obesity estimated to have been prevented were entirely concentrated among these children, with an estimated 196 cases and 188 cases prevented per 100 000 children for children with household incomes at or below 130% and between 131% to 185% of the FPL, respectively, and no change predicted for the highest income group. This resulted in the gap in obesity prevalence between children in poverty compared with children with family incomes at or above 350% of the FPL shrinking by 4.5%. Similarly, because WIC participants are more likely to identify as Black or Hispanic than white, reductions in disparities by race/ethnicity were also observed, with 126 cases of childhood obesity prevented per 100 000 for Black children and 183 cases prevented per 100 000 for Hispanic children, compared with 33 cases per 100 000 prevented for White children.

Secondary Scenario

Meanwhile, we estimate that if there had been complete participation in WIC among eligible 2- to 4-year olds, 29.6 million children (95% UI, 29.0–30.0 million) (ie, an additional 15.6 million) would have been reached in this 10-year period, and that 145 000 cases of childhood obesity (95% UI, 125 000–166 000) could have been prevented in 2019 (Table 1). Complete participation would have resulted in similar implementation costs to the primary scenario (because most costs were incurred at the agency and retailer levels, and thus would not depend on the number of WIC participants) but with more overall health care cost savings ($161 million; 95% UI, $157–$165 million for full participation compared with $67.6 million; 95% UI, $65.7–$69.6 million for the historical model), resulting in lower net costs to

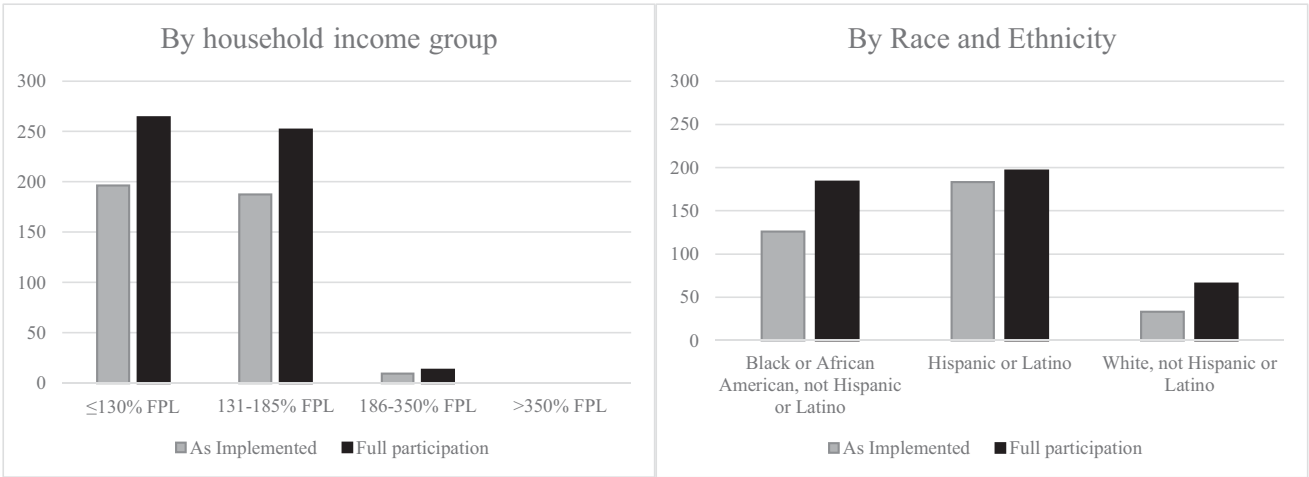

FIGURE 1
Projected cases of childhood obesity prevented per 100 000 people in 2019 attributable to the WIC package change in historical and full participation scenarios, by household income status and race/ethnicity.

society of $86.8 million (95% UI, 82.7–90.6 million). Subsequently, this would have resulted in higher health care cost savings per dollar invested ($0.65; 95% UI, $0.63–$0.67) and a substantially lower cost per QALY gained ($2180 per QALY; 95% UI, $1980–$2430). If all income-eligible children had been reached, the gap in obesity prevalence between children in poverty compared with children with family incomes at or above 350% of the FPL would have shrunk by 6.0%.

DISCUSSION

In this study, we projected that the 2009 changes to the WIC food package were highly cost-effective for preventing childhood obesity and improved health equity. Updating the food package is estimated to have prevented nearly 60 000 cases of childhood obesity in the year 2019 alone, entirely among children living in households with low income, and to have been a good investment for health, at a cost-per-QALY of $10 600. This cost-per-QALY is well below most established willingness-to-pay thresholds, which typically range from $50 000 to $150 000 per QALY in the United States.[44,45] Furthermore, the package change is estimated to have narrowed socioeconomic gaps in obesity prevalence. As policymakers consider strategies to improve health and promote health equity, our analyses show that updating nutrition standards for this critical food assistance program—one that reaches millions of young children with low incomes and provides a range of benefits for healthy development—was likely a beneficial and cost-effective policy.

Furthermore, this study found that the population health benefits could have been more than doubled, while resulting in similar implementation costs, if WIC had been able to reach all eligible 2- to 4-year-old children. In other words, the United States missed out on preventing an additional 82 300 cases of childhood obesity in 2020 because of WIC's not reaching all eligible preschool-aged children. In turn, payers of health care costs in the United States, including public and private insurance and families, missed out on saving an additional $93.4 million in health care costs. Diminished retention in the WIC program as children age, dropping from nearly 100% coverage of eligible infants to only 25% coverage of eligible 4-year olds,[21] is a critical concern for WIC.[22] Children and families cannot receive the numerous economic, health, and developmental benefits of the WIC program if they are not participating in the program in the first place.

Our results suggest 2 key considerations for leveraging WIC to promote eating patterns that help equitably prevent chronic disease and obesity. First, policy efforts to further improve the nutritional quality of the WIC food packages are needed. The results from the 2009 package change for population health are promising. However, surveillance data of obesity in WIC preschool-aged children suggests a leveling off of the decline in obesity prevalence,[46] suggesting that the 2009 food package changes may have had all of the impact they can. The USDA, using science-based recommendations from the National Academy of Medicine, recently proposed regulations to update the WIC package change further, including making a change introduced during the COVID-19 pandemic to increase the benefit amount for the fruit and vegetable cash-value voucher permanent. Such changes to strengthen WIC's nutritional offerings might further benefit population health. Second, more research and action are needed to better understand how to improve WIC's reach. Existing research suggests that reduced satisfaction with the food package for children plays a role, particularly for families whose cultural food traditions do not align with foods in the package (eg, families who do not consume dairy or cold breakfast cereal).[47,48] Experiencing stigma while shopping with WIC benefits has also been cited as a potential reason, with confusion and mislabeled items in WIC-participating retailers contributing to these experiences.[49] Mechanisms to streamline and use electronic apps and tools for WIC to address some of these issues, such as smartphone apps to help identify WIC-eligible products in-store[47,50] and the use of electronic-benefit-transfer cards,[51] have had promising effects.[52] Further evaluation of strategies to help keep eligible participants enrolled throughout their eligibility period is needed.

There are several limitations to this study. Because it is not possible to randomize children to receive WIC benefits, the evidence we used for the effect of the WIC package change on child BMI is subject to bias. It is possible that the association between the WIC package change and decreased obesity prevalence over time is due to compositional changes in the WIC population or some other population-wide effect. However, the original analysis used for the BMI effect in this paper adjusted for changes in sociodemographic composition of the WIC population over time and also accounted for changes in economic conditions over time[17]; moreover, the findings of a change in dietary intake and weight status related to the 2009 WIC package change have been consistently replicated across multiple studies and contexts.[12–14,18] Other obesity prevention interventions, such as breastfeeding or physical activity interventions, could also have theoretically influenced childhood obesity among WIC 2- to 4-year olds, though such influences have not been quantified. Other limitations related to data availability include a lack of data on whether there were differential effects of the WIC package change by race/ethnicity—our model estimates of disparities changes are based solely on the fact that WIC is used by relatively higher proportions of Black and Hispanic children, not on estimated differences in effect size—and a lack of data about the administrative costs required for increasing WIC participation in our secondary scenario. A further limitation is that this cost-effectiveness model focuses solely on obesity prevention and does not consider other potential impacts on child health that may

have resulted from the WIC package change. For example, it is unknown whether the package change had any impacts on children's cognitive development.

CONCLUSIONS

The WIC 2009 food package change is estimated to have reduced childhood obesity for children in households with low income and to be highly cost-effective while improving health equity. WIC's beneficial impact could be expanded by identifying strategies to increase enrollment and improve retention in the program.

ABBREVIATIONS

CHOICES: Childhood Obesity Intervention Cost Effectiveness Study
FPL: federal poverty line
QALY: quality-adjusted life year
WIC: Special Supplemental Nutrition Program for Women, Infants, and Children
UI: uncertainty interval
USDA: US Department of Agriculture

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REFERENCES

1. U.S. Department of Agriculture, U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2020–2025*. 9th ed. USDA; 2020
2. United States Department of Agriculture Food and Nutrition Services. Special Supplemental Nutrition Program for Women, Infants, and Children (WIC): about WIC. Available at: https://www.fns.usda.gov/wic/about-wic. Accessed June 7, 2022
3. United States Department of Agriculture Food and Nutrition Services. WIC eligibility requirements. Available at: https://www.fns.usda.gov/wic/wic-eligibility-requirements. Accessed June 7, 2022
4. USDA Food and Nutrition Service. WIC program participation and costs. Available at: https://fns-prod.azureedge.us/sites/default/files/resource-files/wisummary-12.pdf. Accessed December 18, 2022
5. United States Department of Agriculture Food and Nutrition Service. WIC 2019 eligibility and coverage rates. Available at: https://www.fns.usda.gov/wic/2019-eligibility-coverage-rates. Accessed January 3, 2023
6. Bitler MP, Currie J. Does WIC work? The effects of WIC on pregnancy and birth outcomes. *J Policy Anal Manage*. 2005;24(1):73–91
7. Jackson MI. Early childhood WIC participation, cognitive development and academic achievement. *Soc Sci Med*. 2015;126:145–153
8. Kreider B, Pepper JV, Roy M. Identifying the effects of WIC on food insecurity among infants and children. *South Econ J*. 2016;82(4):1106–1122
9. Weaver RG, Brazendale K, Hunt E, Sarzynski MA, Beets MW, White K. Disparities in childhood overweight and obesity by income in the United States: an epidemiological examination using three nationally representative datasets. *Int J Obes*. 2019;43(6):1210–1222
10. Ogden CL, Carroll MD, Lawman HG, et al. Trends in obesity prevalence among children and adolescents in the United States, 1988-1994 through 2013-2014. *JAMA*. 2016;315(21):2292–2299
11. Institute of Medicine. *WIC Food Packages: Time for a Change*. The National Academies Press; 2005
12. Schultz DJ, Byker Shanks C, Houghtaling B. The impact of the 2009 Special Supplemental Nutrition Program for Women, Infants, and Children Food Package revisions on participants: a systematic review. *J Acad Nutr Diet*. 2015;115(11):1832–1846
13. Ng SW, Hollingsworth BA, Busey EA, Wandell JL, Miles DR, Poti JM. Federal nutrition program revisions impact low-income households' food purchases. *Am J Prev Med*. 2018;54(3):403–412
14. Tester JM, Leung CW, Crawford PB. Revised WIC food package and children's diet quality. *Pediatrics*. 2016;137(5):e20153557
15. Andreyeva T, Tripp AS. The healthfulness of food and beverage purchases after the federal food package revisions: the case of two New England states. *Prev Med*. 2016;91:204–210
16. Andreyeva T, Luedicke J, Tripp AS, Henderson KE. Effects of reduced juice allowances in food packages for the women, infants, and children program. *Pediatrics*. 2013;131(5):919–927
17. Daepp MIG, Gortmaker SL, Wang YC, Long MW, Kenney EL. WIC food package changes: trends in childhood obesity prevalence. *Pediatrics*. 2019;143(5):e20182841
18. Chaparro MP, Crespi CM, Anderson CE, Wang MC, Whaley SE. The 2009 Special Supplemental Nutrition Program for Women, Infants,

and Children (WIC) food package change and children's growth trajectories and obesity in Los Angeles County. *Am J Clin Nutr*. 2019;109(5):1414–1421

19. Pan L, Freedman DS, Sharma AJ, et al. Trends in obesity among participants aged 2-4 years in the Special Supplemental Nutrition Program for Women, Infants, and Children - United States, 2000-2014. *MMWR Morb Mortal Wkly Rep*. 2016;65(45):1256–1260
20. Food and Nutrition Service. Proposed rule: Special Supplemental Nutrition Program for Women, Infants, and Children: Revisions in the Women, Infants, and Children food packages (docket FNS-2022-0007-0001). Available at: https://www.regulations.gov/document/FNS-2022-0007-0001. Accessed November 1, 2023
21. Farson Gray K, Balch-Crystal E, Giannarelli L, Johnson P. National- and state-level estimates of WIC eligibility and WIC program reach in 2019. Available at: https://fns-prod.azureedge.us/sites/default/files/resource-files/WICEligibles2019-Volume1-revised.pdf. Accessed November 1, 2023
22. United States Department of Agriculture Food and Nutrition Service. WIC and WIC FMNP informational memorandum: American Rescue Plan Act of 2021 (P.L. 117-2), Program Modernization. Available at: https://fns-prod.azureedge.us/sites/default/files/resource-files/WICandFMNPInfoMemo-American-Rescue-Plan-Act-Pgm-Modernization.pdf.pdf. Accessed November 1, 2023
23. Gortmaker SL, Wang YC, Long MW, et al. Three interventions that reduce childhood obesity are projected to save more than they cost to implement. *Health Aff (Millwood)*. 2015;34(11):1932–1939
24. Cradock AL, Barrett JL, Kenney EL, et al. Using cost-effectiveness analysis to prioritize policy and programmatic approaches to physical activity promotion and obesity prevention in childhood. *Prev Med*. 2017;95(suppl):S17–S27
25. Sharifi M, Franz C, Horan CM, et al. Cost-effectiveness of a clinical childhood obesity intervention. *Pediatrics*. 2017;140(5):e20162998
26. Kenney EL, Cradock AL, Long MW, et al. Cost effectiveness of water promotion strategies in schools for preventing childhood obesity and increasing water intake. *Obesity (Silver Spring)*. 2019;27(12):2037–2045
27. United States Department of Agriculture Food and Nutrition Service. National- and state-level estimates of Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) eligibles and program reach in 2014, and updated estimates for 2005–2013. Available at: https://fns-prod.azureedge.us/sites/default/files/ops/WICEligibles2014.pdf. Accessed November 20, 2022
28. United States Department of Agriculture Food and Nutrition Service. National- and state-level estimates of WIC eligibles and WIC program reach in 2015, final report: volume 1. Available at: https://fns-prod.azureedge.us/sites/default/files/ops/WICEligibles2015-Volume1.pdf. Accessed November 20, 2022
29. United States Department of Agriculture Food and Nutrition Service. National- and state-level estimates of WIC eligibility and WIC program reach in 2017, final report: volume 1. Available at: https://fns-prod.azureedge.us/sites/default/files/resource-files/WICEligibles2017-Volume1.pdf. Accessed November 20, 2022
30. United States Department of Agriculture Food and Nutrition Service. National- and state-level estimates of WIC eligibility and WIC program reach in 2016, final report: volume 1. Available at: https://fns-prod.azureedge.us/sites/default/files/resource-files/WICEligibles2016-Volume1.pdf. Accessed November 20, 2022
31. United States Department of Agriculture. WIC policy memorandum 2011-5: WIC nutrition risk criteria. Available at: https://fns-prod.azureedge.us/sites/default/files/2011-5-WICNutritionRiskCriteria.pdf. Accessed November 6, 2023
32. Drummond MF, Sculpher MJ, Claxton K, Stoddart GL, Torrance GW. *Methods for the Economic Evaluation of Health Care Programmes*. Oxford University Press; 2015
33. Gold MR, Siegel JE, Russell LB. *Cost-Effectiveness in Health and Medicine*. Oxford University Press; 1996
34. Gleason S, Morgan R, Bell L, Pooler J. Impact of the revised WIC food package on small WIC vendors: insight from a four-state evaluation. Available at: https://www.calwic.org/storage/FourStateWICFoodPackageEvaluation-Full_Report-20May11.pdf. Accessed November 1, 2023
35. National Academies of Sciences Engineering Medicine. Review of WIC food packages: improving balance and choice. Available at: https://nap.nationalacademies.org/catalog/23655/review-of-wic-food-packages-improving-balance-and-choice-final. Accessed November 1, 2023
36. U.S. Bureau of Labor Statistics. Employer costs for employee compensation – September 2014, USDL-14-2208. Available at: https://www.bls.gov/news.release/archives/ecec_12102014.pdf. Accessed October 13, 2022
37. U.S. Bureau of Labor Statistics. May 2019 national occupational employment and wage estimates. Available at: https://www.bls.gov/oes/2019/may/oes_nat.htm. Accessed October 13, 2022
38. Ward ZJ, Long MW, Resch SC, Giles CM, Cradock AL, Gortmaker SL. Simulation of growth trajectories of childhood obesity into adulthood. *N Engl J Med*. 2017;377(22):2145–2153
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;16(3):e0247307
40. 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;38(3):277–305
41. Shaw JW, Johnson JA, Coons SJ. US valuation of the EQ-5D health states: development and testing of the D1 valuation model. *Med Care*. 2005;43(3):203–220
42. Muennig P, Lubetkin E, Jia H, Franks P. Gender and the burden of disease attributable to obesity. *Am J Public Health*. 2006;96(9):1662–1668
43. Dupuis R, Block JP, Barrett JL, et al. Cost effectiveness of calorie labeling at large fast-food chains across the US [published online ahead of print August 14, 2023]. *Am J Prev Med*. doi: 10.1097/00005650-200503000-00003
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;371(9):796–797
45. Vanness DJ, Lomas J, Ahn H. A health opportunity cost threshold for cost-effectiveness analysis in the United States. *Ann Intern Med*. 2021;174(1):25–32

46. Kline N, Zvavitch P, Wroblewska K, Worden M, Mwombela B, Thorn B. WIC participant and program characteristics 2020. Available at: https://fns-prod.azureedge.us/sites/default/files/resource-files/WICPC2020-1.pdf. Accessed November 2, 2022

47. Gago CM, Wynne JO, Moore MJ, et al. Caregiver perspectives on underutilization of WIC: a qualitative study. *Pediatrics*. 2022;149(2):e2021053889

48. Weber SJ, Wichelecki J, Chavez N, Bess S, Reese L, Odoms-Young A. Understanding the factors influencing low-income caregivers' perceived value of a federal nutrition programme, the Special Supplemental Nutrition Program for Women, Infants and Children (WIC). *Public Health Nutr*. 2019;22(6):1056–1065

49. Chauvenet C, De Marco M, Barnes C, Ammerman AS. WIC recipients in the retail environment: a qualitative study assessing customer experience and satisfaction. *J Acad Nutr Diet*. 2019;119(3):416–424.e2

50. Zimmer MC, Beaird J, Steeves EA. WIC participants' perspectives of facilitators and barriers to shopping with eWIC compared with paper vouchers. *J Nutr Educ Behav*. 2021;53(3):195–203

51. Vasan A, Kenyon CC, Feudtner C, Fiks AG, Venkataramani AS. Association of WIC participation and electronic benefits transfer implementation. *JAMA Pediatr*. 2021;175(6):609–616

52. United States Department of Agriculture Food and Nutrition Services. Child nutrition programs: COVID-19 waivers by state. Available at: https://www.fns.usda.gov/disaster/pandemic/covid-19/cn-waivers-flexibilities. Accessed November 1, 2023

53. Long MW, Polacsek M, Bruno P, et al. Cost-effectiveness analysis and stakeholder evaluation of 2 obesity prevention policies in Maine, US. *J Nutr Educ Behav*. 2019;51(10):1177–1187

54. Tiehen L, Frazão E. Where do WIC participants redeem their food benefits? An analysis of WIC food dollar redemption patterns by store type. Available at: https://www.ers.usda.gov/webdocs/publications/44073/57246_eib152.pdf?v=0. Accessed March 12, 2023

55. United States Department of Agriculture Food and Nutrition Service. 2013 WIC vendor management study. Available at: https://fns-prod.azureedge.us/sites/default/files/resource-files/2013WICVendor.pdf. Accessed March 12, 2023

56. Andreyeva T, Middleton AE, Long MW, Luedicke J, Schwartz MB. Food retailer practices, attitudes and beliefs about the supply of healthy foods. *Public Health Nutr*. 2011;14(6):1024–1031