



Short Communication

Changes in nutrient and food group intakes among children and women participating in the Special Supplemental Nutrition Program for Women, Infants, and Children: findings from the 2005–2008 and 2011–2014 National Health and Nutrition Examination Surveys

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Abstract

Objective: To use nationally representative data to evaluate changes in nutrient and food intakes among children and women participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) before *v.* after implementation of the 2009 food package revisions.

Design: Cross-sectional study using National Health and Nutrition Examination Survey (NHANES) data. NHANES survey cycles were pooled to assess nutrient/food group intakes among household WIC participants pre- (2005–2008) *v.* post- (2011–2014) implementation of the 2009 food package revisions.

Setting: Information regarding WIC participation and 24 h diet recalls were collected at NHANES examination.

Participants: Children 24–59 months old and women 19–50 years of age in households receiving WIC benefits in the NHANES 2005–2008 and 2011–2014.

Results: Comparison of WIC participants' dietary intake pre- and post-revision demonstrated changes in mean population intakes of both nutrients and food groups. The food package revisions were associated with increased intakes of fibre ($P=0.004$ children, $P=0.013$ women) and whole grains ($P=0.001$ children, $P=0.087$ women). For children only, vegetable intake shifted to higher consumption of legumes ($P=0.013$) and decreased intake of starchy vegetables ($P=0.042$). No significant changes were observed for dairy or fruit intake of children or women.

Conclusions: The study provides insight to what goals of the package revisions were achieved. The findings can inform future food package revisions.

Keywords

Special Supplemental Nutrition Program for Women, Infants, and Children
National Health and Nutrition Examination Survey
2009 revisions
Food package
Nutrient intake
Diet quality

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) provides nutrition education, food benefits and referrals to social and medical services to low-income (<185% federal income to poverty ratio) women, infants and children who are at nutrition risk⁽¹⁾. In 2009, the composition and quantities of foods included in the WIC food package were revised to more closely align WIC benefits with dietary recommendations⁽²⁾. These revisions were the most substantial changes to the WIC food

package since the programme's inception⁽²⁾. Changes included the addition of wholegrain products, fruit and vegetable cash-value vouchers, reductions in milk, cheese and juice allowances, and restrictions on milk fat content⁽²⁾. Understanding the impact of the comprehensive food package revisions on dietary intake of WIC participants is important, but significant knowledge gaps remain.

There are limited studies that used nationally representative data to assess the impact of the package revisions on

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dietary intake. A report by the National Academies of Sciences, Engineering, and Medicine (NASEM) reviewed the WIC food package, defined nutrient/food group priorities and provided recommendations for future food package modifications⁽³⁾. In the NASEM review, no nationally representative data examining the impact of the 2009 food package changes on nutrient intake pre- *v.* post-implementation were identified⁽³⁾. Previous work using National Health and Nutrition Examination Survey (NHANES) data has shown the food package revisions to be associated with higher Healthy Eating Index scores for children participating in WIC compared with non-participants⁽⁴⁾. However, women were not included in the analyses and use of Healthy Eating Index scores precludes assessment of specific foods and nutrients targeted by the package revisions. Direct comparison of food/nutrient intakes of WIC children and women pre- *v.* post-implementation of the food package revisions using nationally representative data is important to better understand the impact of the food package revisions. The present study directly addressed these knowledge gaps and used NHANES data to evaluate changes in dietary intake of WIC children and women before *v.* after implementation of the 2009 food package revisions, with a focus on priority nutrients and food groups identified by the NASEM for future package changes⁽³⁾.

Methods

Data source

The present cross-sectional study was conducted using nationally representative survey data from the NHANES. NHANES participants complete physical examinations and comprehensive questionnaires at NHANES mobile examination centres that travel the country according to a complex, multistage probability sampling design that is representative of the non-institutionalized, civilian US population⁽⁵⁾. Dietary data were collected by the NHANES via 24 h recalls using the US Department of Agriculture's automated multiple-pass method⁽⁶⁾. For children under 6 years of age, dietary intake was reported via proxy. Additional information on NHANES dietary interview procedures can be found elsewhere^(7,8). Dietary and nutrient intakes were obtained from the NHANES and its related component What We Eat In America (WWEIA)⁽⁹⁾. WWEIA dietary intake information was processed by the US Department of Agriculture's Food and Nutrient Database for Dietary Studies (FNDDS)⁽⁹⁾. The FNDDS codes diet recall information into disaggregated food and nutrient components (e.g. added sugars, dark green vegetables, saturated fat). Thus, use of WWEIA data allowed for assessment of specific food and nutrient intakes on a given day.

Study design

Two NHANES survey cycles (2005–2006/2007–2008) were pooled to assess dietary intake among household WIC participants prior to the 2009 food package revisions; henceforth referred to as 'pre-revision'. Two survey cycles (2011–2012/2013–2014) were also pooled to represent dietary intake after the 2009 food package revisions; henceforth referred to as 'post-revision'. NHANES cycles that occurred immediately post-implementation (2009–2010) were omitted to allow time for the policy change to take full effect.

WIC participation was defined at the household level, as opposed to the individual level, to capture the full reach of WIC benefits. Data on nutrient/food intakes of WIC participants in the pre-revision sample were compared with those of WIC participants in the post-revision sample. Pre-/post-revision comparisons were performed for children 24–59 months old (i.e. ages from 2nd up to 5th birthday) and women 19–50 years of age. Children younger than 24 months were excluded from the analyses as the Dietary Guidelines do not apply to children younger than 2 years of age and the priority food groups identified by NASEM are for children aged 2–5 years⁽³⁾. Analyses for women were for ages 19–50 years as is consistent with the literature⁽³⁾. For women, sub-analyses by pregnancy status were not performed because no postpartum variable is available in NHANES 2005–2006 and the NHANES discontinued oversampling of pregnant women after 2006, which limited the number of pregnant, low-income WIC women surveyed.

Dietary data from NHANES 24 h recall allow for calculation of the means of the population's food and nutrient intakes. A single day was selected in order to maximize congruency between dietary recall data collection and questionnaires related to WIC utilization. Nutrient/food group variables included in the analysis were selected on the basis of the NASEM report and represent priority nutrients and food groups for the WIC food package⁽³⁾. Vitamin D was excluded from the analysis, as it is not provided in 2005–2006 NHANES. For children only, vitamin A, vitamin E and P were also analysed due to inadequacies among children in the WIC programme⁽³⁾.

Statistical analysis

Multivariable linear regression analysis was used to evaluate nutrient/food intakes pre- and post-revision. Models were adjusted for all relevant covariates. For both children and women, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, Other/Mixed) and income (assessed by income to poverty ratio: <135 %, 135–185 %, >185 %) were modelled categorically, while age, household size and total energy intake were modelled continuously. Models for children were categorically adjusted for sex. Survey weights and clustering were used to account for non-response bias

**Table 1** Dietary intake of children 25–59 months old† participating in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) before (2005–2008; 'pre-revision') and after (2011–2014; 'post-revision') the comprehensive WIC food package revisions

Nutrient/food category	Pre-revision (n 569)		Post-revision (n 509)		P value (significance)	Recommended amount
	Mean	SE	Mean	SE		
Nutrients to increase‡						Guideline (per d)§§
Fibre (g)	10.6	0.3	11.6	0.3	0.004**	14/16.8–19.6 (DGA)
K (mg)	2104	46	2058	43	0.348	3000/3800 (AI)
Ca (mg)	939	30	985	32	0.192	700/1000 (RDA)
Fe (mg)	11.8	0.4	11.8	0.3	0.948	7/10 (RDA)
Zn (mg)	8.6	0.2	8.1	0.2	0.061	3/5 (RDA)
Nutrients to limit‡						
Added sugars (tsp-equiv.)	12.1	0.6	11.1	1.0	0.242	<10 % energy (DGA)
Saturated fat (% energy)§	11.7	0.3	11.3	0.2	0.288	<10 % energy (DGA)
Na (mg)	2178	50	2245	38	0.172	1500/1900 (UL)
Other nutrients of concern						
Vitamin E (mg AT)	4.3	0.2	5.3	0.2	<0.001***	6/7 (RDA)
Vitamin A (µg RAE)	547	26	562	19	0.510	300/400 mg RAE (RDA)
P (mg)	1040	18	1100	18	0.012*	460/500 (RDA)
Priority food groups¶						DGA recommendation¶¶¶
Seafood (oz-equiv.)††	0.06	0.05	0.02	0.02	0.209	0.7
Total vegetables (cup-equiv.)	0.71	0.06	0.65	0.05	0.307	1.5
Dark green vegetables (cup-equiv.)	0.02	0.01	0.06	0.03	0.320	0.1
Total red and orange vegetables (cup-equiv.)	0.20	0.02	0.20	0.03	0.879	0.4
Total starchy vegetables (cup-equiv.)	0.33	0.04	0.23	0.04	0.042*	0.5
Legumes computed as vegetables (cup-equiv.)	0.05	0.01	0.08	0.01	0.013*	0.07
Other vegetables (cup-equiv.)	0.16	0.01	0.16	0.02	0.919	0.4
Nuts and seeds (oz-equiv.)	0.25	0.05	0.23	0.06	0.738	0.4
Total protein foods (oz-equiv.)‡‡	3.03	0.15	2.92	0.13	0.511	3.5
Whole grains (oz-equiv.)	0.53	0.06	0.82	0.08	0.001**	2.3
Total dairy (cup-equiv.)	2.15	0.09	2.12	0.15	0.869	2.5

tsp-equiv., teaspoon-equivalents; % energy, percentage of total energy intake; AT, α -tocopherol; RAE, retinol activity equivalents; oz-equiv., ounce-equivalents; cup-equiv., cup-equivalents; DGA, Dietary Guidelines for Americans 2015–2020; AI, Adequate Intake level; UL, Upper Intake level; NHANES, National Health and Nutrition Examination Survey; NASEM, National Academies of Sciences, Engineering, and Medicine.

Least-square means from linear regression models are presented with SE, representing population dietary intake. Models are adjusted for energy (total kilojoules), sex, age, race/ethnicity, income (income to poverty ratio) and household size.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

†Children living in households receiving WIC benefits at the time of NHANES interview. Analyses are for children ages from 2nd up to 5th birthday, representing WIC-eligible ages for which DGA recommendations apply.

‡Derived from the NASEM report in review of the WIC food package⁽⁹⁾. Vitamin D was excluded because it was not a variable in NHANES 2005–2006.

§As this variable is a percentage of total energy intake, the presented mean is not energy-adjusted.

|| Inadequacies among children aged 2–5 years in WIC that have a higher prevalence than other micronutrients⁽⁹⁾.

¶Food group priorities for future food package revisions⁽⁹⁾.

††Seafood (finfish, shellfish and other seafood) high in *n*-3 fatty acids.

‡‡Total meat, poultry, seafood, organ meats, cured meats, eggs, soya, nuts and seeds; excludes legumes.

§§Reported for children aged 1–3 years/children aged 4 years. In instances where recommendations differ by sex, the value is reported as a range representing female–male. Recommendations represent daily nutrition goals derived from DGA 2015–2020⁽²¹⁾. Source of goal noted in parentheses.

||| This recommendation is approximately equivalent to <6 tsp added sugars/d.

¶¶¶DGA recommendations made on a per week basis have been converted to a per day basis in order to promote comparability between results and dietary recommendations.

and unequal probability of selection due to the complex, multistage probability sampling design of the NHANES. All analyses were conducted using survey procedures in the statistical software package SAS version 9.4.

Results

There were 1078 children 24–59 months old and 1025 women 19–50 years of age living in households receiving WIC benefits that had complete information on dietary intake and were used for the present analysis. Of these, 569 children and 537 women were from pre-revision NHANES cycles. The post-revision sample comprised 509 children and 488 women. There were nineteen children

and sixty-seven women with missing information on WIC participation status. For children, the pre- and post-revision samples did not differ by sex ($P = 0.948$), racial/ethnic group ($P = 0.620$), income ($P = 0.162$), age ($P = 0.903$) or household size ($P = 0.741$). For women, the pre- and post-revision samples did not differ by racial/ethnic group ($P = 0.538$), income ($P = 0.089$), age ($P = 0.536$) or household size ($P = 0.290$).

The relationship between the food package revisions and nutrient/food group intakes of WIC children is reported in Table 1. Increases were observed for reported mean (SE) intakes of fibre (10.6 (0.3) *v.* 11.6 (0.3) g, $P = 0.004$), vitamin E (4.3 (0.2) *v.* 5.3 (0.2) mg, $P < 0.001$) and P (1040 (18) *v.* 1100 (18) mg, $P = 0.012$) post-revision compared with the pre-revision sample. Children in the post-revision sample

**Table 2** Dietary intake of women† participating in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) before (2005–2008; 'pre-revision') and after (2011–2014; 'post-revision') the comprehensive WIC food package revisions

Nutrient/food category	Pre-revision (n 537)		Post-revision (n 488)		P value (significance)	Recommended amount
	Mean	SE	Mean	SE		
Nutrients to increase‡						Guideline (per d)‡‡
Ca (mg)	881	27	935	35	0.157	1000 (RDA)
Fe (mg)	14.4	0.5	14.1	0.5	0.642	18 (RDA)
Folate (µg)	351	15	380	13	0.112	400 (RDA)
Fibre (g)	14.6	0.6	16.4	0.7	0.013*	28/25.2 (DGA)
K (mg)	2303	54	2402	55	0.145	4700 (AI)
Nutrients to limit‡						
Added sugars (tsp-equiv.)	21.1	0.8	17.8	1.6	0.068	<10 % energy§§
Saturated fat (% energy)§	10.9	0.2	10.9	0.2	0.956	<10 % energy
Na (mg)	3096	58	3342	63	0.002**	2300 (UL)
Priority food groups						DGA recommendation
Whole fruit (cup-equiv.)	0.54	0.06	0.49	0.07	0.547	0.1–0.3
Total fruit (cup-equiv.)	0.91	0.10	1.00	0.16	0.672	2.0
Total vegetables (cup-equiv.)	1.36	0.10	1.45	0.09	0.375	3.5
Dark green vegetables (cup-equiv.)	0.05	0.01	0.09	0.03	0.208	0.4
Total red and orange vegetables (cup-equiv.)	0.44	0.04	0.48	0.06	0.491	1.0
Total starchy vegetables (cup-equiv.)	0.37	0.03	0.40	0.04	0.609	1.0
Legumes computed as vegetables (cup-equiv.)	0.14	0.03	0.18	0.06	0.438	0.4
Other vegetables (cup-equiv.)	0.50	0.06	0.50	0.04	0.954	0.8
Nuts and seeds (oz-equiv.)	0.30	0.06	0.44	0.16	0.329	0.7
Seafood (oz-equiv.)¶	0.08	0.04	0.12	0.05	0.439	1.4
Total protein foods (oz-equiv.)††	5.17	0.21	4.83	0.28	0.290	6.5
Whole grains (oz-equiv.)	0.62	0.08	0.89	0.19	0.087	4.5
Total grains (oz-equiv.)	6.28	0.17	6.66	0.22	0.133	9.0
Total dairy (cup-equiv.)	1.53	0.08	1.69	0.18	0.334	3.0

tsp-equiv., teaspoon-equivalents; % energy, percentage of total energy intake; cup-equiv., cup-equivalents; oz-equiv., ounce-equivalents; DGA, Dietary Guidelines for Americans 2015–2020; AI, Adequate Intake level; UL, Upper Intake level; NHANES, National Health and Nutrition Examination Survey; NASEM, National Academies of Sciences, Engineering, and Medicine.

Least-square means from linear regression models are presented with SE, representing population dietary intake. Models are adjusted for energy (total kilojoules), age, race/ethnicity, income (income to poverty ratio) and household size.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

†Adult females aged 19–50 years living in households receiving WIC benefits at the time of NHANES interview.

‡Derived from the NASEM report in review of the WIC food package⁽⁹⁾.

§As this variable is a percentage of total energy intake, the presented mean is not energy-adjusted.

|| Food group priorities for future WIC food packages⁽⁹⁾.

¶Seafood (finfish, shellfish and other seafood) high in *n*-3 fatty acids.

††Total meat, poultry, seafood, organ meats, cured meats, eggs, soya, nuts and seeds; excludes legumes.

‡‡Reported for women aged 19–30 years and 31–50 years. Recommendations that vary by age reported as 19–30 years/31–50 years. Recommendations represent daily nutrition goals from DGA 2015–2020⁽²¹⁾. Source of goal noted in parentheses.

§§This recommendation is approximately equivalent to <6 tsp added sugars/d.

||| For pregnant and breast-feeding women based on a 10 878 kJ (2600 kcal) food pattern, derived from the NASEM report⁽⁹⁾. DGA recommendations made on a per week basis have been converted to a per day basis in order to promote comparability between results and dietary recommendations.

also demonstrated better reported intakes of food groups compared with the pre-revision sample, with higher reported mean (SE) intakes of whole grains (0.53 (0.06) *v.* 0.82 (0.08) ounce-equivalents, $P = 0.001$) and legumes (0.05 (0.01) *v.* 0.08 (0.01) cup-equivalents (cup-equiv.), $P = 0.013$) and decreased intake of total starchy vegetables (0.33 (0.04) *v.* 0.23 (0.04) cup-equiv., $P = 0.042$). No significant change in mean (SE) intake of total fruit (1.7 (0.1) *v.* 1.6 (0.1) cup-equiv., $P = 0.788$), whole fruit (0.71 (0.1) *v.* 0.69 (0.1) cup-equiv., $P = 0.924$) or fruit juice (1.0 (0.1) *v.* 0.9 (0.1) cup-equiv., $P = 0.773$) was observed.

The relationship between the 2009 policy change and nutrient/food group intakes of WIC women is reported in Table 2. WIC women reported higher intakes of fibre (14.6 (0.6) *v.* 16.4 (0.7) g, $P = 0.013$) and Na (3096 (58) *v.* 3342 (63) mg, $P = 0.002$) post-revision compared with the

pre-revision sample. Like in children, increased mean (SE) consumption of legumes (0.14 (0.03) *v.* 0.18 (0.06) cup-equiv., $P = 0.438$) and whole grains (0.62 (0.08) *v.* 0.89 (0.19) cup-equiv., $P = 0.087$) was observed, but failed to reach significance. No significant change in mean (SE) intake of total fruit (0.9 (0.1) *v.* 1.0 (0.2) cup-equiv., $P = 0.672$), whole fruit (0.54 (0.06) *v.* 0.49 (0.07) cup-equiv., $P = 0.547$) or fruit juice (0.4 (0.1) *v.* 0.5 (0.1) cup-equiv., $P = 0.434$) was observed.

Discussion

Comparing nutrient intakes in two nationally representative samples of women and children indicated that nutrient intakes were better in the post-WIC package revision



sample. In children, increased intakes of fibre, vitamin E and P were observed post-revision compared with the pre-revision sample. Increased fibre intake was also observed for women. Greater fibre intake in children may be explained in part by increased consumption of whole grains and legumes that were also observed. The 2009 food package revisions included more whole grains and a greater variety of protein foods such as beans and legumes⁽¹⁰⁾. This suggests that the increase in whole grain and legume varieties in the food package translated to increased whole grain and legume consumption, which contributed to improved fibre intake. For nutrient intake, women also reported higher Na intake, which is difficult to contextualize given the mixed literature on Na in the general US population. There is evidence of an increasing proportion of Na intake derived from snacks⁽¹¹⁾ and increased snack behaviours in women relative to men⁽¹²⁾; however, Na intake has not changed significantly over time⁽¹³⁾.

Despite significant reductions in whole milk and cheese allowances in the revised package⁽¹⁰⁾, total dairy and saturated fat consumption of WIC participants did not change significantly. Previous studies show decreased whole milk and cheese purchases by New England WIC households after the package revisions and no corresponding increase in substitution from non-WIC funds, suggesting that WIC purchases shifted to low-fat/reduced-fat milk⁽¹⁴⁾. Our findings suggest that the reductions in saturated fat from purchased milk and cheese observed in some regions of the country⁽¹⁴⁾ did not translate to decreased dairy and saturated fat intakes of WIC children and women nationwide.

The revised food package included fruit and vegetable cash-value vouchers and restrictions on juice allowances⁽¹⁰⁾. Whole fruit and total fruit were identified by the NASEM as priority food groups for future package revisions for WIC women and are displayed in Table 2. We found no change in total fruit, whole fruit or fruit juice consumption by WIC children or women, suggesting that although the revisions included an incentive to purchase fresh fruits via new cash-value vouchers, the projected increase in fruit consumption was not observed. Recommendations to eliminate fruit juice and shift funds to the fresh cash-value vouchers^(3,15,16) are important policy considerations for future package modifications. The revised food package also allowed dried and canned beans/peas. This revision was made in order to increase options in the meat/meat alternatives category and because low intake of cooked dry beans/peas was a concern for both children and women⁽²⁾. We found significantly greater legume consumption among children in the post-revision sample compared with pre-revision sample; legume intake also increased among women but failed to reach significance. This strongly suggests that the addition of canned beans/peas to the food package translated to increased legume consumption among WIC participants.

The revised WIC food package included more whole grains such as whole-wheat bread, substitutions for whole-wheat bread (e.g. oatmeal, brown rice), a shift in WIC-approved cereals such that at least 50% were whole grain and a mandate that WIC-approved stores stock appropriate quantities of these breads and cereals at all times⁽¹⁰⁾. Our findings demonstrate increased whole grain consumption post-revision among both WIC children and women compared with the pre-revision sample; however, the increase observed for women failed to reach significance. This shows that the 2009 policy change helped address WIC participants' whole grain intake, but the present analysis of two cross-sectional population samples cannot say for certain that the package revisions caused changes in intake. Other studies show the 2009 food package revisions to be associated with increased availability of whole grains in stores^(17,18) and increased purchases of whole grains among WIC participants at both regional⁽¹⁹⁾ and national⁽²⁰⁾ levels. This suggests that increased availability and purchases of wholegrain products translated to a national increase in whole grain consumption among WIC participants.

While associations between the food package revisions and nutrient/food intakes were identified, the cross-sectional nature of the NHANES precludes causal inferences. There are known limitations with 24 h diet recall data. For example, recall data for children depended on the accuracy of reporting by a proxy respondent. However, this is the case among all responders and thus would not have preferentially affected the report of children's dietary intake by pre- *v.* post-revision designation. Results of the present analysis were reported for WIC children 24–59 months old and women 19–50 years of age collectively. Data for women were not reported by pregnancy status because the NHANES discontinued oversampling of pregnant women after 2006 and there is no postpartum variable in the NHANES 2005–2006. In addition, nineteen of the 1078 children and sixty-seven of the 1025 women had missing information on WIC participation status, which could lead to under- or overestimation of mean intake; however, this may have occurred in an equal amount pre- *v.* post-revisions. Despite these limitations, the present study provides important insight regarding nutritional intake differences observed following the 2009 food package revisions among WIC participants. Strengths of the study include use of nationally representative data from the NHANES, which yields results that are highly generalizable to the WIC population. Direct comparison of specific food/nutrient items pre- *v.* post-revision provides insight regarding differences in dietary intake observed following the 2009 WIC policy change. Since we focused on the priority nutrients and food groups for future package revisions⁽³⁾, our findings can be used to inform future policy change.

In summary, the 2009 food package revisions were associated with improved nutrient intakes among children, including fibre, vitamin E and P. Higher fibre intake was also observed for women. For both children and women,



the food package revisions were also associated with increased whole grain intake but did not achieve the intended reductions in total dairy/saturated fat intake or juice consumption. For children only, vegetable intake shifted to more legumes and less starchy vegetables; it is not clear why there may be a decrease in starchy vegetables, although perhaps the increased awareness and promotion of healthier food choices may have contributed. The present study provides insight to what goals of the package revisions were achieved, and where gaps still exist, thus aiding evaluation of the policy change. Our findings can inform future food package revisions.

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