Published in final edited form as:

Am J Prev Med. 2018 July ; 55(1): e11–e18. doi:10.1016/j.amepre.2018.04.003.

100% Juice, Fruit and Vegetable Intake Among Children in the Special Supplemental Nutrition Program for Women, Infants and Children and Nonparticipants

Kelsey A. Vercammen, BHSc¹, Alyssa J. Moran, MPH, RD², Laura Y. Zatz, MPH^{2,3}, and Eric B. Rimm, ScD^{1,2}

¹Department of Epidemiology, Harvard T.H. Chan School of Public Health, Boston, Massachusetts

²Department of Nutrition, Harvard T.H. Chan School of Public Health, Boston, Massachusetts

³Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, Boston, Massachusetts

Abstract

Introduction: The Special Supplemental Nutrition Program for Women, Infants and Children (WIC) provides monthly food packages to low-income children (aged 1–4 years) in the U.S., including 128 ounces of 100% fruit juice and an \$8 cash value voucher for purchasing fruits and vegetables. The fruit juice allowance translates to 71%–107% of the maximum intake recommended by the American Academy of Pediatrics (4–6 ounces/day). Careful examination of WIC food package allocations is necessary because overconsumption of fruit juice among young children has been linked to weight gain and juice lacks important nutrients found in whole fruit (e.g., fiber).

Methods: A total of 1,576 children aged 2–4 years were assessed using the 2009–2014 National Health and Nutrition Examination Surveys. Multivariate linear regressions were conducted in 2017 to analyze the association between WIC program participation and intake of 100% fruit juice, whole fruits and vegetables. Logistic regression was used to examine the association between WIC program participation and the odds of exceeding the American Academy of Pediatrics maximum intake for juice.

Results: Adjusting for child and parent/caregiver characteristics, WIC participants consumed significantly more 100% fruit juice ($\beta=0.22$ cup equivalents/day, 95% CI=0.04, 0.40) compared with income-eligible nonparticipants, but not more whole fruits or total vegetables. WIC participants had 1.51-times greater odds (95% CI=1.06, 2.14) of exceeding the age-specific American Academy of Pediatrics maximum intake for juice compared with income-eligible nonparticipants.

Address correspondence to: Kelsey A. Vercammen, BHSc, Department of Epidemiology, Harvard T.H. Chan School of Public Health, 677 Huntington Ave., Boston MA 02115. kev266@mail.harvard.edu.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain

No financial disclosures were reported by the authors of this paper.

Conclusions: These findings support recommendations to reduce 100% fruit juice allowances in the WIC program and re-allocate those funds to the cash value voucher to increase whole fruit and vegetable consumption.

INTRODUCTION

The Special Supplemental Nutrition Assistance Program for Women, Infants and Children (WIC) is a federal program that provides prescription supplemental food packages to more than 7 million women (pregnant, postpartum, and breastfeeding), infants, and children up to age 5 years whose household incomes are 185% or less than the Federal Poverty Line (FPL).

¹ Participants are provided with paper vouchers or an electronic benefit card (similar to a debit card) that enables them to redeem a maximum monthly quantity of WIC-approved foods (e.g., 2 pounds whole wheat bread) at WIC-authorized retailers. The quantity and type of foods in each food package varies by pregnancy/breastfeeding status and child age.^{2,3} Additionally, participants receive a cash value voucher (CVV) or electronic cash value benefit (CVB), which can be used to purchase fruits and vegetables.³

Within their monthly food packages, children (aged 1–4 years) are allocated 128 fluid ounces of 100% fruit or vegetable juice and an \$8.00 CVB/CVV.³ The American Academy of Pediatrics (AAP) recommends a maximum of 4 ounces/day of 100% fruit juice for children aged 1–3 years and 4–6 ounces/day for children aged 4–6 years,⁴ meaning that the WIC food packages provide 71% to 107% of the daily maximum. By contrast, the CVB/CVV is estimated to provide only 43% of the 0.5 cup equivalents of whole fruit and 11% of the 1.5 cup equivalents of vegetables recommended by the 2015–2020 Dietary Guidelines for Americans (DGA) for children aged 2–4 years consuming a 1,300 calorie diet.^{5,6} Although fruit juice can be a good source of micronutrients (e.g., vitamin C), overconsumption has been linked to weight gain and dental caries because of its high sugar content.^{7–11} Additionally, juice lacks the fiber found in whole fruit, which promotes satiety.¹²

Congress has mandated that the Food and Nutrition Service of the U.S. Department of Agriculture (USDA) must evaluate the WIC food packages every 10 years to ensure they are aligned with the goals of the DGA.¹³ In October 2009, the USDA revised the food packages based on recommendations from the National Academy of Sciences, Engineering and Medicine (formerly known as the Institute of Medicine), resulting in the most substantial changes since the program's inception.^{14,15} Key changes included a reduction in the amount of 100% fruit juice (from 288 fluid ounces to 128 fluid ounces for children each month) and the implementation of the CVV for purchasing fruits and vegetables (initially \$8–\$10/month for women and \$6/month for children).¹⁶ The value of the CVV/CVB was increased to \$8/month for children in 2014 and \$11/month for all women in 2015.^{17,18}

Few studies have examined the intake of fruit juice, fruit or vegetables among WIC participants, with most assessing intake prior to WIC's revisions in 2009.^{19–23} The present study aims to provide an updated comparison of total fruit, 100% fruit juice, whole fruit and total vegetable intake between WIC participants and nonparticipants following the 2009 WIC food package revisions. This study contributes to the evidence base for future revisions

to WIC food packages and informs other interventions to promote fruit and vegetable intake among young children.

METHODS

The analysis used data from the National Health and Nutritional Examination Survey (NHANES), a repeated cross-sectional study that assesses the health and nutrition status of Americans.^{24,25} Released every 2 years, NHANES uses multistage, clustered probability sampling and is designed to be representative of the U.S. non-institutionalized, civilian population.²⁴ In order to increase the reliability and precision of estimates, NHANES oversamples certain population subgroups including racial and ethnic minorities, although it does not explicitly oversample the WIC population.²⁴ A complete description of data collection procedures and analytic guidelines is available through NHANES.²⁵

This analysis combined data from children in three survey cycles (2009–2010, 2011–2012, and 2013–2014) to ensure a sufficient sample of WIC participants and nonparticipants. Survey cycles from before 2009 were not included as this would capture intake of WIC participants prior to the implementation of the revised food packages in October 2009.

Study Population

From a total of 2,284 eligible children aged 2–4 years, the study population for this analysis was limited to 1,576 (69.0%) children who had complete data on dietary intake, WIC participation, and all covariates. Participants were excluded if they were missing data on dietary intake data ($n=405$), overweight/obesity status ($n=202$), household income ($n=183$), age at examination ($n=113$), household education status ($n=68$), household marital status ($n=56$), and WIC participation ($n=24$) or SNAP participation ($n=25$). Children who were missing data on dietary intake were not significantly different from children with complete data on dietary intake with respect to most individual and parent/caregiver characteristics. However, there was a significant difference in the number of participants missing dietary intake across income categories, with children from low-income households more likely to be missing dietary intake data.

Measures

Consistent with previous studies,^{21,26} children were considered WIC participants if their household reported receiving WIC benefits in the past 12 months. Children were considered nonparticipants if their household did not report WIC participation, with income-eligible nonparticipants reporting income $\leq 185\%$ of the FPL and higher-income nonparticipants reporting income $>185\%$ of the FPL.

NHANES conducted two in-person 24-hour dietary recall interviews, with primary caretakers reporting on behalf of children aged 2 to 5 years. Only the first 24-hour recall was used in this analysis because the higher nonresponse for the second 24-hour recall would limit the sample size. NHANES classified participants' dietary recall status as reliable or not reliable based on the quality and completeness of the dietary recall response; participants with unreliable data recall status were not included in the analysis.

The Food Patterns Equivalents Database was used to convert foods and beverages reported in the dietary recall to USDA food pattern components, which include: (1) intact citrus, melons, and berries; (2) intact other fruits; (3) fruit juice; (4) total fruits (including intact fruits and fruit juice); and (5) total vegetables (including intact/whole vegetables and vegetable juice).²⁷ The researchers combined all intact fruits to create a new whole fruits category. Because the consumption of 100% vegetable juice consumed by children in the analytical sample was negligible, vegetable juice and whole vegetables were not analyzed separately.

The following participant covariates were included in all models as categorical variables: sex (male/female), age (24–35, 36–47, and 48–60 months), race/ethnicity (non-Hispanic white, non-Hispanic black, Mexican American, other Hispanic, other race/ethnicity), and weight status (underweight, normal weight, overweight, obese). To determine weight status, height and weight were collected in the NHANES Mobile Examination Center by trained technicians. BMI percentiles were then calculated using the 2000 CDC Growth Charts,²⁸ with 0–<5th percentile indicating underweight, 5th to <85th percentile indicating normal weight, 85th to <95th percentile indicating overweight and >95th percentile indicating obesity. Parent/caregiver covariates were also controlled for as categorical variables: marital status (single/no partner, married/partnered), education status (less than high school, high school graduate or more), income-to-poverty ratio (0%–50% FPL, 51%–100%, 101%–150%, >150%), and SNAP participation in the past 12-months (participant, nonparticipant).

Statistical Analysis

All analyses were weighted to account for the multistage, clustered probability sampling of NHANES. To ensure there was no statistically significant trend in consumption of 100% fruit juice, whole fruit, total fruit or total vegetables during the study period, an ordinal variable indicating survey cycle (2009–2010, 2011–2012, 2013–2014) was included with all covariates in adjusted linear regression analyses. No linear trend in the outcome was observed for the survey cycle variable ($p>0.05$) for any of the analyses, and there were no significant differences in consumption between survey cycles.

Multiple linear regression was used to assess the association between WIC participation and 100% fruit juice, whole fruit, total fruit (sum of 100% fruit juice and whole fruit), and total vegetable consumption. Logistic regression was used to assess the association between WIC participation and the odds of exceeding AAP's age-specific maximum juice intake (4 ounces/day for children aged 2–3 years and 6 ounces/day for children aged 4 years). All models were adjusted for child characteristics (gender, age, race/ethnicity, overweight/obesity) and parent/caregiver characteristics (education, marital status, SNAP participation, and income-to-poverty ratio).

Since the 2009–2010 survey cycle included children who may have received benefits prior to the implementation of the revisions, sensitivity analyses were conducted using only 2011–2014 data. Analyses were conducted in 2017 using SAS, version 9.3.

RESULTS

Table 1 reports characteristics of the study sample. A total of 1,576 children (677 WIC participants, 409 income-eligible nonparticipants, and 490 higher-income nonparticipants) were included in the analysis. Significant differences between WIC participants and nonparticipants were found for race/ethnicity ($p<0.0001$) and age ($p=0.03$), as well as parent/caregiver educational attainment ($p<0.0001$), marital status ($p<0.0001$), SNAP participation status ($p<0.0001$), and income-to-poverty ratio ($p<0.0001$). Compared with nonparticipants, there were higher percentages of non-Hispanic black, Mexican American, and Hispanic children among WIC participants. A higher proportion of children participating in WIC came from a household that participated in SNAP and had an income $<100\%$ of the FPL. A higher proportion of parents/caregivers of WIC participants were unmarried and attained less than a high school education.

Figure 1 and Appendix Table 1 provide adjusted mean intakes of 100% fruit juice, whole fruit, total fruit, and total vegetables for WIC participants, income-eligible nonparticipants, and higher-income nonparticipants. Compared with income-eligible nonparticipants, WIC participants consumed significantly more total fruit (including fruit juice) ($\beta=0.30$ cup equivalents/day, 95% CI=0.04, 0.57), and 100% fruit juice ($\beta=0.22$ cup equivalents/day, 95% CI=0.04, 0.40), but not more whole fruit ($\beta=0.08$ cup equivalents/day, 95% CI= -0.09, 0.26) or total vegetables ($\beta=0.06$ cup equivalents/day, 95% CI= -0.05, 0.17). Compared with higher-income nonparticipants, WIC participants did not consume significantly more total fruit ($\beta=0.19$ cup equivalents/day, 95% CI= -0.17, 0.56), 100% fruit juice ($\beta=0.18$ cup equivalents/day, 95% CI= -0.04, 0.40) or whole fruit ($\beta=0.01$ cup equivalents/day, 95% CI= -0.21, 0.24), but did consume significantly less total vegetables ($\beta= -0.12$ cup equivalents/day, 95% CI= -0.22, -0.02).

WIC participants were significantly more likely to exceed the age-specific AAP-recommended maximum intake of 100% fruit juice compared with income-eligible nonparticipants (OR=1.51, 95% CI=1.06, 2.14), but not compared with higher-income nonparticipants (OR=1.02, 95% CI=0.62, 1.69).

Sensitivity analyses using only 2011–2014 data produced similar point estimates compared to the 2009–2014 data (Appendix Table 2). In 2011–2014, WIC participants consumed significantly more 100% fruit juice ($\beta=0.20$ cup equivalents/day, 95% CI=0.01, 0.39) compared with income-eligible nonparticipants. WIC participants consumed fewer total vegetables compared with higher-income nonparticipants ($\beta= -0.11$ cup equivalents/day, 95% CI= -0.24, 0.01), although the difference was no longer statistically significant.

DISCUSSION

The findings of this study suggest that WIC participants aged 2–4 years consume more fruit juice and are more likely to exceed the AAP's recommended limit on daily fruit juice intake than income-eligible nonparticipants. These results add to a growing body of evidence^{29,30} (including a 2017 report by the National Academies of Sciences, Engineering and Medicine)⁶ suggesting that the WIC fruit juice allowance is too high. WIC is intended to be

supplemental. However, in providing 71%–107% of the AAP maximum recommended intake, the program does not adequately account for other sources of fruit juice, including participation in other federal programs (e.g., Child and Adult Care Food Program, Head Start).

This study also found that consumption of whole fruits and vegetables among low-income children is low. Both WIC participants and income-eligible non-participants barely meet the DGA recommendation for whole fruit (0.7 cup equivalents/day) and fail to meet the DGA recommendation for vegetables (1.5 cup equivalents/day). Compared with higher-income nonparticipants, WIC participants consume significantly fewer vegetables.

To the best of the authors' knowledge, this study is the first to characterize consumption of fruit juice, whole fruit and vegetables among children in WIC following the 2009 food package revisions that reduced the fruit juice allowance and introduced the CVV. Prior to 2009, a number of studies consistently demonstrated that consumption of juice was higher among WIC participants than income-eligible nonparticipants.^{19–23} For example, Ponza et al.²⁰ reported that a significantly higher proportion of toddlers participating in WIC in 2002 consumed 100% fruit juice on a given day compared with nonparticipants (74.0% versus 55.5%). Newby and colleagues²² examined consumption of 100% fruit juice among WIC participants aged 2–5 years in 2004, reporting a mean consumption of 10.8 fluid ounces/day among females and 10.6 fluid ounces/day among males. In comparison, the mean intake in this study for WIC participants (6.16 fluid ounces/day) is much lower, suggesting that 100% fruit juice consumption has declined among WIC participants since the 2009 revisions. This is consistent with findings from Andreyeva et al.³¹ who reported that the 2009 WIC revisions were associated with a 23.5% decrease in monthly supermarket purchases of juice among WIC households over a 2-year period.

This study found that WIC participants consume significantly more 100% fruit juice than income-eligible nonparticipants but not higher-income nonparticipants. This is in contrast to previous studies which have found higher consumption of 100% fruit juice and sugar-sweetened beverages among low-income children compared with high-income children.^{32,33} However, although the difference in consumption between WIC participants and higher-income nonparticipants is not statistically significant, the effect estimate is similar to the difference in consumption between WIC participants and lower-income participants. The wider variation in fruit juice intake among higher-income nonparticipants (likely because this group captures a wider range of household incomes) means the analysis may not be adequately powered to detect a significant difference between WIC participants and higher-income nonparticipants.

Although comparisons between WIC participants and nonparticipants are an essential part of this study, it is also important to acknowledge that all groups reported excessive intake of 100% fruit juice and insufficient intake of vegetables, while barely meeting the DGA recommendations for whole fruit. This finding is consistent with previous studies that have found that most children in the U.S. have low whole fruit and vegetable consumption,^{34–36} with a 2016 study reporting 91% of children aged 2 and 3 years in the U.S. do not meet the DGA recommendation for vegetables and 27% do not meet the DGA recommendation for

whole fruit.³⁴ Although national data indicate that the proportion of children aged 2–5 years who consume juice on a given day declined from 56% in 2003 to 45% in 2014,³⁷ intake remains high. There is a need for targeted policies inside and outside of the WIC program that aim to improve whole fruit and vegetable consumption and reduce excessive 100% fruit juice consumption among young children in the U.S. For example, early child care and education programs could limit the provision of juice. Given the health risks associated with overconsumption of juice among young children,^{7–11} WIC should consider decreasing or eliminating the juice allocation. In their most recent report on WIC food packages, the National Academies of Sciences, Engineering and Medicine proposed that WIC should reduce the fruit juice benefit for children from 128 to 64 fluid ounces per month and shift the corresponding funds towards the CVB/CVV (from \$8 to \$12 per month).⁶ Others have argued that the fruit juice allocation should be removed entirely,^{29,30} or that participants should have the choice to substitute their fruit juice benefit for whole fruits and vegetables.³⁰ Previous studies have found that price is a substantial barrier to adequate fruit and vegetable consumption for low-income households.^{38–40} The CVB/CVV helps address this barrier and has been associated with significant improvements in overall diet quality and vegetable consumption.^{26,41} Hence, WIC could further improve affordability and consumption of fruits and vegetables by re-allocating funding from juice towards the CVB/CVV. This would allow the program to remain cost-neutral while increasing participants' ability to purchase fruits and vegetables.

Another strategy for increasing whole fruit and vegetable consumption among WIC participants is to improve redemption of the CVB/CVV. Only 77%⁶ of the value of CVB/CVV is redeemed annually, translating to \$100 million worth of unredeemed fruits and vegetables.⁴² In prior studies, WIC participants cited barriers to redemption such as: inability to pay the difference if the price of selected fruits and vegetables exceeded the voucher's value (i.e., split tender), inability to split paper vouchers across multiple shopping trips, and difficulty converting produce, which is sold by weight, to cash value.^{43–45} Fortunately, some of these challenges are being addressed through program changes. For example, USDA recently required state agencies to implement split tender⁴⁶ and states are transitioning to the electronic benefit transfer system that allows shoppers to redeem items as needed.⁴⁷ However, there are still opportunities for retailers to aid shoppers. For example, some stores sell produce in dollar increments at the register so that WIC participants can easily add produce to their purchase if they have remaining value on their CVB/CVV.^{45,48}

Future research should explore the impact of proposed decreases in juice allocation or increases in CVV/CVB on redemption and consumption of those categories; it is unclear whether reallocating the juice benefit to the CVV/CVB would increase fruit and vegetable consumption, particularly because so many WIC participants do not redeem the full amount of the CVV/CVB. It would also be important to study impacts on other program outcomes; for example, it is possible that increasing the CVV may improve the perceived value of the program and increase retention. Finally, because WIC-authorized foods make up only a small portion of participants' overall diets, studies should assess how changes to the juice and CVV/CVB benefits may impact the health/nutrition status of WIC participants.

Limitations

First, the NHANES is cross-sectional, limiting the ability to make strong causal inferences and establish temporality. Second, income-eligible nonparticipants may be different than WIC participants in ways that could not be fully accounted for in the analysis. Third, the small sample size of this study was not sufficient to conduct subgroup analyses of how participation in other nutrition assistance programs or race/ethnicity may modify associations; in addition, NHANES is not designed to be nationally representative of the WIC population. Fourth, the use of a single 24-hour recall may have increased random error because of within-person variation in daily fruit and vegetable intake, potentially underestimating differences between the groups. Fifth, because the 24-hour recall was completed by primary caregivers, intakes may be underestimated if children consume foods or beverages without their caregiver's knowledge (e.g., at daycare). Finally, children from low-income households were more likely to be missing dietary recall data. Given that children from low-income households are more likely to be WIC eligible and drink more fruit juice, this may have resulted in an underestimate of the difference between WIC participants and income-eligible nonparticipants.

CONCLUSIONS

Children aged 2–4 years participating in WIC exceed the maximum 100% fruit juice intake recommended by AAP, but do not meet the DGA minimum recommended intake of vegetables. Future WIC food package revisions should consider decreasing the 100% fruit juice allowance while increasing benefits for the CVV/CVB.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGMENTS

This content is solely the responsibility of the authors and does not necessarily represent the official views of NIH. Ms. Moran and Ms. Zatz are supported by a T32 training grant (DK 007703) from NIH. The authors thank Ms. Laura Vercammen and Dr. Allison Magness for their helpful comments.

KAV developed the research question, conducted the statistical analysis, interpreted the data, and drafted the manuscript. EBR developed the research question, interpreted the data, provided manuscript revisions, and approved the final version of the manuscript. AJM and LYZ developed the research question, provided critical manuscript revisions, and approved the final version of the manuscript.

REFERENCES

1. U.S. Department of Agriculture, *Food and Nutrition Service. About WIC- WIC at a Glance.* www.fns.usda.gov/wic/about-wic-wic-glance. Published 2015 Accessed September 22, 2017.
2. U.S. Department of Agriculture, *Food and Nutrition Service. Eligible Food Items.* www.fns.usda.gov/snap/eligible-food-items. Published 2017 Accessed September 22, 2017.
3. U.S. Department of Agriculture, *Food and Nutrition Service. WIC Food Packages - Maximum Monthly Allowances.* www.fns.usda.gov/wic/wic-food-packages-maximum-monthly-allowances. Published 2016 Accessed September 22, 2017.
4. Heyman MB, Abrams SA. Fruit juice in infants, children, and adolescents: current recommendations *Pediatrics*. 2017; 139(6):e20170967. <https://doi.org/10.1542/peds.2017-0967>. [PubMed: 28562300]

5. DHHS. 2015–2020 dietary guidelines for Americans Washington, DC: U.S. Department of Agriculture; 2015.
6. National Academies of Sciences, Engineering, and Medicine. *Review of WIC Food Packages: Improving Balance and Choice: Final report* Washington, DC: National Academies Press; 2017.
7. Dennison BA, Rockwell HL, Baker SL. Excess fruit juice consumption by preschool-aged children is associated with short stature and obesity *Pediatrics*. 1997; 99(1):15–22. [PubMed: 8989331]
8. Faith MS, Dennison BA, Edmunds LS, Stratton HH. Fruit juice intake predicts increased adiposity gain in children from low-income families: weight status-by-environment interaction *Pediatrics*. 2006; 118(5):2066–2075. <https://doi.org/10.1542/peds.2006-1117>. [PubMed: 17079580]
9. Shefferly A, Scharf RJ, DeBoer MD. Longitudinal evaluation of 100% fruit juice consumption on BMI status in 2–5- year- old children *Pediatr Obes*. 2016; 11(3):221–227. <https://doi.org/10.1111/ijpo.12048>. [PubMed: 26110996]
10. Sichieri R, Yokoo EM, Pereira RA, Veiga GV. Water and sugar-sweetened beverage consumption and changes in BMI among Brazilian fourth graders after 1-year follow-up *Public Health Nutr*. 2013; 16(1):73–77. <https://doi.org/10.1017/S1368980012001309>. [PubMed: 22640686]
11. Welsh JA, Cogswell ME, Rogers S, Rockett H, Mei Z, Grummer-Strawn LM. Overweight among low-income preschool children associated with the consumption of sweet drinks: Missouri, 1999–2002 *Pediatrics*. 2005; 115(2):e223–e229. <https://doi.org/10.1542/peds.2004-1148>. [PubMed: 15687430]
12. Wojcicki JM, Heyman MB. Reducing childhood obesity by eliminating 100% fruit juice *Am J Public Health*. 2012; 102(9):1630–1633. <https://doi.org/10.2105/AJPH.2012.300719>. [PubMed: 22813423]
13. U.S. Code, 2010 Edition *Title 42 – The Public Health and Welfare. Chapter 13A – Child Nutrition. Sec. 1786 – Special supplemental nutrition program for women, infants, and children*. 2010.
14. National Academy of Medicine. *WIC Food Packages: Time for a Change* Washington, DC: National Academy of Medicine 2005:1–17.
15. *Special Supplemental Nutrition Program for Women, Infants, and Children (WIC): revisions in the WIC food packages. Code of Federal Regulations (CFR) 7 CFR 246*.
16. Food and Nutrition Service. *Special Supplemental Nutrition Program for Women, Infants and Children (WIC) Revisions in the WIC Food Packages Rule To Increase Cash Value Vouchers for Women* Published 2009.
17. Food and Nutrition Service. *Special Supplemental Nutrition Program for Women, Infants and Children (WIC): Revisions in the WIC Food Packages* Published 2014.
18. U.S. Department of Agriculture, Food and Nutrition Service. *Reissued - WIC Policy Memorandum #2015–4 Increase in the Cash Value Voucher for Pregnant, Postpartum, and Breastfeeding Women* Published 2015.
19. McElligott JT, Roberts JR, Varadi EA, O'Brien ES, Freeland KD, Basco WT Jr. Variation in fruit juice consumption among infants and toddlers: associations with WIC participation *South Med J*. 2012; 105(7):364–369. <https://doi.org/10.1097/SMJ.0b013e31825c0252>. [PubMed: 22766665]
20. Ponza M, Devaney B, Ziegler P, Reidy K, Squatrito C. Nutrient intakes and food choices of infants and toddlers participating in WIC *J Am Diet Assoc*. 2004; 104(suppl 1):71–79. <https://doi.org/10.1016/j.jada.2003.10.018>.
21. Watowicz RP, Taylor CA. A comparison of beverage intakes in U.S. children based on WIC participation and eligibility *J Nutr Educ Behav*. 2014; 46(3):S59–S64. <https://doi.org/10.1016/j.jneb.2014.02.002>. [PubMed: 24809998]
22. Newby P, Peterson KE, Berkey CS, Leppert J, Willett WC, Colditz GA. Beverage consumption is not associated with changes in weight and body mass index among low-income preschool children in North Dakota *J Am Diet Assoc*. 2004; 104(7):1086–1094. <https://doi.org/10.1016/j.jada.2004.04.020>. [PubMed: 15215766]
23. U.S. Department of Agriculture, Food and Nutrition Service. *Diet Quality of American Young Children by WIC Participation Status: Data from the National Health and Nutrition Examination Survey, 2005–2008 - Summary* Published 2015.
24. CDC. *About the National Health and Nutrition Examination Survey* Published 2017.

25. CDC, National Center for Health Statistics. *National Health and Nutrition Examination Survey*. www.cdc.gov/nchs/nhanes/index.htm. Published 2017 Accessed September 30, 2017.
26. Tester JM, Leung CW, Crawford PB. Revised WIC food package and children's diet quality *Pediatrics*. 2016; 137(5):e20153557. <https://doi.org/10.1542/peds.2015-3557>. [PubMed: 27244804]
27. U.S. Department of Agriculture, Agricultural Research Service. Food Patterns Equivalents Database: USDA Food Patterns Equivalents Data for Analyzing Dietary Data Food Surveys Research Group: Beltsville M, ed; 2009–2014.
28. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM. CDC growth charts: United States Adv Data. 2000; (314):1–27.
29. Ferris HA, Isganaitis E, Brown F. Time for an end to juice in the Special Supplemental Nutrition Program for Women, Infants, and Children *JAMA Pediatr*. 2017; 171(6):509–210. <https://doi.org/10.1001/jamapediatrics.2017.0134>. [PubMed: 28437541]
30. Nagata JM, Djafari JT, Chamberlain LJ. The option of replacing the Special Supplemental Nutrition Program for Women, Infants, and Children fruit juice supplements with fresh fruits and vegetables *JAMA Pediatr*. 2016; 170(9):823–824. <https://doi.org/10.1001/jamapediatrics.2016.1178>. [PubMed: 27399219]
31. 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. <https://doi.org/10.1542/peds.2012-3471>. [PubMed: 23629613]
32. Beck AL, Patel A, Madsen K. Trends in sugar-sweetened beverage and 100% fruit juice consumption among California children *Acad Pediatr*. 2013; 13(4):364–370. <https://doi.org/10.1016/j.acap.2013.02.010>. [PubMed: 23688439]
33. C.S. Mott Children's Hospital. Too Much of a Good Thing? Kids in Low-Income Families Drinking More Juice than Recommended Ann Arbor, MI: C.S. Mott Children's Hospital; 2012.
34. Fox MK, Gearan E, Cannon J. Usual food intakes of 2-and 3-year old U.S. children are not consistent with dietary guidelines *BMC Nutr*. 2016; 2:67. <https://doi.org/10.1186/s40795-016-0106-2>.
35. Grimm KA, Kim SA, Yaroch AL, Scanlon KS. Fruit and vegetable intake during infancy and early childhood *Pediatrics*. 2014; 134(suppl 1):S63–S69. <https://doi.org/10.1542/peds.2014-0646K>. [PubMed: 25183758]
36. Kim SA, Moore LV, Galuska D. Vital signs: fruit and vegetable intake among children—United States, 2003–2010 *MMWR Morb Mortal Wkly Rep*. 2014; 63(31):671–676. [PubMed: 25102415]
37. Bleich SN, Vercammen KA, Koma JW, Li Z. Trends in beverage consumption among children and adults, 2003–2014 *Obesity (Silver Spring)*. 2018; 26(2):432–441. <https://doi.org/10.1002/oby.22056>. [PubMed: 29134763]
38. Cassady D, Jetter KM, Culp J. Is price a barrier to eating more fruits and vegetables for low-income families? *J Am Diet Assoc*. 2007; 107(11):1909–1915. <https://doi.org/10.1016/j.jada.2007.08.015>. [PubMed: 17964310]
39. Hendrickson D, Smith C, Eikenberry N. Fruit and vegetable access in four low-income food deserts communities in Minnesota *Agric Human Values*. 2006; 23(3):371–383. <https://doi.org/10.1007/s10460-006-9002-8>.
40. Reicks M, Randall JL, Haynes BJ. Factors affecting consumption of fruits and vegetables by low-income families *J Am Diet Assoc*. 1994; 94(11):1309–1311. [https://doi.org/10.1016/0002-8223\(94\)92467-8](https://doi.org/10.1016/0002-8223(94)92467-8). [PubMed: 7963177]
41. Singleton CR, Opoku-Agyeman W, Affuso E. WIC cash value voucher redemption behavior in Jefferson County, Alabama, and its association with fruit and vegetable consumption *Am J Health Promot*. 2018; 32(2):325–333. <https://doi.org/10.1177/0890117117730807>. [PubMed: 28950724]
42. Richardson, C.; Results from the NWA Fruit and Vegetable CVV Redemption Survey. 2013. www.paramountcommunication.com/nwica/NWA_CVV_Survey_Morning.pdf Published
43. Gleason S, Pooler J. The effects of changes in WIC food packages on redemptions *Altarum Institute, U.S. Department of Agriculture Economic Research Service, Food Assistance and Nutrition Research Program*. Published 2011.

44. NajjarSK. *Barriers to WIC Benefits Redemption among Participants in Washington State (Thesis)*. University of Washington. Published 2014.
45. PayneCR, NiculescuM, GuthrieJF, MancinoL. *Can a better understanding of WIC customer experiences increase benefit redemption and help control program foodcosts?* *J Hunger Environ Nutr*. In press Online October 9, 2017 <https://doi.org/10.1080/19320248.2017.1364191>.
46. U.S. Department of Agriculture, Food and Nutrition Service. WIC Policy Memorandum #2017–2: State Agency Compliance with Split Tender Implementation Requirements Published 2016.
47. U.S. Department of Agriculture, Food and Nutrition Service. *WIC - Electronic Benefits Transfer (EBT) Guidance and Resources*. www.fns.usda.gov/wic/wic-electronic-benefits-transfer-ebt-guidance. Published 2017.
48. AmmermanA, De MarcoM, HardingM, HartmanT, RhodeJ. *Buying wisely and well: managing WIC food costs while improving the WIC customer's shopping experience*. Durham: Duke-UNC USDA Center for Behavioral Economics and Healthy Food Choice Research (BECHR). Published 2015.</References>

Figure 1.

Adjusted intakes of total fruit, juice, whole fruit, and vegetables comparing WIC participants with nonparticipants.

Note: Error bars indicate the 95% CI of estimate. For total fruit, whole fruit, and total vegetables, the national guideline is the amount recommended in the DGA for a 1,300 calorie diet, which is appropriate for most children aged 2–4 years. For 100% fruit juice, the depicted guideline is the AAP recommendations for the maximum amount for children aged 1–3 years (4 ounces) and the lower bound of the maximum range recommended for children aged 4–6 years (4–6 ounces). Unlike the DGA values for total fruit, whole fruit, and total vegetables, the recommendation for fruit juice should be viewed as a maximum intake recommendation (i.e., a limit rather than a target). Total fruit is the sum of fruit juice and whole fruit. *Indicates statistically significant difference ($p < 0.05$) between nonparticipant group and WIC participants.

WIC, Special Supplemental Nutrition Program for Women, Infant and Children; DGA, 2015–2020 Dietary Guidelines for Americans; AAP, American Academy of Pediatrics.

Characteristics of Study Sample Consisting of Children Aged 2–4 Years in NHANES 2009–2014

Table 1.

Characteristic	Overall (n=1,576)	WIC participants (n=677)	Income-eligible nonparticipants (n=409)	Higher-income nonparticipants (n=490)	p-value ^a
Gender, n (%)					0.53
Female	775 (48.6)	344 (51.6)	193 (47.2)	238 (47.4)	
Male	801 (51.4)	333 (48.4)	216 (52.8)	252 (52.6)	
Race/Ethnicity, n (%)					<0.0001
Non-Hispanic white	465 (53.3)	124 (27.1)	131 (51.8)	210 (71.9)	
Non-Hispanic black	372 (14.0)	193 (24.1)	117 (18.2)	62 (5.0)	
Mexican American	338 (14.2)	207 (27.7)	73 (12.1)	58 (6.1)	
Hispanic	185 (8.7)	92 (13.3)	43 (8.9)	50 (5.4)	
Other	216 (9.8)	61 (7.8)	45 (9.0)	110 (11.5)	
Age, n (%)					0.03
24–35 months	599 (32.3)	296 (38.5)	134 (29.7)	169 (29.6)	
36–47 months	474 (33.5)	192 (32.3)	124 (31.0)	158 (35.6)	
48–60 months	503 (34.2)	189 (29.3)	151 (39.35)	163 (34.8)	
Weight status, n (%) ^b					0.38
Underweight	70 (3.3)	31 (3.7)	14 (2.5)	25 (3.4)	
Normal weight	1,145 (74.8)	486 (73.3)	294 (73.0)	365 (76.7)	
Overweight	199 (13.8)	82 (12.7)	60 (16.4)	57 (13.3)	
Obese	162 (8.1)	78 (10.4)	41 (8.1)	43 (6.6)	
Education, parent/caregiver, n (%)					<0.0001
Less than high school	410 (18.5)	253 (35.7)	129 (22.8)	28 (4.5)	
High school graduate or more	1,166 (81.5)	424 (64.3)	280 (77.2)	462 (95.5)	
Marital status, parent/caregiver, n (%)					<0.0001
Single/No partner	449 (22.4)	245 (36.2)	159 (32.7)	45 (7.4)	
Married/Partnered	1,127 (77.6)	432 (63.8)	250 (67.3)	445 (92.6)	
SNAP participation household, n (%)					<0.0001
Not a participant in SNAP	882 (66.9)	214 (31.4)	197 (55.4)	471 (97.2)	
Participant in SNAP	694 (33.1)	463 (68.6)	212 (44.6)	19 (2.8)	
Income household, n (%)					<0.0001

Characteristic	Overall (n=1,576)	WIC participants (n=677)	Income-eligible nonparticipants (n=409)	Higher-income nonparticipants (n=490)	p-value ^a
0–50% FPL	265 (12.0)	186 (26.9)	79 (15.6)	0 (0.0)	
51%–100% FPL	353 (17.4)	223 (34.5)	130 (28.0)	0 (0.0)	
101%–150% FPL	287 (14.9)	152 (21.1)	135 (34.4)	0 (0.0)	
>150% FPL	671 (55.8)	116 (17.6)	65 (21.9)	490 (100.0)	

Note: Boldface indicates statistical significance ($p < 0.05$). N reports number in NHANES sample, (%) reports weighted percentage.

^a P-value from design-based Chi-square test.

^b Weight status was classified using age and sex specific BMI percentile cutoffs from the Center for Disease Control (CDC), wherein 0–<5th percentile indicates underweight, 5–<85th percentile indicates normal weight, 85–<95th percentile indicates overweight and 95th percentile indicates obesity.

FPL, Federal Poverty Line; SNAP, Supplemental Nutrition Assistance Program; WIC, Special Supplemental Nutrition Program for Women, Infant and Children; NHANES, National Health and Nutrition Examination Survey.