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Dietary quality and usual intake of under-consumed nutrients and related food groups differ by food security status for rural, Midwestern food pantry clients

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ABSTRACT

Background—While food pantry users represent a predominantly food insecure population, dietary intake may differ among food secure (FS), low food secure (LFS), and very low food secure (VLFS) clients. Usual intake of food groups and nutrients by food security status has not previously been compared among food pantry clients.

Objective—This study aimed to estimate the usual intake of under-consumed nutrients (potassium, dietary fiber, choline, magnesium, calcium, vitamins A, D, E, C and iron) and related food groups (vegetables, fruits, whole grains, and dairy) and dietary quality, and to evaluate their relationship with food security status.

Design—This cross-sectional, secondary analysis used baseline data from a prior intervention study (Clinical Trial Registry: [NCT03566095](#)). A demographic questionnaire, the U.S. Household Food Security Survey Module, and up to three 24-hour dietary recalls on non-consecutive days including weekdays and weekends were collected.

Participants/setting—This community-based study included a convenience sample of adult, Midwestern food pantry clients (n=579) recruited in 2014.

Main outcome measures—Main outcomes evaluated were Healthy Eating Index-2010 scores and usual intakes of under-consumed nutrients and related food groups.

Statistical analyses performed—Linear regression models and the National Cancer Institute method, both adjusting for confounders, estimated associations of food security status with diet quality and usual intake, respectively.

Results—Being FS was associated with a higher whole grains HEI-2010 score and higher mean usual intake of whole grains compared to being LFS. Being FS was associated with higher usual intakes of iron and dairy compared to being VLFS. Being FS was associated with a higher mean usual intake of dark green vegetables compared to being LFS and VLFS. Usual intakes were below Federal guidance for all food security subgroups.

Conclusions—Although food security status may differentiate dietary intake among clients, improvements are needed among all clients.

Keywords

Diet Quality; Food Insecurity; Emergency Food Assistance; Healthy Eating Index; Usual Intake

INTRODUCTION

Food pantries are non-profit organizations offering foods at no cost and with limited eligibility requirements. They serve to enhance food access in emergency situations for those unreached through federal nutrition assistance programs and for those whom these resources are not enough. U.S. households using food pantries experience prevalent food insecurity (66%),¹ encompassing both the low food secure/security (LFS) category, when food quality and desirability is limited, and the very low food secure/security (VLFS) category, when quality and amount of foods are inadequate for an active, healthy life.² Rates of VLFS as high as 33% persist among U.S. food pantry users. Food insecurity is associated with intake of fewer vegetables, fruits, and dairy foods; lower intake of several nutrients, including vitamin A, calcium, and magnesium;³ and diet-related chronic disease among low-income Americans.⁴ Because of the high prevalence of LFS and VLFS among food pantry users, this particular subgroup may experience even more chronic or acute dietary shortfalls that link to negative health outcomes compared with the general US and low-income population. However, to the best of the authors' knowledge, micronutrient and food group intake and dietary quality among food pantry clients have never been evaluated collectively to establish a full picture of the dietary patterns unique to this population.

Previous research suggests that although food pantry clients share a need for food assistance resources, this common experience may not result in similar diet quality or intake patterns among all clients.⁵ Only one study in Canada has documented differences in the diets of patrons in the food secure/security (FS), LFS, and VLFS groups who rely on emergency food assistance.⁶ Determining dietary pattern differences of FS, LFS, and VLFS food pantry clients will critically inform the creation of innovative strategies that are tailored to reach food insecure populations, as encouraged by the most recent Dietary Guidelines for Americans (DGA).⁷

The aim of this study was to estimate and compare dietary quality and the usual intake of under-consumed nutrients (potassium, dietary fiber, choline, magnesium, calcium, vitamins A, D, E, C and iron) and related food groups (vegetables, fruits, whole grains, and dairy)⁷ among FS, LFS, and VLFS adult food pantry clients. The National Cancer Institute (NCI) method,^{8,9} originally developed and applied to national survey data such as the National Health and Nutrition Examination Survey, was used in a primary sample of food pantry clients. In a multistate sample of 24 rural, Midwestern food pantries, objectives were to: 1) estimate and compare the diet quality of FS, LFS, and VLFS adult pantry clients using the Healthy Eating Index-2010 (HEI-2010); 2) estimate and compare the usual intakes of under-consumed nutrients¹⁰⁻¹⁶ and related food groups^{7, 17} among FS, LFS, and VLFS clients using the NCI method; and 3) estimate the proportion of FS, LFS, and VLFS clients with usual intakes not meeting Federal guidance using the NCI method. FS clients were hypothesized to consume diets of higher quality (HEI-2010) and higher usual intakes of under-consumed nutrients and related food groups compared to VLFS clients and, to a lesser extent, LFS clients. A high proportion of participants overall were hypothesized to have usual intakes below Federal guidance.

MATERIALS AND METHODS

Study design

Data from this cross-sectional, secondary analysis were drawn from the baseline assessment of a multi-state intervention study, Voices for Food, which was carried out in 24 rural, high poverty counties in Indiana (IN), Michigan (MI), Missouri (MO), Nebraska (NE), Ohio (OH), and South Dakota (SD) and aimed to improve food security among rural, Midwestern food pantry clients (Clinical Trial Registry: [NCT03566095](https://clinicaltrials.gov/ct2/show/study/NCT03566095)). A full description of Voices for Food methods has been published in detail elsewhere.¹⁸

Food pantry selection, recruitment and client participants

In each state, four rural food pantries were selected according to previously-described criteria.¹⁸ Briefly, pantries were selected from counties defined as non-metro with poverty rates higher than 16% in 2011,¹⁹ with Cooperative Extension presence, and without well-established food policy councils. A convenience sample of clients was recruited from the pantries from August to November 2014 through flyers that advertised the study during pantry operation hours, and by research staff approaching clients while they waited to receive food. Participants, screened by a trained interviewer, were English-speaking, adults age 18 years (or 19 years in Nebraska indicating legal adult status) who used the food pantry at least one time in the previous 12 months, and who were receiving foods from the pantry on the day of recruitment. The South Dakota State University and Ohio State University Institutional Review Boards approved research activities prior to beginning the study, and participants gave written or verbal consent before completing study materials. A sample size goal of 391 was sought based on an effect size of 0.02 (based on pilot study data),²⁰ power level of 0.80, and alpha level of 0.05 for a two-tailed test. A total of 613 pantry clients were eligible and recruited; 579 (94%) with complete dietary and food security data were included in this analysis.

Assessments and measures

Food pantry clients—Participants were interviewed at one of the participating food pantries by trained research staff and completed an electronic or paper version of a questionnaire that elicited self-reported information on demographic and pantry use characteristics, including: age, sex, race, ethnicity, annual household income, education level, employment status, number of household members, number of children <18 years in the household, usual mode of transportation, participation in federal food assistance programs, frequency of visits to this pantry in the past year, and length of time that food from pantries lasts. The 18-item U.S. Household Food Security Survey Module quantified food security status among household adults over the past year.^{21, 22} This reference period was chosen because it is comparable to most research studies and national estimates where the 12-month tool is standard. Participants also completed the Automated Self-Administered 24-hour Dietary Recall (ASA24™–2014), an internet-based 24-hour dietary recall,²³ with optional staff assistance. Up to two additional dietary recalls were self-completed, or completed through an assisted phone interview, within two weeks of the pantry visit on non-consecutive days and including a weekend day.²⁴ Participants received \$10 as compensation

in the form of a grocery store gift card upon completion of the initial interview, and an additional gift card for each dietary recall completed.

Statistical analysis

Participant characteristics—Variables were classed for analysis as follows: state (IN, MI, MO, NE, OH, SD); age (18–44, 45–64, ≥65 years); sex (female, male); race (White, Black, American Indian, Other); ethnicity (of Hispanic, Latino or Spanish origin, not of Hispanic, Latino or Spanish origin); annual household income (<\$10,000, \$10,000–15,000, >\$15,000); education level (high school graduate or equivalent, some college/trade school); employment status (employed for ≥6 months of the past year, employed for <6 months of the past year); number of household members (1, 2, ≥3), number of children <18 years in the household (any, none); usual mode of transportation used to acquire food (drive themselves, other); frequency of visits to this pantry in the past year (classed as < or ≥5 times to preserve appropriate, comparable sample sizes in each category); number of different pantries visited in the past year (1, >1); length of time that food from pantries lasts (a few days' worth, 1–2 weeks' worth, more than half of food for the month); and having ≥1 family member participating in the following federal food assistance programs: Supplemental Nutrition Assistance Program;²⁵ Meals on Wheels; soup kitchens; the Special Supplemental Nutrition Program for Women, Infants, and Children;²⁶ free or reduced-price school meals; and free or reduced-price meals at summer programs (participating in ≥1 program, participating in 0 programs). Food security scores from the U.S. Household Food Security Survey Module were used to create the following categories: FS, LFS, and VLFS. Total numbers and prevalence of pantry client demographic characteristics were calculated. Characteristics were compared across FS, LFS and VLFS groups using chi-square analysis. Statistical significance was determined by $P < 0.05$ for one-sided chi-square tests.

Application of the HEI-2010 to quantify client diet quality—Dietary information from ASA24TM–2014 was used to calculate HEI-2010 scores for each client over all recorded intake days (≥3) using the Simple HEI Scoring Algorithm - Per Person.²⁷ The HEI-2010 is a density-based score (e.g., amount per 1,000 kcal, ratio of fatty acids) that measures adherence to the DGA, allowing examination of overall diet quality in relation to Federal dietary guidance, as well as dietary patterns in terms of balance among multiple components to examine the quality of the mix of foods. The HEI-2010 is made up of nine adequacy components: total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and fatty acids, and three moderation components: refined grains, sodium, and empty calories (i.e., solid fat, alcohol, and added sugars), most of which are expressed relative to energy intake (i.e., as densities) and then scored according to standards.²⁸ For the adequacy components, a higher score indicates higher consumption; moderation components are reverse-scored, and thus a higher score indicates lower consumption. The 12 component scores are weighted to yield a HEI-2010 total score with a maximum value of 100.²⁸ Since the data were collected prior to the release of the 2015–2020 DGA⁷ and HEI-2015,²⁹ the HEI-2010 is appropriate to reflect the dietary standards in place at the time of data collection.

Multiple linear regression models with food security status as the main independent variable and total or component HEI-2010 scores (one score per person) as the outcome variables compared the mean difference in HEI-2010 score between FS, LFS, and VLFS groups controlling for potential confounding by state, age, sex, race, income, participation in federal food assistance programs, and frequency of visits to this pantry in the past year. Between-group comparisons for HEI-2010 scores were determined using ANOVA with the Least Squares Mean statement and Tukey adjustment for multiple comparisons. Statistical significance was determined by the 95% confidence interval (CI) not including zero.

Application of the NCI method to estimate usual intake of under-consumed nutrients and related food groups—The NCI method^{8, 9} was used to calculate the usual dietary intake of nutrients and food groups. Up to three ASA24™–2014 recalls per participant were included in the analysis. When the percentage of non-consumption of a given food group/nutrient on each recall day was ≤5%, the food group/nutrient was treated as ubiquitously-consumed; when the percentage of non-consumption was >5%, the food group/nutrient was treated as episodically consumed.³⁰ In this study, all nutrients were determined to be ubiquitously consumed, and all food groups episodically consumed. The NCI method uses a two-part model accounting for the probability of consumption and consumption-day amount on a given day, while allowing the random effects for both parts of the model to be correlated.

For the nutrients (ubiquitously-consumed), the probability of daily consumption was assumed to be one, and therefore a one-part “amount only” model was used. In this model, a Box-Cox transformation was applied to 3 days of 24-hour recall data and transformed observations were modeled using linear mixed effects models, with adjustment for covariates via fixed effects. The %MIXTRAN SAS macro³¹ compared the pairwise associations between food security status (i.e., FS vs LFS, FS vs VLFS, LFS vs VLFS) and usual intake of nutrients. The %DISTRIB SAS macro³¹ produced the mean usual intake for each food security subgroup and the proportions of participants consuming below the estimated average requirement (EAR, or exceeding the adequate intake [AI] for nutrients without established EAR values).³² One hundred bootstrap samples of the %DISTRIB macro were generated with samples of 453 participants to obtain the standard deviation of the mean usual intake for each nutrient. Nutrients (from foods and beverages only) included calcium (mg), magnesium (mg), potassium (mg), vitamin A (μg, RAE), vitamin C (mg), vitamin D (μg), iron (mg), choline (mg), fiber (g), and vitamin E (mg). The main predictor in the models (separate model for each nutrient) for estimating usual intake was food security status. Potential confounders adjusted in the models were compressed into two levels to facilitate analysis; variable groupings with the lowest Akaike Information Criterion (AIC) were selected to ensure optimal model fit.³³ Potential confounders were classed as follows: age (<65, ≥65), sex (female, male), race (White, Black/American Indian/Asian/Hawaiian/Other), annual household income (<\$10,000, ≥\$10,000), participation in food assistance programs (0 programs, ≥1 program), frequency of visits to this pantry over the past year (≥5 times, <5 times), state (MI/NE/SD, IN/MO/OH), and day of the week of dietary recall (weekday/weekend); interview sequence of the dietary recall (indicating the first 24-hour

recall) and total energy intake (a continuous variable) were also included as covariates in all models.

For the food groups (episodically-consumed), the probability of daily consumption was not assumed to be one, and therefore the two-part model was used. The first part estimated the probability of consuming a food using logistic regression, while the second part was identical to the “amount only” model described for nutrients above. Potential confounders adjusted in the models were similarly compressed into two levels to facilitate analysis identical to that described in the nutrient analysis above. In order to compare the pairwise associations between food security status (i.e., FS vs LFS, FS vs VLFS, LFS vs VLFS) and usual intake of food groups, authors adapted the %DISTRIB macro to include an estimate statement described here.³⁴ The ratio of means were computed for “low risk” and “high risk” covariate patterns, which were assigned using the covariate categories explained previously to determine the range of the association of food security status with usual intake. Low risk reflected a pattern associated with higher intake of food groups: age = 65; sex = Male; race = White; annual household income = \$10,000; participation in food assistance programs = 0 programs; frequency of visits to this pantry over the past year = 5 times; state = IN/MO/OH; day of the week of dietary recall = weekday. All models controlled for mean energy intake (1438 kilocalories) and a variable representing the interview sequence of the dietary recalls (indicating the first 24-hour recall). Associations between food security status and usual intake of food groups were expressed for high risk and low risk groups separately as ratios ($\frac{FS}{LFS}, \frac{FS}{VLFS}, \frac{LFS}{VLFS}$). Means and standard deviations of the usual intake and the proportions of clients consuming below the DGA recommended intakes for food groups were determined as described above for nutrients. Food groups included total fruit (cup equivalents), total vegetables (cup equivalents), dark green vegetables (cup equivalents), whole grains (ounce equivalents), and dairy (cup equivalents). All analyses were performed using SAS version 9.4.³⁵

RESULTS

Pantry clients (n=579) were predominantly white (79%), females (72%) between 18–64 years (81%), who achieved an education level of ‘high school graduate or equivalent’ or below (67%), were employed for <6 months over the course of the previous year (76%), participated in 1 federal food assistance program over the course of the previous year (80%), and were classified as food insecure (food insecure=78%; LFS=30%; VLFS=48%) (Table 1). When participants were compared by food security status, significant differences in characteristics were observed for state, age, participation in 1 federal food assistance program, and the number of times this pantry (where the participant was recruited) was visited in the previous 12 months. A lower proportion of VLFS clients (11%) reported being 65 years old compared to FS (31%) and LFS (47%) clients. A greater proportion of VLFS clients (86%) reported being enrolled in 1 federal food assistance program compared to FS (73%) and LFS (78%) clients. A greater proportion of LFS (52%) and VLFS (55%) clients reported visiting this pantry <5 times in the past year compared to FS (40%) clients.

Whole grains HEI-2010 score differed between FS and LFS pantry clients (CI: 0.11, 1.85), with FS clients achieving an average of one point higher compared to LFS clients (Table 2). Mean usual intake of energy differed between LFS and VLFS clients, with VLFS clients consuming an average of 50 kilocalories less energy daily (CI: -7.36, -0.96) (Table 3). Mean usual intake of iron differed between FS and VLFS clients, with VLFS clients consuming an average of 0.6 milligrams less iron daily (CI: -0.55, -0.11) (Table 3). Over 90% of all clients (including FS, LFS and VLFS clients) consumed below the EARs for vitamin D and vitamin E and less than 15% of all clients exceeded the AIs for potassium, fiber, and choline (Table 3). Over 85% of all clients consumed below target recommendations for total fruit, total vegetables, dark green vegetables, whole grains and dairy food groups (Table 4). FS status compared to LFS status was associated with higher mean usual intakes of whole grains and dark green vegetables; differences ranged from 1.33 (for participants with otherwise 'low risk' covariate patterns, CI: 0.08, 0.58) to 1.40 times higher (for participants with otherwise 'high risk' covariate patterns, CI: 0.12, 0.69) for whole grains and from 1.61 (CI: 0.27, 0.95) to 1.60 (CI: 0.24, 0.95) times higher for dark green vegetables (Table 5). FS status compared to VLFS status was associated with higher mean usual intakes of dark green vegetables and dairy; differences ranged from 1.59 (CI: 0.23, 0.95) to 1.58 (CI: 0.22, 0.94) times higher for dark green vegetables and from 1.24 (CI: 0.07, 0.41) to 1.30 (CI: 0.10, 0.50) times higher for dairy (Table 5).

DISCUSSION

This study, to the best of authors' knowledge, represents the first comparison of diet quality (estimated using the HEI-2010) and usual intake of under-consumed nutrients and related food groups (estimated using the NCI method) among U.S. food pantry clients by FS, LFS, and VLFS subgroups. Informing food pantry operators that, even among this very low-resource group, client needs may differ by food security status represents a small step towards better serving clients. FS clients were expected to consume diets of higher quality (HEI-2010) and usual intake of nutrients and food groups (NCI method) compared to VLFS clients and, to a lesser extent, LFS clients. Evidence partially supported these hypotheses; FS clients had a higher whole grains HEI-2010 score and mean usual intake of whole grains compared to LFS clients, higher mean usual intakes of iron and dairy compared to VLFS clients, and higher mean usual intake of dark green vegetables compared to both LFS and VLFS clients. A high proportion of clients were expected to have mean usual intakes of nutrients and food groups that did not meet dietary recommendations. Consistent with this hypothesis, over 90% of clients had intakes below the EAR for vitamin D and E, less than 15% of all clients exceeded the AI for potassium, fiber, and choline, and over 85% of all clients consumed below target recommendations for total fruit, total vegetables, dark green vegetables, whole grains and dairy food groups.

Regarding dietary quality, FS client diets were higher in whole grains relative to calories compared to LFS clients and were closer to DGA recommendations. Improving the access to whole grains at food pantries and nutrition education to promote and prepare these foods may ultimately improve client diet quality scores for all clients and for LFS clients in particular. In addition to differences in diet quality, the present study established differences in usual intake (quantity consumed) among FS, LFS, and VLFS pantry clients. FS clients

consumed more whole grains over the 3 recall days compared to LFS clients, consistent with the finding that FS clients' diets conformed more closely to the DGA regarding whole grain quality compared to LFS clients. Thus, FS clients not only consumed a higher proportion of whole grains relative to other food groups in their diets, but also consumed a higher quantity of whole grain foods compared to LFS clients. FS clients consumed more iron and dairy compared to VLFS clients. FS clients consumed more dark green vegetables compared to both LFS and VLFS clients. FS clients did not have a higher HEI-2010 score for dairy compared to VLFS clients or higher HEI-2010 component scores for total vegetables or greens and beans compared to LFS and VLFS clients. This finding suggests that although FS clients consumed a higher amount of dairy and dark green vegetables, they did not consume a higher proportion of these foods relative to other food groups in their diets compared to LFS and VLFS clients.

Although the present study provided evidence for differences in diet quality and quantity by food security status, usual intake analysis showed that most nutrients and all food groups were under-consumed by almost all pantry clients, regardless of food security classification. This is not surprising since the nutrients and food groups investigated in this study are documented as under-consumed for all Americans.⁷ Yet, the overwhelming percentage in this sample not meeting the EAR or exceeding the AI was alarming. Under-consumption by all food security groups highlights the importance of interventions to improve dietary quality for all pantry clients. Discrepancies in intake between food security subgroups suggest there are particular foods and nutrients that dietary interventions should focus on to improve dietary disparities between clients and may cautiously inform other food-insecure population subgroups. Findings from this study provide novel insights into differences in dietary quality and intake by food security status, even within a population of pantry clients who share the common experience of relying on emergency food assistance.

Strengths

This study, to the best of authors' knowledge, presented the first investigation of both diet quality and usual intake among food pantry clients. Both the proportions of food groups consumed relative to Federal guidance, as well as the actual amounts consumed, were characterized by food security status. Investigation of both dietary quality and intake is critical to determining dietary patterns. HEI-2010 measures how closely one's diet adheres to the 2010 Dietary Guidelines for Americans in terms of diet quality independent of quantity. Although this measure is meaningful, in low-income communities it is also important to consider the quantities of food groups and nutrients consumed. The authors responded to this critical need by applying the NCI method to estimate usual intakes of nutrients and food groups of public health concern in the pantry-user population while also mitigating measurement error. The very high prevalence of food insecurity allowed researchers to stratify the study sample by LFS and VLFS, contributing the first comparison of consumption patterns between FS, LFS, and VLFS pantry clients and establishing differences between the dietary patterns of these subgroups. Another strength of this study is the collection of up to three 24-hour dietary recalls on non-consecutive days. Using multiple 24-hour recalls compared to using a single dietary recall is recommended when the research objective is to describe the mean usual intake and proportion of individuals above or below

an intake threshold.³⁶ Although not representative, the range of food pantries across several states in the Midwest strengthens this study sample.

Limitations

Nutrient intake in the present study was compared to EAR and AI values for females between 31–50 years. Although the study population was mostly females in this age range, it also included a small proportion of males and older adults; federal guidance for markers of adequacy for nutrients are, in many cases, higher for males,^{10–16} and thus the proportion not meeting requirements may have been under-estimated for males in the sample. The EAR, which is designed to assess prevalence of inadequacy,³⁷ was not available for all nutrients evaluated in this study and the AI, which approximates the nutrient intake by a group of healthy people,³² was used in these cases. There is a difference of interpretation between the proportion not meeting the EAR and the proportion not exceeding the AI which deems these results inappropriate to compare. The 24-hour recalls used to measure diet quality and quantity in this study did not account for supplements; resulting estimates do not represent total intake. Under-reporting of energy intake when using 24-hour dietary recalls is known³⁸ and could have contributed to bias in this study; however, a recent study reported the ASA24 to perform relatively well among women with low incomes.²⁴ Compensation of up to \$30 in the form of grocery store gift cards could have resulted in higher quality and/or quantity of foods being purchased at stores and may have introduced bias to the second and third dietary recalls that were collected after the day of recruitment. Food security status was associated with dietary quality and intake in this study; however, food security assessment has a reference period of 12 months while the reference period for dietary assessment was two weeks. Thus, food security status did not necessarily reflect the household's experience during data collection, as households might experience episodes of food insecurity throughout the year due to changes in circumstances.¹ However, given that we identified associations between 12-month food security status and 3 days of dietary intake, it is likely that the true association was under-estimated; this potential under-estimation should be considered when interpreting the results of this study. Finally, generalization of results is limited by the convenience nature of the sample, which may have introduced bias by including only English-speaking clients who were inclined to participate. A sample that includes non-English speakers may represent additional barriers to resources; thus, the estimates in the present study could be conservative.

CONCLUSIONS

Food security was associated with a higher whole grains HEI-2010 score, as well as a higher mean usual intake of whole grains, compared to low food security among food pantry clients. Food security was associated with higher mean usual intakes of iron and dairy compared to very low food security. Food security was also associated with a higher mean usual intake of dark green vegetables compared to both low food security and very low food security among food pantry clients. FS, LFS, and VLFS pantry clients showed differences in dietary quality and usual intake, suggesting that food security status may be associated with dietary patterns, even among the vulnerable food pantry client sample. However, most pantry clients, regardless of food security status, consumed less than Federal guidance for all

food groups evaluated in this study and below markers of adequacy for magnesium, calcium, vitamin A, vitamin D, vitamin E, and vitamin C.

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RESEARCH SNAPSHOT

Research Question

Do dietary quality and usual intake of under-consumed nutrients and food groups differ by food security status?

Key Findings

This cross-sectional, secondary analysis included 579 adult food pantry clients from the Midwestern U.S. Food security (FS) was associated with: 1) higher whole grains Healthy Eating Index-2010 score and higher usual intake of whole grains compared to low FS, 2) higher usual intakes of iron and dairy compared to very low FS, and 3) higher usual intake of dark green vegetables compared to low and very low FS. Usual intakes of all dietary components were below Federal guidance for most pantry clients, regardless of food security status.

Table 1.

Unadjusted Sociodemographic Characteristics by Adult Food Security Status in a Sample of Adult Clients from Rural, Midwestern, Food Pantries Participating in the Voices for Food Study in 2014 (*n*=579)

Characteristics	All Clients	Food secure	Low food secure	Very low food secure	Chi-squared
	<i>n</i> (%) ^a	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>P</i> -value ^b
Total	579 (100)	131 (23)	172 (30)	276 (48)	
State					0.01
Indiana	151 (26)	30 (23)	39 (23)	82 (30)	
Michigan	98 (17)	17 (13)	33 (19)	48 (17)	
Missouri	140 (24)	33 (25)	37 (22)	70 (25)	
Nebraska	50 (9)	10 (8)	24 (14)	16 (6)	
Ohio	78 (13)	20 (15)	18 (10)	40 (14)	
South Dakota	62 (11)	21 (16)	21 (12)	20 (7)	
Sex					0.51
Male	137 (28)	34 (30)	46 (30)	57 (26)	
Female	350 (72)	79 (70)	105 (70)	166 (74)	
Age, years					0.0002
18–44	182 (37)	36 (32)	50 (33)	96 (42)	
45–64	215 (44)	43 (38)	66 (43)	106 (47)	
65	96 (19)	35 (31)	36 (47)	25 (11)	
Race					0.40
White	380 (79)	87 (78)	116 (80)	177 (78)	
Black	40 (8)	12 (11)	12 (8)	16 (7)	
American Indian	38 (8)	10 (9)	12 (8)	16 (7)	
Other ^c	25 (5)	3 (3)	5 (3)	17 (8)	
Ethnicity					0.22
Of Hispanic, Latino, or Spanish origin	16 (3)	1 (1)	7 (5)	8 (4)	
Not of Hispanic, Latino, or Spanish origin	460 (97)	108 (99)	138 (95)	214 (96)	
Highest education level					0.60
High school graduate or equivalent	331 (67)	77 (68)	105 (70)	149 (65)	
Some college/trade school	162 (33)	37 (32)	45 (30)	80 (35)	
Employment status ^d					0.39
Employed ≥ 6 months	133 (24)	32 (25)	45 (26)	56 (21)	
Employed <6 months	428 (76)	94 (75)	125 (74)	209 (79)	
Income ^e					0.06
<\$10,000	292 (54)	56 (56)	77 (50)	159 (60)	
\$10,000 - \$15,000	112 (21)	31 (25)	37 (24)	44 (17)	
>\$15,000	136 (25)	35 (29)	40 (26)	61 (23)	
Household size ^d					0.34

Characteristics	All Clients	Food secure	Low food secure	Very low food secure	Chi-squared
	<i>n</i> (%) ^a	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>P</i> -value ^b
1 member	173 (30)	41 (32)	57 (33)	75 (27)	
2 members	135 (23)	36 (28)	35 (20)	64 (23)	
3 members	268 (47)	53 (41)	79 (46)	136 (49)	
Participation in food assistance programs ^{d,f}					0.009
1 program	466 (80)	96 (73)	134 (78)	236 (86)	
0 programs	113 (20)	35 (27)	38 (22)	40 (14)	
Estimated amount of household foods from all pantries in the last month					0.12
A few days' worth	243 (45)	44 (39)	67 (42)	132 (51)	
1–2 weeks' worth	187 (35)	40 (35)	61 (38)	86 (33)	
More than half of food for the month	105 (20)	29 (26)	33 (21)	43 (16)	
Number of pantries visited ^d					0.16
1 pantry	265 (48)	67 (55)	79 (47)	119 (45)	
>1 pantry	291 (52)	55 (45)	88 (53)	148 (55)	
Frequency of visits to this pantry ^d					0.02
<5 times	294 (51)	53 (40)	89 (52)	152 (55)	
5 times	285 (49)	78 (60)	83 (48)	124 (45)	

^aTotals may not add up to the total number of participants due to missing values.

^bStatistical significance is $P < 0.05$ for chi-squared comparisons between food secure, low food secure and very low food secure households.

^cIncludes Native Hawaiian, Asian, and any combinations of races.

^dOver the past 12 months.

^eSelf-reported total combined income of all household members over the past 12 months including income from jobs, businesses, pensions, Social Security or retirement payments, disability payments, and any other money income received.

^fIncludes the Supplemental Nutrition Assistance Program; Meals on Wheels; Soup Kitchens; the Special Supplemental Nutrition Program for Women, Infants, and Children; free or reduced-price school meals; and free or reduced-priced meals at summer programs.

Table 2.

Association^a of Adult Food Security Status with Healthy Eating Index-2010 (HEI-2010) Scores in a Sample of Adult Clients from Rural, Midwestern, Food Pantries Participating in the Voices for Food Study in 2014

HEI-2010 component (maximum score)	Mean (standard deviation) ^b <i>n</i> = 440			95% confidence interval [lower, upper] for mean differences ^{b,c,d}		
	Food Secure (FS) <i>n</i> = 103	Low food secure (LFS) <i>n</i> = 129	Very low food secure (VLFS) <i>n</i> = 208	FS vs LFS	FS vs VLFS	LFS vs VLFS
Total score (100)	45.3 (1.5)	42.2 (1.4)	43.2 (1.4)	-0.65, 6.81	-1.46, 5.57	-4.26, 2.21
Total vegetables (5)	3.3 (0.2)	3.4 (0.2)	3.3 (0.2)	-0.65, 0.34	-0.54, 0.40	-0.34, 0.52
Greens and beans (5)	1.4 (0.2)	1.3 (0.2)	1.0 (0.2)	-0.42, 0.72	-0.10, 0.97	-0.21, 0.78
Total fruit (5)	1.9 (0.2)	1.8 (0.2)	1.9 (0.2)	-0.55, 0.65	-0.57, 0.56	-0.58, 0.46
Whole fruit (5)	1.6 (0.3)	1.4 (0.2)	1.5 (0.2)	-0.45, 0.78	-0.45, 0.71	-0.57, 0.50
Whole grains (10)	2.8 (0.4)	1.8 (0.3)	2.4 (0.3)	0.11, 1.85	-0.43, 1.21	-1.35, 0.16
Dairy (10)	4.4 (0.4)	3.9 (0.4)	3.4 (0.4)	-0.53, 1.58	-0.03, 1.96	-0.47, 1.36
Total protein foods (5)	4.3 (0.2)	4.5 (0.1)	4.4 (0.1)	-0.57, 0.19	-0.43, 0.29	-0.22, 0.45
Seafood & plant proteins (5)	1.4 (0.2)	1.2 (0.2)	1.0 (0.2)	-0.38, 0.80	-0.15, 0.97	-0.32, 0.71
Fatty acids (10)	4.1 (0.4)	4.3 (0.4)	4.5 (0.4)	-1.20, 0.79	-1.31, 0.57	-1.03, 0.70
Sodium (10)	2.6 (0.4)	2.7 (0.4)	2.9 (0.4)	-1.01, 0.94	-1.21, 0.63	-1.10, 0.59
Refined grains (10)	6.9 (0.5)	6.2 (0.4)	6.8 (0.4)	-0.41, 1.77	-0.99, 1.07	-1.59, 0.30
Empty calories (20)	10.6 (0.8)	9.7 (0.7)	10.1 (0.7)	-0.95, 2.75	-1.24, 2.25	-2.00, 1.21

^aModels were structured as follows: HEI_{client}= client_food_security_status + covariates. All models were evaluated for potential confounding presented by the following covariates: state, age, sex, race, income, participation in 1 federal food assistance program, and frequency of visits to this pantry in the last 12 months.

^bLeast Squares Means

^cTukey's adjustment for multiple comparisons

^dStatistical significance was determined by confidence interval not including zero.

Table 3.

Association^a of Adult Food Security Status with Usual Intake of Under-Consumed Nutrients in a Sample of Adult Clients from Rural, Midwestern, Food Pantries Participating in the Voices for Food Study in 2014

Nutrient (Estimated Average Requirement [EAR] or Adequate Intake [AI] level) ^b	Prevalence (%) of total usual nutrient intakes below EAR or above AI	Mean usual intake (standard deviation) by food security status				95% confidence interval [lower, upper] for mean differences (P-value) ^c		
		Food secure (FS)	Low food secure (LFS)	Very low food secure (VLFS)	FS	LFS	VLFS	FS vs LFS
Energy, kcal/day	-	-	1441 (53)	1467 (48)	1417 (53)	-2.21, 4.54 (0.50)	-6.57, 0.14 (0.06)	-7.36, -0.96 (0.01)
Potassium, mg/day (4700 ^d)	2	4	1779 (93)	1940 (107)	1622 (91)	-4.78, 1.35 (0.27)	-4.01, 1.68 (0.42)	-2.06, 3.17 (0.68)
Dietary fiber, g/day (25 ^d)	2	4	9.9 (0.6)	10.9 (0.6)	9.2 (0.5)	-0.56, 0.05 (0.10)	-0.62, -0.04 (0.02)	-0.34, 0.19 (0.57)
Choline, mg/day (425 ^d)	7	11	232 (14)	257 (15)	213 (12)	-2.10, 0.19 (0.10)	-2.05, 0.10 (0.08)	-0.97, 0.95 (0.99)
Magnesium, mg/day (265 ^e)	87	82	178 (9)	194 (10)	164 (8)	-2.71, -0.11 (0.03)	-2.06, 0.30 (0.14)	-0.49, 1.70 (0.28)
Calcium, mg/day (800 ^e)	79	73	600 (38)	676 (44)	573 (47)	-1.78, 0.35 (0.19)	-2.11, -0.03 (0.04)	-1.29, 0.53 (0.41)
vitamin A, gg, RAE/day (500 ^e)	71	66	429 (29)	473 (31)	392 (30)	-2.77, -0.19 (0.02)	-0.45, 0.09 (0.19)	-1.05, 1.11 (0.96)
vitamin D, gg/day (10 ^e)	98	96	3.0 (0.2)	3.4 (0.2)	2.8 (0.3)	-0.42, 0.14 (0.34)	-0.45, 0.09 (0.19)	-0.29, 0.21 (0.76)
vitamin E, alpha-tocopherol, mg/day (12 ^e)	97	95	4.6 (0.3)	5.3 (0.5)	4.3 (0.3)	-0.21, 0.16 (0.80)	-0.31, 0.04 (0.14)	-0.25, 0.07 (0.28)
vitamin C, mg/day (60 ^e)	73	70	48.0 (4.1)	53.0 (5.2)	45.3 (4.6)	-0.70, 0.64 (0.66, 0.61)		

Nutrient (Estimated Average Requirement [EAR] or Adequate Intake [AI] level) ^b	Prevalence (%) of total usual nutrient intakes below EAR or above AI		Mean usual intake (standard deviation) by food security status				95% confidence interval [lower, upper] for mean differences (P-value) ^c		
	Food secure (FS)	Very low food secure (VLFS)	Low food secure (LFS)	FS	LFS	VLFS	FS vs LFS	FS vs VLFS	LFS vs VLFS
Iron, mg/day (8.1) ^e	41	51	36	10.5 (0.6)	11.8 (0.7)	9.9 (0.6)	-0.48, -0.01 (0.93)	-0.55, -0.11 (0.93)	-0.28, 0.13 (0.96)

^aModel followed guidelines described for calculating usual intake according to the National Cancer Institute method, and were structured as: HEI_{client}= energy + weekday/weekend identifier + 24-hour recall sequence identifier + client food security status + covariates. All models were evaluated for potential confounding presented by the following covariates: state, age, sex, race and income, participation in 1 federal food assistance program, frequency of visits to this pantry in the last 12 months.

^bInstitute of Medicine dietary references intakes.¹⁰⁻¹⁶

^cStatistical significance was determined at $P < 0.0167$ to adjust for multiple comparisons (FS vs LFS, FS vs VLFS, LFS vs VLFS) using Bonferroni method.

^dAI used for females 31–50 years

^eEAR used for females 31–50 years

Table 4.

Mean Usual Intakes of Food Groups and Proportions Below Target Recommendations by Adult Food Security Status in a Sample of Adult Clients from Rural, Midwestern, Food Pantries Participating in the Voices for Food Study in 2014

Food group (target ^a)	Food security status	Mean (standard deviation)	Prevalence (%) below target
Total fruit (1.5 cup equiv./day)	Food secure	0.50 (0.06)	94
	Low food secure	0.52 (0.06)	92
	Very low food secure	0.43 (0.05)	95
Total vegetables (2 cup equiv./day)	Food secure	1.21 (0.08)	91
	Low food secure	1.31 (0.09)	87
	Very low food secure	1.12 (0.07)	92
Dark green vegetables (0.2 ^b cup equiv./day)	Food secure	0.07 (0.01)	93
	Low food secure	0.06 (0.01)	94
	Very low food secure	0.06 (0.01)	95
Whole grains (3 ounce equiv./day)	Food secure	0.57 (0.06)	99
	Low food secure	0.57 (0.06)	99
	Very low food secure	0.46 (0.05)	99
Dairy (3 cup equiv./day)	Food secure	1.10 (0.09)	96
	Low food secure	1.25 (0.10)	93
	Very low food secure	1.04 (0.10)	96

^aTarget values based on Healthy US-style Food Patterns recommendations from the 2010 Dietary Guidelines for Americans for minimal calorie intake for adults (1600 kcal).¹⁷ The study population mean usual intake of energy = 1438 kcal.

^bDark green vegetables recommendation is 1.5 cup equiv./week. $1.5 \div 7 = 0.2$ cup equiv./day

Table 5.

^a Association of Adult Food Security Status with Usual Intake of Food Groups for ‘High Risk’ and ‘Low Risk’ Covariate Patterns in a Sample of Adult Clients from Rural, Midwestern, Food Pantries Participating in the Voices for Food Study in 2014

Food group	Covariates (a-h)										Ratios of mean usual intake between adult food secure (FS), low food secure (LFS), and very low food secure (VLFS) clients 95% confidence interval [lower, upper] (P-value) ^b		
	Risk Level ^c	(a) Age	(b) Sex	(c) Race ^d	(d) Income ^e	(e) Participation ^f	(f) Frequency	(g) State ^g	(h) Weekday/ Weekend ^h	$\frac{FS}{LFS}$	$\frac{FS}{VLFS}$	$\frac{LFS}{VLFS}$	
Total fruit	High	<45y	F	Other	<\$10,000	1 program	<5 times	MI, NE, SD	Weekend	1.13	1.20	1.08	
	Low	45y	M	White	\$10,000	0 programs	5 times	IN, MO, OH	Weekday	[-0.30, 0.56] (0.54)	[-0.17, 0.57] (0.29)	[-0.33, 0.48] (0.71)	
Total vegetables	High	<45y	F	Other	<\$10,000	1 program	<5 times	MI, NE, SD	Weekend	1.05	1.02	0.97	
	Low	45y	M	White	\$10,000	0 programs	5 times	IN, MO, OH	Weekday	[-0.33, 0.66] (0.51)	[-0.14, 0.70] (0.19)	[-0.33, 0.60] (0.56)	
Dark green vegetables	High	<45y	F	Other	<\$10,000	1 program	<5 times	MI, NE, SD	Weekend	1.60	1.58	0.97	
	Low	45y	M	White	\$10,000	0 programs	5 times	IN, MO, OH	Weekday	[-0.13, 0.23] (0.60)	[-0.16, 0.20] (0.83)	[-0.21, 0.14] (0.73)	
Whole grains ^j	High	<45y	F	Other	<\$10,000	1 program	<5 times	MI, NE, SD	Weekend	1.40	1.27	0.88	
	Low	45y	M	White	\$10,000	0 programs	5 times	IN, MO, OH	Weekday	[-0.14, 0.22] (0.63)	[-0.16, 0.20] (0.83)	[-0.20, 0.15] (0.77)	
Dark green vegetables	High	<45y	F	Other	<\$10,000	1 program	<5 times	MI, NE, SD	Weekend	1.60	1.58	0.97	
	Low	45y	M	White	\$10,000	0 programs	5 times	IN, MO, OH	Weekday	[-0.14, 0.22] (0.63)	[-0.16, 0.20] (0.83)	[-0.20, 0.15] (0.77)	
Whole grains ^j	High	<45y	F	Other	<\$10,000	1 program	<5 times	MI, NE, SD	Weekend	1.40	1.27	0.88	
	Low	45y	M	White	\$10,000	0 programs	5 times	IN, MO, OH	Weekday	[-0.14, 0.22] (0.63)	[-0.16, 0.20] (0.83)	[-0.20, 0.15] (0.77)	

Food group	Covariates (a-h)								Ratios of mean usual intake between adult food secure (FS), low food secure (LFS), and very low food secure (VLFS) clients 95% confidence interval [lower, upper] (P-value) ^b				
	(a) Age	(b) Sex	(c) Race ^d	(d) Income ^e	(e) Participation ^f	(f) Frequency	(g) State ^g	(h) Weekday/ Weekend ^h	$\frac{FS}{LFS}$	$\frac{FS}{VLFS}$	$\frac{LFS}{VLFS}$		
	Risk Level ^c												
	Low	45y	M	White	\$10,000	0 programs	5 times	IN, MO, OH	Weekday	(0.005)	1.33	1.20	0.80
	High	<45y	F	Other	<\$10,000	1 program	<5 times	MI, NE, SD	Weekend	[0.08, 0.58]	[0.09, 0.49]	[0.17, 0.36]	[0.62, 0.22]
	Low	45y	M	White	\$10,000	0 programs	5 times	IN, MO, OH	Weekday	[0.00, 0.46]	[0.10, 0.50]	[0.05, 0.004]	[0.17, 0.34]
	High	<45y	F	Other	<\$10,000	1 program	<5 times	MI, NE, SD	Weekend	[0.04, 0.40]	[0.07, 0.41]	[0.02, 0.006]	[0.18, 0.24]

^a Authors adapted the National Cancer Institute method to include estimate statements described by Toozé et al., 2002³⁴ that calculated ratios of usual intake by food security subgroups ($\frac{FS}{LFS}, \frac{FS}{VLFS}, \frac{LFS}{VLFS}$). Energy was set equal to the mean, 1438 kilocalories.

^b Statistical significance was determined at $P < 0.0167$ to adjust for multiple comparisons (FS vs LFS, FS vs VLFS, LFS vs VLFS) using Bonferroni method.

^c Risk level pertains to the risk for the outcome (low food group intake).

^d Other includes Black, American Indian, Native Hawaiian, Asian, and any combinations of races.

^e Total combined income of all members of household over the past 12 months.

^f Participation in food assistance programs in the past 12 months, including: Supplemental Nutrition Assistance Program; Meals on Wheels; Soup Kitchens; the Special Supplemental Nutrition Program for Women, Infants, and Children; free or reduced-price school meals; and free or reduced-priced meals at summer programs.

^g IN = Indiana; MI = Michigan; MO = Missouri; NE = Nebraska; OH = Ohio; SD = South Dakota

^h Weekday/weekend controls for whether recalls were completed on weekdays or weekend days, as this is known to associate with dietary intake.

ⁱ Interpretation: [numerator of ratio (food security category)] compared to [denominator of ratio (food security category)] is associated with an increased mean usual intake of [food group]. The increase ranged from [‘low risk’ ratio] times (for participants with otherwise ‘low risk’ covariate patterns) to [‘high risk’ ratio] times (for participants with otherwise ‘high risk’ covariate patterns). Example: ‘Food secure status compared to low food secure status was associated with increased mean usual intake of whole grains. The increase ranged from 1.33 times (for participants with otherwise ‘low risk’ covariate patterns) to 1.40 times (for subjects with otherwise ‘high risk’ covariate patterns).