

Diet Quality and Associations with Food Security among Women Eligible for Indiana Supplemental Nutrition Assistance Program-Education

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ABSTRACT

Background: The diet quality among adults receiving nutrition education lessons through Supplemental Nutrition Assistance Program-Education (SNAP-Ed) is currently unknown.

Objectives: The objectives of this study were to characterize the diet quality of Indiana SNAP-Ed-eligible women; estimate their mean usual intake of fruits, vegetables, dairy, and whole grains compared to Dietary Guidelines for Americans (DGA) recommendations; and determine if these dietary outcomes differed by food security status.

Methods: SNAP-Ed paraprofessionals recruited participants from August 2015 to May 2016 for this secondary analysis of cross-sectional data collected as the baseline assessment for a randomized controlled trial. Participants were SNAP-Ed-eligible women aged ≥ 18 y interested in nutrition education lessons. Dietary outcomes were assessed by one or two 24-h dietary recalls. The Healthy Eating Index (HEI)-2010 was used to characterize diet quality. Mean usual intake of food groups was estimated using the National Cancer Institute Method. Food security status was classified using the US Household Food Security Survey Module. Data were analyzed in October 2019.

Results: Mean \pm SEM HEI-2010 total score was 42 ± 0.9 for the study sample. Mean \pm SE usual intake of servings of fruits (0.61 ± 0.08 cups [144.32 ± 18.93 mL]), vegetables [1.4 ± 0.10 cups (331.2 ± 23.66 mL)], dairy [1.5 ± 0.11 cups (354.88 ± 26.02 mL)], and whole grains [0.48 ± 0.06 ounces (13.61 ± 1.70 g)] did not differ by food security subgroup. Mean HEI-2010 total score was significantly higher by 4.8 ± 2.0 points for the food-secure than for the food-insecure subgroup ($P = 0.01$). Mean HEI-2010 component scores were 1.1 ± 0.5 points higher for whole grain ($P = 0.01$) and 1.0 ± 0.5 points higher for dairy ($P = 0.05$) in the food-secure than in the food-insecure subgroup. The proportions of the study sample not meeting the DGA recommendations for food group intake were $\geq 85\%$ for both food-secure and -insecure subgroups.

Conclusions: Indiana SNAP-Ed-eligible women reported poor diet quality, highlighting their need for nutrition interventions aiming to improve food security and diet as per DGA recommendations in low-income populations. *J Nutr* 2020;150:2191–2198.

Keywords: SNAP, SNAP-Ed, low-income, food insecurity, nutrition education, diet quality

Introduction

Food insecurity, a situation that many low-income Americans face, is characterized by limited access to food and has been associated with poor adherence to the Dietary Guidelines for Americans (DGA) 2015–2020 (1, 2). These circumstances increase the risk of preventable nutrition-related poor health outcomes such as diabetes, hypertension, and poor mental health (3). Nutrition assistance in the form of financial or food benefits provided through the Supplemental Nutrition

Assistance Program (SNAP) and 14 other US federally supported programs in the hunger safety net enhance access to food for the low-income US population (4, 5). SNAP-Education (SNAP-Ed) is an intervention aimed to improve the dietary quality of low-income adults and children who qualify for SNAP with the goal of aligning dietary behaviors with the recommendations in the DGA (6, 7). SNAP and SNAP-Ed participation, however, are independent, meaning participation in one does not necessitate participation in the other.

SNAP-Ed intervenes broadly at the community and policy levels, as well as directly at the individual level through one-to-one or small group interactive lessons led by a nutrition education paraprofessional. Federal SNAP-Ed guidance encourages consumption of nutrient-dense foods and the maintenance of a healthy weight (7). Key food groups promoted through SNAP-Ed direct education include fruit, vegetables, low-fat dairy, and whole grains because they provide important nutrients that are inadequate in the diets of the low-income population (8).

Although SNAP-Ed lessons have reached millions of participants, the usual dietary intake of the specific population participating in SNAP-Ed has not been quantified. Previous research has demonstrated that food insecurity negatively affects dietary intake among low-income populations (9, 10). Thus, a secondary but critically important goal of SNAP-Ed is to reduce food insecurity. SNAP-Ed addresses this programmatic goal via resource management education and further supports the goals of SNAP. Yet, attention has not been given to the usual dietary intake and dietary quality of SNAP-Ed-eligible participants, as well as to differences of food-secure and -insecure subgroups, before participation in SNAP-Ed. Findings may be useful for development of future educational content and have potential to inform SNAP-Ed federal guidance (11).

The primary objective of this study was to characterize the diet quality of Indiana SNAP-Ed-eligible women. This primary objective included an assessment of the mean usual intakes of foods from the fruit, vegetable, dairy, and whole grain food groups and their comparison with the DGA recommendations. A secondary objective was to determine how food security status among Indiana SNAP-Ed-eligible women was associated with each of these dietary outcomes.

Methods

Study sample

SNAP-Ed-eligible individuals (income \leq 130% of the federal poverty guideline or meeting specific resource requirements) who expressed interest in receiving nutrition education lessons were recruited by county-level SNAP-Ed paraprofessionals from August 2015 to May 2016 ($n = 261$). Study participants were Indiana residents aged \geq 18 y, able to speak and read English, eligible for SNAP-Ed, not pregnant at recruitment, and a new client of SNAP-Ed (no lessons during the previous year). Indiana SNAP-Ed paraprofessionals voluntarily assisted with the study. Participants were recruited following program delivery protocol by the paraprofessional through either direct conversation engagement or referrals. First, interest in and eligibility for receiving nutrition education were affirmed, followed by interest in participating in the study, and finally eligibility for the study was determined via screening survey. Eligibility for Indiana SNAP-Ed included self-reported eligibility for SNAP; the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC); or nutritional risk. Examples of

recruitment sites included food pantries, WIC, other healthcare clinics, SNAP offices, and county Cooperative Extension offices. Participation in SNAP or other food assistance programs was not required for study eligibility because it was not required for SNAP-Ed eligibility. Participants were recruited from 31 counties throughout Indiana, covering most areas of the state.

Data for this secondary cross-sectional analysis were collected as the baseline assessment in a longitudinal randomized controlled trial (RCT) where SNAP-Ed paraprofessionals allocated participants 1:1 to receive a nutrition education intervention (treatment group) or to wait 1 y to receive nutrition education (control group). Data were analyzed in October 2019 and the RCT was registered at clinicaltrials.gov as NCT#03436784.

The Human Research Protection Program of the Purdue University Institutional Review Board approved all study and SNAP-Ed protocols. Study participants provided informed consent. Study participants ($n = 194$) who completed characteristics and food security surveys and at least one 24-h dietary recall were included in the analysis. Men ($n = 14$, 7%) were removed from analysis to reduce potential issues in data analysis due to contributing excess variation in intakes (i.e., energy intake).

Measures

Participant and household characteristics.

Participant and household characteristics were self-completed via survey and classified as categorical variables. Variables used in the statistical analysis included age group, race, food pantry use, participation in WIC, and number of household children. The reference time period covered the previous 30 d for food assistance participation (SNAP, WIC, and food pantries).

Food security status.

The 18-item US Household Food Security Survey Module with a reference period of the previous 12 mo was self-completed (12). Because the 18-item questionnaire includes questions specific to children in the household, only the 10 items querying food security among household adults were used to compare participant households with and without children on a common scale. Food security classification and imputation for missing data methods are described in detail elsewhere (13–15). Briefly, the food security score was quantified for each participant (range: 0–10) and used to create a binary categorical variable classifying food security status (food secure = score 0–2; food insecure = score 3–10). This 2-category, rather than 4-category, classification was used to align with the SNAP-Ed program evaluation which uses a 2-item food security screener that only distinguishes between food secure and food insecure. Maintaining consistency with the program evaluation makes interpretation of the results more meaningful and actionable for policy-makers and SNAP-Ed paraprofessionals.

Dietary assessment.

Dietary intake was assessed from administration of one or two 24-h dietary recalls on nonconsecutive days during the week and weekends using the Automated Self-Administered 24-Hour Dietary Recall (ASA-24HR) 2014 version developed by the National Cancer Institute (NCI) (16). The ASA-24HR is a validated web-based 24-h dietary assessment tool that uses the Automated Multiple Pass Method. The ASA-24HR 2014 version aligned with the data collection period. The first ASA-24HR was administered in 1 of 2 ways: self-administered by the participant online, or interviewer-assisted either in person by the SNAP-Ed paraprofessionals or over the phone by undergraduate research assistants. A subset of participants completed a second ASA-24HR administered over the phone by research assistants. All participants were encouraged to complete the second ASA-24HR; however, scheduling conflicts or unwillingness of the participant were some of the reasons that only a subset successfully completed a second ASA-24HR. SNAP-Ed paraprofessionals and research assistants underwent in-person research methods training and followed the ASA-24HR prompts using a standardized protocol that has been shown to produce similar results

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Abbreviations used: ASA-24HR, Automated Self-Administered 24-Hour Dietary Recall; DGA, Dietary Guidelines for Americans; HEI, Healthy Eating Index; NCI, National Cancer Institute; RCT, randomized controlled trial; SNAP, Supplemental Nutrition Assistance Program; SNAP-Ed, Supplemental Nutrition Assistance Program-Education; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

between self-administration of the ASA-24HR and interviewer-assisted administration using the USDA Automated Multiple Pass Method (17, 18).

Diet quality.

ASA-24HR data were used to quantify diet quality through application of the Healthy Eating Index-2010 (HEI-2010) (19, 20). The HEI-2010 version matched the data collection period, which occurred before the release of the HEI-2015. The HEI-2010 total score is a density-based score that has a range from 0 to 100 and is composed of 12 component scores with maximum scores of 5–20 (19, 20). The HEI-2010 scoring algorithm was used to calculate HEI scores at the person level by constructing a ratio (e.g., amount per 1000 kcal, ratio of fatty acids) for dietary components that are assigned scores based on HEI scoring standards (21). When 2 ASA-24HRs were available for a participant, the algorithm summed each dietary intake component across both days per person and divided by the sum of total energy to calculate the ratio. Higher HEI-2010 total and component scores indicate closer adherence to the DGA recommendations and higher diet quality. Components encouraged to be consumed in moderation (empty calories, sodium, and refined grains) are scored so that a higher score indicates a lower intake.

Dietary intake.

Mean usual intakes of foods from the total fruit, total vegetable, total dairy, and whole grain food groups were compared to the daily recommended servings for adult women from the DGA Healthy US-Style Eating Pattern using a 1600-kcal/d intake for women based on the median energy intake of the total study sample (1628 kcal/d) (1). Cup equivalents presented for total fruits, total vegetables, and total dairy, and ounce equivalents presented for whole grain were calculated by ASA-24HR software and based on the number of units per 100 g provided by the Food Patterns Equivalents Database and Food and Nutrient Database for Dietary Studies version 4.1 (22). Total fruits includes juice and whole or cut fruits. Total vegetables includes all vegetables except legumes (i.e., dry beans and peas). Total dairy is comprised of milk, yogurt, cheese, and whey. Whole grains are defined as grains containing the entire grain kernel (22). These food groups represent the key dietary outcomes of direct SNAP-Ed core nutrition education lessons, which focus on the “promotion of fruits and vegetables, whole grains, and low-fat dairy” (7).

Statistical analysis

To test whether HEI-2010 total and component scores differed by food security status, scores were separately assessed as response variables using general linear regression models with food security status as the main independent variable of interest. Potential confounders were initially identified as characteristics known to interfere in the relation of food security and dietary intake from previous literature (23). Chi-square comparisons were used to identify those characteristics (age group, food pantry use, and WIC) that significantly differed between food-secure and -insecure groups which were included in modeling. Only age group was significant ($P \leq 0.05$) in each of the HEI-2010 models and, as such, retained in all models along with food security status. In the HEI-2010 dairy component model, race and the number of children in the household were significant with age group and food security status also included as covariates. All HEI-2010 results are presented as means \pm SEMs. Statistical significance was set at $P \leq 0.05$ for all outcomes in this study. All statistical analyses were completed using SAS® software version 9.4 (SAS Institute Inc.).

The NCI method (MIXTRAN SAS macro version 2.1, DISTRIB SAS macro version 2.1) was applied to estimate the mean usual intake for food groups and the proportion of the study sample consuming below DGA recommended intakes in the total sample and stratified by food security status (24, 25). Up to 2 ASA-24HRs were included per participant. Food groups were considered episodically consumed when $>5\%$ of the study sample reported no intake on either recall day (fruits, vegetables, dairy, and whole grains). The NCI method 2-part model was applied to estimate mean usual intake of episodic food groups by fitting the outcomes of the probability (part 1) and amount of consumption

(part 2), allowing for correlation between the 2 outcomes. Each food group was modeled separately and included the covariates age group (31 y, ≥ 31 y), food pantry use (yes, no), receiving WIC benefits (yes, no), dietary recall day of the week (weekday, weekend), sequence of recall (first, second), and mean energy intake (kcal/d) as a continuous variable. A bootstrap method ($n = 200$ resamples) was applied to estimate SEs (26, 27). Mean usual intakes estimated using the NCI method are presented, consistent with federal guidance, as mean \pm SE units in cup or ounce equivalents. Cup and ounce equivalents maintain consistency with SNAP-Ed education and program evaluation, enhancing practical application of the results for practitioners, policy-makers, and nutrition education researchers.

To test whether food-secure and food-insecure participants differed in mean usual intake of food groups, the authors adapted the modeling piece of the NCI method by adding an estimate statement to the nonlinear mixed model in the %MIXTRAN SAS macro to estimate the overall effects of food security in the 2-part model. A ratio specifying covariate values of “high risk” and “low risk” is necessary to adjust the model because of the inclusion of both normal and logistic portions of the model where probabilities are dependent on the covariates (28). Using the model estimates, “high risk” and “low risk” covariate patterns were determined. The low-risk covariate pattern was determined as aged ≥ 31 y, not using food pantries, receiving WIC benefits, and weekday ASA-24HR and reflected a pattern associated with higher intake. The high-risk covariate pattern was determined as aged <31 y, using food pantries, not receiving benefits from WIC, and weekend day ASA-24HR and reflected a pattern associated with lower intake. Finally, ratios of the means for the low- and high-risk covariate patterns were computed to test the effects of food security status on mean usual intake of each food group ($\frac{\text{Food Secure}}{\text{Food Insecure}}$). The ratio may be interpreted as the ratio of mean usual intakes for food-secure compared with food-insecure groups, for different covariate patterns (low or high).

Results

The majority of participants were aged <50 y, and few claimed a race/ethnicity other than white, non-Hispanic (Table 1). High school was the highest level of household education reported by nearly half of the study sample. More participants resided in households where no one had completed high school than in households with either an associate’s or bachelor’s degree. Three-quarters of the study sample reported ≥ 1 child living in the household whereas one-quarter reported no children. Half of participants reported employment in the household, and half of those households had full-time employment. Two-thirds of all participants reported food insecurity in the past 12 mo. Age group, participation in WIC, and food pantry use significantly varied between the food-secure and food-insecure subgroups. Over half of younger participants (aged 18–30 y) reported food security, whereas nearly half of middle-aged participants (aged 31–50 y) reported food insecurity. Participation rates in SNAP were around two-thirds and did not differ across the food-secure and food-insecure groups. However, a greater percentage of food-insecure participants were using food pantries, whereas a greater percentage of food-secure participants were receiving WIC benefits. No differences were detected for employment status, SNAP participation, race/ethnicity, Hispanic/Latino heritage, education, or marital status between the food-secure and food-insecure subgroups.

All participants ($n = 194$) completed 1 ASA-24HR and a subset completed a second recall ($n = 79$, 40%). Most recalls covered weekdays ($n = 191$, 70%); fewer covered weekends ($n = 82$, 30%). The mean HEI-2010 total score was 42 ± 0.9 for the entire study sample (Table 2). Differences

TABLE 1 Comparisons of self-reported characteristics between food-secure and food-insecure Indiana SNAP-Ed-eligible women¹

Characteristic	All	Food secure	Food insecure	χ^2 P value ²
<i>n</i> (%)	194 (100)	64 (33)	130 (67)	
Age group, y				<0.01
18–30	81 (42)	37 (58)	44 (34)	
31–50	75 (39)	19 (30)	56 (43)	
≥51	38 (19)	8 (12)	30 (23)	
Race/ethnicity				0.8
White	172 (91)	57 (90)	115 (91)	
Other	17 (9)	6 (10)	11 (9)	
Hispanic/Latino ³	20 (11)	8 (13)	12 (9)	0.4
Education ⁴				0.9
No HS diploma	33 (17)	11 (17)	22 (17)	
HS diploma/GED	84 (43)	29 (45)	55 (42)	
Some college/tech	49 (25)	15 (23)	34 (26)	
Associate's degree	18 (9)	6 (9)	12 (9)	
Bachelor's or higher	10 (5)	3 (5)	7 (5)	
Marital status				0.06
Never married	47 (24)	20 (31)	27 (21)	
Married/with partner	84 (43)	30 (47)	54 (42)	
Separated/divorced	63 (32)	14 (22)	49 (38)	
Children				0.2
None	47 (24)	14 (22)	33 (25)	
1–2	95 (49)	27 (42)	68 (52)	
3–4	43 (22)	19 (30)	24 (18)	
≥5	9 (5)	4 (6)	5 (4)	
SNAP ^{3,5}	122 (63)	41 (64)	81 (62)	0.8
Food pantry ^{3,5}	104 (54)	24 (38)	80 (62)	<0.01
WIC ^{3,5}	82 (42)	42 (66)	40 (31)	<0.01
Employed ^{3,6}	101 (52)	34 (53)	67 (52)	0.8
Part-time	50 (51)	14 (42)	36 (55)	0.2
Full-time	49 (50)	19 (58)	30 (45)	

¹Values are *n* (%). For some variables, numbers may not add up to sample size owing to missing values for a small number of participants (<5%), and percentages do not always add up to 100% owing to rounding. GED, General Education Diploma; HS, high school; SNAP, Supplemental Nutrition Assistance Program; SNAP-Ed, Supplemental Nutrition Assistance Program-Education; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

²Fisher's exact test used when 25% of cells had expected counts <5. Statistical significance at $P \leq 0.05$.

³Hispanic/Latino, SNAP, food pantry, WIC, and employed are binary variables with affirmative level shown.

⁴Highest level of education achieved in a household.

⁵SNAP, food pantry, and WIC participation reference time period is the previous 30 d.

⁶Employment was for the participant during the previous 12 mo.

by food security status were observed for diet quality. The HEI-2010 total score was 4.8 points lower in the food-insecure than in the food-secure SNAP-Ed-eligible subgroup. The HEI-2010 whole grains component score was significantly lower in the food-insecure than in the food-secure group. Food-insecure SNAP-Ed-eligible study participants reported a marginally but significantly lower HEI-2010 dairy component score than their food-secure counterparts. The remaining 10 HEI-2010 dietary component models were not statistically different between the food-insecure and food-secure groups (Table 2).

Mean usual intakes of fruits, vegetables, dairy, and whole grains for 85%–100% of the study sample were below daily serving target recommendations in the DGA for both food-secure and food-insecure subgroups (Table 3). The ratios of

means comparing mean usual intakes for food-secure and food-insecure groups for different covariate patterns (low risk or high risk) were not significantly different for any of the 4 food groups (results not shown).

Therefore, food-secure status compared with food-insecure status was not associated with a difference in mean usual intake of total fruits, total vegetables, total dairy, or whole grains.

Discussion

This study characterized the overall diet quality of a sample of Indiana SNAP-Ed-eligible women, including the intake of food groups emphasized in the DGA and in SNAP-Ed lessons. The overall diet quality was poor and ~16 points lower on the HEI than among the general US population, which had an estimated HEI-2010 total score of 58.27 ± 0.98 during 2011–2012 among adults aged 18–64 y ($n = 4044$) (2). Compared with the US population, the SNAP-Ed-eligible study sample scored similarly (<1 point difference) for the HEI-2010 total vegetables and total protein components (maximum score: 5), as well as the whole grains, dairy, refined grains, and sodium components (maximum score: 10). For the HEI-2010 greens and beans, total fruit, whole fruit, and seafood and plant proteins components (maximum score: 5), the SNAP-Ed-eligible study sample scored lower than the US population by a range of 1.1–2.4 points, and by 3.33 points for the HEI-2010 empty calories component (maximum score: 20). Higher HEI scores have been associated with reduced risk of obesity, cardiovascular disease, cancer, type 2 diabetes, and all-cause mortality (29–31). These findings likely translate to heightened risk of several chronic diseases due to poor diet (32), results strengthened by the additional evidence of very low adherence to daily food group recommendations. Over 85% of the Indiana SNAP-Ed-eligible study sample reported mean usual intakes that did not meet recommended servings for each of the following food groups: fruits, vegetables, dairy, and whole grains. Such results provide justification for SNAP-Ed federal guidance to focus on these food groups as key dietary outcomes. These foods are rich in nutrients such as potassium, folate, magnesium, vitamin A, and fiber. Low intakes of these important food groups are implicated in the mechanisms through which poor diet quality is associated with chronic disease risk (33–35).

Further analysis revealed significant associations between food security status and diet quality. Food-insecure SNAP-Ed-eligible women reported lower diet quality by a mean difference of 4.8 points compared with their food-secure counterparts, a difference in HEI considered meaningful (36). Increases in HEI points of similar magnitude, in conjunction with improvements in blood pressure, have been associated with reduced risk of mortality and chronic disease in prior studies (36, 37). Together, these study results highlight the association of diet quality with health outcomes and the importance of addressing diet quality in interventions that aim to improve diet-related health outcomes. The results also show that a majority of this food-insecure, low-income, and resource-seeking population experienced greater hardship in meeting their nutrition recommendations than those who were food secure. The difference between the SNAP-Ed-eligible food security subgroups, largely driven by lower intakes of dairy and whole-grain foods among the food insecure, underscores a need to enhance access to and consumption of these and other nutrient-dense foods such as fruits and vegetables. Previous studies among adults have shown associations between food

TABLE 2 HEI-2010 score comparisons between food-secure and food-insecure Indiana SNAP-Ed-eligible women¹

HEI component (max score)	All (n = 194)	Food secure (n = 64)	Food insecure (n = 130)	Difference ²	P value ³
Total HEI (100)	42.0 ± 0.9	46.1 ± 1.7	41.3 ± 1.1	4.8 ± 2.0	0.01
Total vegetables (5)	3.1 ± 0.1	3.1 ± 0.2	3.2 ± 0.1	0 ± 0.3	0.9
Greens and beans (5)	1.3 ± 0.1	1.6 ± 0.3	1.2 ± 0.2	0.4 ± 0.3	0.2
Total fruit (5)	1.5 ± 0.1	1.6 ± 0.3	1.5 ± 0.2	0.1 ± 0.3	0.6
Whole fruit (5)	1.5 ± 0.2	1.7 ± 0.3	1.5 ± 0.2	0.2 ± 0.3	0.6
Total protein foods (5)	4.1 ± 0.1	4.4 ± 0.2	4.1 ± 0.1	0.2 ± 0.2	0.2
Seafood and plant proteins (5)	1.4 ± 0.1	1.6 ± 0.3	1.2 ± 0.2	0.3 ± 0.3	0.3
Refined grains (10)	6.6 ± 0.2	6.8 ± 0.5	6.7 ± 0.3	0.1 ± 0.5	0.8
Whole grains (10)	2.0 ± 0.2	2.9 ± 0.4	1.8 ± 0.3	1.1 ± 0.5	0.01
Dairy (10)	5.8 ± 0.3	5.8 ± 0.6	4.8 ± 0.6	1.0 ± 0.5	0.05
Fatty acid (10)	3.6 ± 0.2	3.8 ± 0.5	3.7 ± 0.3	0.1 ± 0.5	0.8
Sodium (10)	3.1 ± 0.2	3.3 ± 0.4	3.0 ± 0.3	0.3 ± 0.5	0.5
Empty calories (20) ⁴	8.3 ± 0.4	9.2 ± 0.8	8.0 ± 0.6	1.1 ± 1.0	0.2

¹Values are adjusted least squares means ± SEMs. HEI-2010, Healthy Eating Index-2010; SNAP-Ed, Supplemental Nutrition Assistance Program-Education.

²Values are the difference between food-secure and food-insecure adjusted least squares means ± SEMs. General linear regression models were adjusted for age group of participant except the dairy model which was adjusted for participant race and number of children in the household. First 24-h dietary recall, n = 194; second recall, n = 79.

³Statistical significance was determined at P ≤ 0.05 for the difference in HEI-2010 score comparing the food-secure and food-insecure groups.

⁴Empty calories includes saturated fats, added sugars, and alcohol.

insecurity and low intake of fruits, vegetables, and dairy, as well as nutrients commonly found in these foods such as calcium, vitamin A, magnesium, and fiber (33). Further stratification of food security subgroups to include marginal, low, and very low food security status may reveal additional dietary disparities between specific subgroups and provide insight as to whether these disparities are due to reduced access to foods in general compared with access to health-promoting foods of high dietary quality (38). However, this study, a baseline analysis of a longitudinal RCT, was not powered to detect these differences.

Improving access and affordability of healthy foods among the SNAP-Ed-eligible population at the environmental level through SNAP-Ed interventions may help improve alignment of their dietary intake with federal guidelines in the DGA. These efforts may also help this population reduce disparities in dietary intake associated with food insecurity. For example, grain products, such as breads and cereals, are commonly available from food pantries, although they may or may not include whole-grain options (39). Approximately half of the study sample reported food pantry use, and 76% of those participants were food insecure. Enhanced access to whole grains and dairy products through the emergency food pantry system may be one way to bridge the gap in dietary intake among food-secure and -insecure SNAP-Ed-eligible clients. In addition to improved availability of whole grains and dairy at the environmental level, prioritizing and enriching the dairy and whole grain education lessons at the individual level with

further applications to integrate these foods with daily diets and provide links to economical access of these foods for food-insecure clients may also help improve intake. Determining how direct SNAP-Ed, environmental-level SNAP-Ed interventions, and other nutrition assistance programs such as SNAP, WIC, and food pantries interact to improve food security and dietary intake is a current research opportunity with implications for optimizing federal program funding to achieve program goals.

The results of this study are directly applicable to nutrition education programs, including SNAP-Ed, the Expanded Food and Nutrition Education Program, and WIC educational opportunities, and to food companies that could fill the dietary gaps between food-insecure and food-secure participants and among the SNAP-Ed eligible population compared with US adults. However, additional research is needed to identify effective interventions that help this resource-seeking population overcome barriers to achieving and maintaining food security through the assistance of SNAP-Ed and other programs. The study results highlight a need for interventions to increase access to and promotion of key nutrient-dense food groups for all SNAP-Ed-eligible participants, especially those identifying as food insecure. Evidence from a longitudinal RCT of SNAP-Ed has shown improved food security among participants and their households over short- and long-term periods despite other studies that did not find improvement (13, 40, 41); however, dietary improvement among this population remains a gap in the research. A handful of previous studies associated SNAP-Ed

TABLE 3 Mean usual food group intakes and proportions below recommendations among Indiana SNAP-Ed-eligible women by food security status¹

Food group (daily target ²)	All (n = 194)	Food secure (n = 64)	Food insecure (n = 130)
Total fruits (1.5 cup equivalent)	0.61 ± 0.08 (0.90)	0.65 ± 0.09 (0.88)	0.59 ± 0.08 (0.91)
Total vegetables (2 cup equivalent)	1.4 ± 0.10 (0.86)	1.4 ± 0.10 (0.89)	1.4 ± 0.12 (0.85)
Total dairy (3 cup equivalent)	1.5 ± 0.11 (0.95)	1.6 ± 0.15 (0.95)	1.4 ± 0.11 (0.95)
Whole grains (3 ounce equivalent)	0.48 ± 0.06 (1.00)	0.46 ± 0.06 (1.00)	0.49 ± 0.06 (1.00)

¹Values are mean ± SE cup equivalents and ounce equivalents based on the number of units per 100 g provided by the Food Patterns Equivalents Database (22) and, in parentheses, the proportions of the study sample reporting intakes below the recommended daily target for each food group. Mean usual intake was calculated using the National Cancer Institute Method (24). Food group models included the covariates age group (31 y, ≥31 y), food pantry use (yes, no), receiving WIC benefits (yes, no), dietary recall day of the week (weekday, weekend), sequence of recall (first, second), and mean energy intake (kcal/d) as a continuous variable. SEs were estimated by applying a bootstrap method (n = 200 resamples). SNAP-Ed, Supplemental Nutrition Assistance Program-Education.

²Daily target values from the Dietary Guidelines for Americans 2010 Daily Serving Recommendations for women (1600 kcal/d) (1).

improvements with dietary outcomes, such as intake of fruits, vegetables, dairy, and folate-containing foods (42–46); attitudes and self-efficacy toward health-promoting dietary behaviors (43); and intentions to improve dietary behaviors (47). A randomized controlled SNAP-Ed intervention study found no short-term improvements in dietary intake (11, 13). Additional studies, particularly using longitudinal, randomized controlled study designs, and rigorous dietary assessment methods are needed to evaluate the impact of SNAP-Ed on dietary intake and quality (11).

The current study revealed that an even greater percentage of the SNAP-Ed-eligible population does not meet daily recommendations for fruit, vegetable, and whole grain intake than previously reported and supports results from studies finding evidence of poor dietary choices in the SNAP-Ed-eligible population (48–50). Intake of dairy was not previously quantified and included here for the first time. These results further the evidence characterizing the low diet quality especially among the SNAP-Ed-eligible population by the use of a more specific and less biased dietary assessment via the ASA-24HR dietary recall tool, an improvement over previous dietary assessment methods (51, 52). Compared to a behavioral checklist, use of a 24-h dietary recall reduces response bias, inaccurate estimation of total daily serving sizes, and inaccurate identification of whole-grain foods. Furthermore, the estimation of long-term mean daily intake for episodic food groups is difficult to accurately self-report and quantify owing to nondaily consumption, leading to measurement error.

Minimization of dietary assessment measurement error through the administration of multiple ASA-24HRs on a subset of the study sample and application of the NCI method is a major strength of the current study (53). Study personnel received extensive training on research methods including administration of the dietary recalls and the importance of following study protocols to reduce bias. One possible source of bias was the different options for ASA-24HR administration (self-administered or interviewer-assisted, online, in-person, or over the phone). Social desirability bias and difficulty estimating accurate portion sizes may have affected reported intakes, especially during interviewer-assisted ASA-24HR, typically resulting in underreporting (54). Research has also documented underreporting by women and populations with low socioeconomic status and low levels of education, characteristics of this current study sample (55); however, more recent research has validated the ASA-24HR 2016 version in a similar sample of adult women meeting income eligibility requirements for SNAP (56). Potential limitations of the study results are that the study sample does not necessarily represent the greater SNAP-Ed population, resulting in the potential for limited generalizability of the study findings to other SNAP-Ed-eligible populations. An additional potential limitation was not tracking whether women were breastfeeding, which could have resulted in overestimation of intakes.

The results presented here highlight a critical need for improvements in diet quality, particularly targeting food-insecure audiences within low-resource populations. Direct nutrition education interventions are 1 potentially effective method to change dietary behavior. Additional studies are needed to evaluate the effectiveness of various nutrition education interventions, including nutrition education through SNAP-Ed, in order to eliminate disparities in diet quality associated with food security status, improve overall diet quality and dietary intake, and reduce the risk of diet-related chronic disease among low-income Americans.

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