The American Journal of Clinical Nutrition 123 (2026) 101141

The American Journal of CLINICAL NUTRITION

journal homepage: https://ajcn.nutrition.org/

Original Research Article

Understanding the association of food insecurity and nutrition insecurity with diet quality: a cross-sectional analysis of 2 national samples

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A B S T R A C T

Background: Food insecurity is associated with poor diet quality. However, nutrition security may better predict diet quality as it specifically measures healthy food access.

Objectives: This study aims to examine the associations between food security, nutrition security, and joint food and nutrition security status with diet quality.

Methods: Data came from 2 cross-sectional surveys of United States adults (n = 4554) and Supplemental Nutrition Assistance Program (SNAP) participants (n = 1463). For United States adults, food security was measured with the 18-item Household Food Security Survey Module, and diet quality was measured with the Prime Diet Quality Score (PDQS). For SNAP adults, food security was measured with the USDA's 6-item Food Security Survey, and diet quality was measured with the rapid PDQS (rPDQS). Nutrition security was measured with the Center for Nutrition and Health Impact's Household Nutrition Security (HNS) in both samples. Linear regression models analyzed the relationship between food and nutrition security and diet quality separately and jointly, adjusting for sociodemographic covariates.

Results: In the United States adult sample, 52.8% were food and nutrition secure (FS/NS), 16.4% were food insecure and nutrition secure (FI/NS), 4.2% were food secure and nutrition insecure (FS/NI), and 26.6% were food and nutrition insecurity (FI/NI). In the SNAP sample, 24.1% were FS/NS, 27.5% were FI/NS, 1.4% were FS/NI, and 46.9% were FI/NI. After multivariate adjustment, food insecurity was associated with lower diet quality in both samples [United States adults: $\beta = -1.2$ PDQS points; 95% confidence interval (CI): $= -1.9, -0.54$; SNAP sample: $\beta = -0.92$ rPDQS points; 95% CI: $-1.7, -0.14$]. Nutrition insecurity was not associated with lower diet quality for either sample. In both samples, joint food and nutrition insecurity was associated with the lowest diet quality compared with other groups.

Conclusions: Further research is needed to understand the utility of the HNS because food insecurity was more strongly associated with lower diet quality than nutrition insecurity.

Keywords: food security, nutrition security, diet quality, Supplemental Nutrition Assistance Program

Introduction

In 2023, 13.5% of Americans experienced food insecurity [1]. Food security is defined as "having access at all times to enough food for an active, healthy life" [2]. Those with food insecurity are more likely to have lower diet quality and poor health outcomes, including increased risk of cardiometabolic diseases such as obesity, diabetes, hypertension, and coronary artery disease, compared with individuals with FS [3–7]. The United States Household FS Survey Module (HFSSM) is a validated food security measure that is used to track progress toward national goals of reducing FI [8].

Abbreviations: CI, confidence interval; CNHI, Center for Nutrition and Health Impact; FI/NI, food insecure and nutrition insecure; FS/NI, food secure and nutrition insecure; FI/NS, food insecure and nutrition secure; FS/NS, food secure and nutrition secure; HFSSM, Household Food Security Survey Module; HNS, household nutrition security; PDQS, prime diet quality screener; rPDQS, rapid prime diet quality screener; SNAP, Supplemental Nutrition Assistance Program.

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https://doi.org/10.1016/j.ajcnut.2025.101141
Received 15 September 2025; Received in revised form 3 December 2025; Accepted 16 December 2025; Available online 20 December 2025
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Although food security is associated with diet quality, it does not explicitly assess whether households can access foods that support "a healthy, active life" [9,10]. The questionnaire includes the question, "I/we couldn't afford to eat balanced meals," but cognitive testing has shown that "balanced" has different meanings for different populations [9,11–13]. Accordingly, there is growing interest in measuring access to healthy foods, in conjunction with FS, via the construct of nutrition security. Nutrition security is defined by the USDA as "consistent and equitable access to healthy, safe, affordable foods essential to optimal health and well-being [14]. A useful nutrition security measure should have similar policy-relevant goals as the HFSSM, whereas providing information beyond what is already learned from the HFFSM.

Seligman et al. [15] proposed a conceptual framework for nutrition security where nutrition security is a mediator between food security status and health outcomes, and healthy diets and nutritional status are subconstructs of nutrition security (Supplemental Figure 1). Seligman et al. [15] define nutrition security as occurring when "an individual *1)* has access to both an adequate quantity and quality of food to promote health across the lifespan and *2)* makes dietary choices that promote health and long-term well-being." This definition acknowledges that finances, taste preferences, and convenience all impact health-promoting food choices. Under this framework, it is possible to be food secure and nutrition secure (FS/NS), food insecure and nutrition insecure (FI/NI), food secure and nutrition insecure (FS/NI), indicating access to a sufficient quantity of food but insufficient access to nutritious food, and food insecure and nutrition secure (FI/NS), indicating lack of access to a sufficient quantity of food but sufficient access to nutritious food. FS/NI is likely common and illustrated by the many Americans who have enough food to eat, but that food does not meet the Dietary Guidelines for Americans recommendations [16]. FI/NS could occur if an individual has a limited food budget and prioritizes more expensive, nutrient-dense foods, leaving inadequate financial resources for enough food. This combination is likely uncommon given the established relationship between FS and diet quality, although there is limited research describing the joint occurrence of food and nutrition security status [3,4].

Although there is not yet a widely accepted measure of nutrition security, the Center for Nutrition and Health Impact (CNHI) created a 4-item household nutrition security (HNS) measure (Supplemental Table 1) [17]. The HNS was positively associated with general health, fruit, vegetable, and "scratch-cooked" meal intake and inversely associated with processed food intake among a convenience sample of individuals at risk of or experiencing food insecurity sampled from food pantries, shelters, and resource centers in 5 states [17,18]. Individuals with nutrition security had a lower odds of self-reported high cholesterol/hypertension, and diabetes. The relationship between the HNS and food security is not straightforward. In a secondary analysis of the original CNHI sample, 36.4% of respondents experienced FI/NS, and 56% of food-insecure respondents reported high control over their ability to select healthy foods [19]. A study of Supplemental Nutrition Assistance Program (SNAP) participants found 24.8% of respondents experienced FI/NS, and 52.1% of nutrition secure respondents responded "often" or "sometimes" to the statement, "I couldn't afford to eat balanced meals" [20]. The relationship between HNS and overall diet quality has not yet been investigated. The objective of this study was to assess the relationship between food security, nutrition security, and diet quality as informed by the Seligman conceptual framework. Under this framework, we hypothesized that *1*) Food insecurity will be strongly correlated with nutrition insecurity, *2*) Nuntrition insecurity will be a stronger predictor of low diet quality than food insecurity, and *3*) FI/NI will be associated with the lowest diet quality compared with the other food and NS categories.

Methods

Participants

This analysis includes 2 cross-sectional samples. The United States adult sample is a national, cross-sectional, online survey of United States adults collected with CloudResearch's Prime Panels in November 2023 [21]. Prime Panels generate diverse samples, have quality control measures in place, and have been used across academic disciplines [22]. Participants were recruited from different market research panels to create a diverse, high-quality sample [22]. We used quotas based on the United States. Census for gender, age, race, and ethnicity to achieve a sample benchmarked to these key United States population demographics. All participants provided informed consent. A total of 9835 individuals began the survey. Responses were dropped for individuals who did not consent ($n = 1050$), completed <75% of the survey ($n = 965$), were under age 18 y ($n = 63$), identified as a bot or duplicate ($n = 370$), failed ≤1 of 3 attention checks ($n = 2227$), had a Qualtrics fraud score ≥30 ($n = 185$), did not live in the United States ($n = 88$), or completed the survey in <10 min ($n = 333$). Individuals with complete information on FS status, NS status, and dietary intake were included for a final analytic sample of 4342 (Supplemental Figure 2). The Johns Hopkins Bloomberg School of Public Health Institutional Review Board approved this study. Participants provided informed consent before starting the survey.

The SNAP participant sample is a nationally representative cross-sectional survey of SNAP participants fielded through the AmeriSpeak panel in June 2024. The AmeriSpeak panel is a probability-based panel overseen by NORC at the University of Chicago [23]. Participants are randomly sampled through the NORC National Sample Frame, which covers 97% of households in the United States. The recruitment rate in this study was 22.3%. All participants provided informed consent. Eligible participants were ≥18 y, had an income <250% of the federal poverty level, and participated in SNAP for ≤3 mo in 2023. A total of 1762 individuals began the survey. Responses were dropped for individuals who completed <75% of the survey ($n = 69$) or had incomplete information on food security status, nutrition security status, or diet quality ($n = 230$) for a final analytic sample of 1463 participants, for a weighted sample of 1440 (Supplemental Figure 3). The survey was available in English and Spanish, and participants could take it via the internet or telephone. The Harvard T. H. Chan School of Public Health Institutional Review Board approved the study. The NORC Institutional Review Board collected informed consent from AmeriSpeak participants.

Measures

A summary of the food security, nutrition security, and diet quality measures is provided in Supplemental Table 2.

Food security

The United States adult sample used the validated 18-item HFSSM [8]. The recall period was modified to the past 30 d per USDA guidelines. Responses were summed to create an food security score (of 10 for adult-only households and of 18 for households with children) and categorized using the USDA scoring system. Categories

were dichotomized to food secure (raw score of 0–2) or food insecure (raw score of 3–10 for households with no children or 3–18 for households with children).

In the SNAP participant sample, food security was measured with the validated 6-item Short Form Foos Security Survey Measure, which measures food security over the past 12 mo [24]. Responses were summed to create an food security score and categorized using the USDA scoring system. Categories were dichotomized to food secure (raw score of 0 or 1) or food insecure (raw score of 2–6).

Nutrition security

In both samples, HNS was measured with the validated 4-item survey described previously [25]. The questions aim to assess a household's ability to obtain nutritious foods that meet their health and dietary needs and preferences in the past 12 mo. Each question is scored from 0 to 4, where 4 indicates never and 0 indicates always. Using the scoring protocol, the mean of the 4 questions is obtained. A binary variable was created where individuals were considered nutrition secure if they scored $\leq$2.0 and nutrition insecure if they scored $>$2.0, following the CNHI guidance [25].

Food and nutrition security

The binary food security and HNS variables were combined to create a 4-level food and nutrition security variable: FS/NS, FI/NS, FS/NI, and FI/NI.

Diet quality

The United States adult sample used the Prime Diet Quality Screener (PDQS)–30 d, a 22-item food-based diet quality index [26]. The PDQS includes 13 healthy components (whole grains, poultry, fish, beans/peas/soy products, low fat dairy, dark green leafy vegetables, cruciferous vegetables, other vegetables, citrus fruit, deep orange fruit, other fruit, nuts and seeds, and liquid oils) and 7 unhealthy components (processed meat, red meat, sugar-sweetened beverages, refined grains, sweets and desserts, fried food away from home, and white roots/tubers). Eggs are a neutral item and were not scored. Response options were once a month or less, 2 to 3 times per month, 1 to 2 times per week, 3 to 4 times per week, 5 to 6 times per week, 1 time per day, or $\geq$2 times per day. Scores for each component range from 0 to 6, with higher scores representing more frequent consumption for healthy components (6 points for 2 times a day per more, 0 for less than once a month or less) and reverse-coded for less healthful components (6 points for less than once a month or less, and 0 points for 2 times a day or more). The possible score range is 0 to 126, where a higher score represents higher diet quality. The PDQS is correlated with usual nutrient intakes measured by the Automated Self-Administered 24-h (ASA24) and the Healthy Eating Index-2015 (HEI-2015) [26].

The SNAP participant sample used the rapid PDQS (rPDQS) 30 d screener, a food-based diet quality index meant to identify consumption of foods clinically meaningful for chronic disease risk [27]. The rPDQS includes 13 items, 6 healthy components (whole grains, beans/lentils/tofu, vegetables, fruit, and nuts) and 7 unhealthy components (processed meat, red meat, full-fat dairy, fast food, sugar-sweetened beverages, refined grains, and sweets and desserts). Response options for frequency of consumption are less than once per week, once per week, 2 to 4 times per week, nearly daily or daily, and twice per day or more. Scores for each component range from 0 to 4, with higher scores for more frequent consumption for healthful components (4 points for twice daily or more, 0 points for less than once per week) and reverse-coded for the less healthful components (4 points for less than once per week, 0 points for twice daily or more). The possible score range is 0 to 52, where a higher score represents higher diet quality. The rPDQS was derived from the PDQS and was also correlated with the HEI-2015. Its development and validation can be found elsewhere [27], but briefly, it was developed as a clinical screener for diet quality and found to be correlated with food group equivalents derived from the ASA24 Dietary Assessment Tool.

Sociodemographic covariates

Covariates that are associated with diet quality in previous studies were included [3,5,28]. In both studies, participants provided their age, gender (male/female), race and ethnicity (Asian-Pacific islander, non-Hispanic Black, Hispanic, non-Hispanic White, and other), educational attainment (high school or less, some college, Bachelor's degree or higher), household size (living alone, 2–3 people, 4 or more people), income (<$25,000, $25,000–$49,999, $50,000–$99,999, $100,000, or more) marital status (married/living together, unmarried), employment status (employed, unemployed) and region of residence (Northeast, Midwest, South, West). There were minor differences in how these variables were measured. For example, in the United States adult sample, age categories were 18 to 29, 30 to 39, 40 to 49, 50 to 59, 60+ y; in the SNAP participant sample, age categories were 18 to 29, 30 to 44, 45 to 59, and 60+ y.

Analysis

The United States adult sample analyses were unweighted, whereas the SNAP participant analyses additionally incorporated sampling weights provided by NORC to generate nationally representative estimates. AmeriSpeak panel weights were created by adjusting for the unequal probability of being selected for participation, nonresponse, and limitations of the sampling frame coverage [23]. Normality of overall diet quality scores was visually inspected with histograms. Sociodemographic differences by food and NS status were examined separately in each sample. Correlation between the 2 measures was assessed with a Phi coefficient. The percentage of each sample that was nutritionally secure was examined by FS status of food secure, low FS, and very low FS. Mean overall and component diet quality scores were examined by joint FS and NS status using analysis of variance. Post hoc testing for significant differences was conducted using Tukey's Honest Significant Difference test to account for multiple comparisons. Mean overall and component diet quality scores for FS and NS separately were compared using the Mann–Whitney *U*-test. Three multivariate regression models were run to understand the association between continuous diet quality score and *1*) FS, *2*) NS, and *3*) joint food and NS. All models were adjusted for age, sex, race and ethnicity, employment status, educational attainment, household size, income, marital status, and region of residence. R version 4.4.1 (R Core Team, 2022) was used. The Strengthening the Reporting of Observational Studies in Epidemiology- Nutrition Epidemiology guidelines were used when writing this article [29].

Results

There was a moderate association between food and nutrition security status, with a Phi coefficient of 0.58 in the United States adult sample and 0.50 in the SNAP sample. In the United States adult sample, 7.5% of adults with food security, 37.9% of adults with low food security, and 75.3% of adults experiencing very low food security

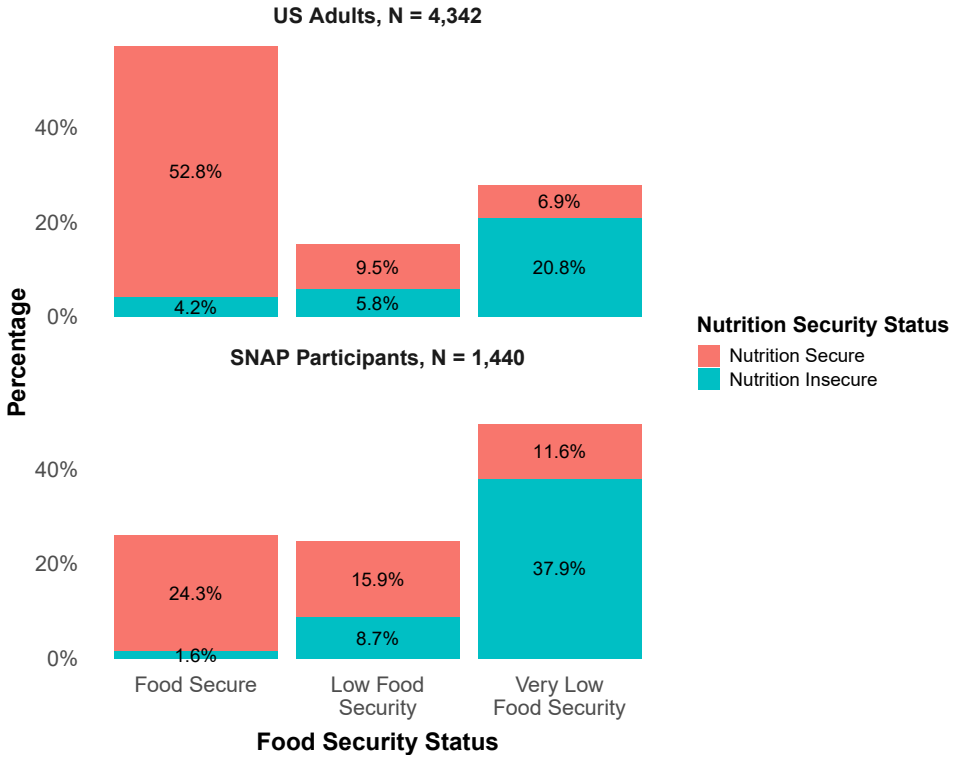


FIGURE 1. Distribution of nutrition security status by food security status among United States adults and SNAP participants. SNAP, Supplemental Nutrition Assistance Program.

were nutrition insecure (Figure 1). In the SNAP participant sample, 6.1% of adults with food security, 35.6% of adults with low food security, and 76.7% of adults with very low food security were nutrition insecure.

Table 1 shows the demographic characteristics of the national United States adult sample. Half of the sample was FS/NS (52.8%), indicating access to enough food and enough healthy food, 16.4% were FI/NS, indicating lack of access to enough food, but access to enough healthy food, 4.2% were FS/NI, indicating access to enough food, but not enough healthy food, and 26.6% were FI/NI, indicating lack of access to enough food and enough healthy food. All sociodemographic variables except region differed by joint food and nutrition status (Ps < 0.05).

Table 2 shows the demographic characteristics of the nationally representative SNAP participant sample. In that sample, 24.3% were FS/NS, 27.5% were FI/NS, 1.6% were FS/NI, and 46.6% were FI/NI. There were no differences in sociodemographic variables by joint food and nutrition security status.

Table 3 shows unadjusted associations between food and nutrition security category and PDQS score for the United States adult sample. In the United States adult sample, the mean diet quality score was significantly higher for adults experiencing FS/NS [44.6; 95% confidence interval (CI): 44.2, 45.0] compared with adults experiencing FI/NS (41.8; 95% CI: 41.0, 42.5) and FI/NI (41.2; 95% CI: 40.5, 41.7). On average, those experiencing FI/NI had less frequent intakes of dark leafy vegetables, cruciferous vegetables, other vegetables, other fruit, and nuts and seeds than those experiencing FS/NS. Those with FI/NI had more frequent intakes of processed meat, red meat, sugar-sweetened beverages, refined grains, and fried foods away from home than those experiencing FS/NS. Adults with FI/NS had less frequent intake of deep orange vegetables, other vegetables, other fruit, and nuts and seeds than those with FS/NS. The FI/NS group had more frequent intake of processed meat, sugar-sweetened beverages, and fried foods away from home than the FS/NS group. Adults with FS/NI had more frequent intakes of processed meat, red meat, sugar-sweetened beverages, and fried foods away from home than the FS/NS group. Those experiencing FS/NI or FI/NI had more frequent intake of poultry, beans, peas, and soy products, and deep orange fruit than those experiencing FS/NS.

Table 4 shows the unadjusted association between food and nutrition security category and rPDQS score for the SNAP sample. Mean diet quality score was significantly higher for individuals experiencing FS/NS (28.1; 95% CI: 27.5, 28.6) and FI/NS (27.2; 95% CI: 26.7, 27.7) compared with FI/NI (25.7, 95% CI: 25.3, 26.2). Individuals experiencing FI/NI had less frequent intakes of fruits and vegetables, and more frequent intakes of processed meat, fast food, sugar-sweetened beverages, and refined grains than those experiencing FS/NS. Those experiencing FI/NI had less frequent intakes of fruits and vegetables and less frequent intakes of processed meat, fast food, and refined grains than those experiencing FI/NS. There were no significant differences between individuals experiencing FS/NI and the other 3 categories.

Supplemental Tables 3 and 4 show the unadjusted association between food security status and diet quality score for the United States adult sample and SNAP participant sample, respectively. Supplemental Tables 5 and 6 show the unadjusted association between nutrition security status and diet quality scores for the United States adult sample and SNAP participant sample. As expected, in both samples, participants with food security generally had better diet quality than those with food insecurity, and similarly, those with nutrition security had better diet quality than those with nutrition insecurity.

TABLE 1
Participant characteristics for the national United States adult sample ($N = 4342$).

Overall	Overall *n* (%)	Food secure, nutrition secure *n* (%)	Food insecure, nutrition secure *n* (%)	Food secure, nutrition insecure *n* (%)	Food insecure, nutrition insecure *n* (%)
	4342	2292 (52.8)	712 (16.4)	183 (4.2)	1155 (26.6)
Age (y)					
18–29	609 (14.0)	197 (8.6)	107 (15.0)	44 (24.0)	261 (22.6)
30–39	626 (14.4)	213 (9.3)	123 (17.3)	35 (19.1)	255 (22.1)
40–49	715 (16.5)	258 (11.3)	154 (21.6)	23 (12.6)	280 (24.2)
50–59	922 (21.2)	480 (20.9)	174 (24.4)	43 (23.5)	225 (19.5)
60–69	666 (15.3)	475 (20.7)	87 (12.2)	23 (12.6)	81 (7.0)
70+	804 (18.5)	669 (29.2)	67 (9.4)	15 (8.2)	53 (4.6)
Gender					
Male	1981 (45.6)	1136 (49.6)	298 (41.9)	75 (41.0)	472 (40.9)
Female	2326 (53.6)	1149 (50.1)	405 (56.9)	105 (57.4)	667 (57.7)
Other/prefer not to say	35 (0.8)	7 (0.3)	9 (1.3)	3 (1.6)	16 (1.4)
Race and ethnicity					
Non-Hispanic White	2798 (64.4)	1564 (68.2)	401 (56.3)	118 (64.5)	715 (61.9)
Non-Hispanic Black	487 (11.2)	232 (10.1)	110 (15.4)	19 (10.4)	126 (10.9)
Hispanic	691 (15.9)	287 (12.5)	134 (18.8)	31 (16.9)	239 (20.7)
Asian-Pacific islander	152 (3.5)	106 (4.6)	23 (3.2)	10 (5.5)	13 (1.1)
Other[1]	214 (4.9)	103 (4.5)	44 (6.2)	5 (2.7)	62 (5.4)
Education					
High school or less	1085 (25.0)	396 (17.3)	231 (32.4)	36 (19.7)	422 (36.5)
Some college	1330 (30.6)	657 (28.7)	230 (32.3)	61 (33.3)	382 (33.1)
Bachelor's degree or higher	1927 (44.4)	1239 (54.1)	251 (35.3)	86 (47.0)	351 (30.4)
Household size					
1 person	1007 (23.2)	560 (24.4)	140 (19.7)	47 (25.7)	260 (22.5)
2–3 people	2352 (54.2)	1332 (58.1)	362 (50.8)	94 (51.4)	564 (48.8)
4+ people	983 (22.6)	400 (17.5)	210 (29.5)	42 (23.0)	331 (28.7)
Income					
<$25,000	893 (20.6)	277 (12.1)	192 (27.0)	44 (24.0)	380 (32.9)
$25,000–$49,999	1140 (26.3)	495 (21.6)	228 (32.0)	50 (27.3)	367 (31.8)
$50,000–$99,999	1341 (30.9)	798 (34.8)	204 (28.7)	61 (33.3)	278 (24.1)
$100,000 or more	815 (18.8)	623 (27.2)	63 (8.8)	25 (13.7)	104 (9.0)
Prefer not to say	153 (3.5)	99 (4.3)	25 (3.5)	3 (1.6)	26 (2.3)
Marital status					
Married[2]	2135 (49.2)	1251 (54.6)	312 (43.8)	75 (41.0)	497 (43.0)
Unmarried[3]	2207 (50.8)	1041 (45.4)	400 (56.2)	108 (59.0)	658 (57.0)
Employment status					
Employed	2069 (47.7)	982 (42.8)	353 (49.6)	99 (54.1)	635 (55.0)
Unemployed[4]	2273 (52.3)	1310 (57.2)	359 (50.4)	84 (45.9)	520 (45.0)
Region					
Northeast	716 (16.5)	382 (16.7)	120 (16.9)	26 (14.2)	188 (16.3)
Midwest	924 (21.3)	492 (21.5)	153 (21.5)	36 (19.7)	243 (21.0)
South	1724 (39.7)	876 (38.2)	292 (41.0)	79 (43.2)	477 (41.3)
West	978 (22.5)	542 (23.6)	147 (20.6)	42 (23.0)	247 (21.4)

[1] Other race includes Middle Eastern or North African, Native American, and other.
[2] Married includes married and living with a partner.
[3] Unmarried includes widowed, divorced, separated, and never married.
[4] Unemployed includes looking for work, stay-at-home parent/caregiver, retired, disabled, and other.

Table 5 shows the associations between diet quality and both individual and joint food and nutrition security status, adjusted for sociodemographic covariates. In model 1, the multivariate-adjusted model for food security status, food-insecure United States adults had a predicted PDQS score of 39.5, which was lower than the predicted PDQS score of 40.7 for food-secure United States adults ($\beta = -1.2$; 95% CI: −1.9, −0.54). Food-insecure SNAP participants had a predicted rPDQS score of 24.4, which was lower than the predicted rPDQS score of 25.3 for food-secure SNAP participants ($\beta = -0.92$; 95% CI: −1.7, −0.14). In model 2, the multivariate-adjusted model for NS status, there was no significant relationship between nutrition security status and diet quality in the United States adult ($\beta = -0.7$; 95% CI: −1.5, 0.00) or SNAP sample ($\beta = -0.70$; 95% CI: −1.4, 0.03). In model 3, the multivariate-adjusted joint food and nutrition exposure model, United States adults with FI/NI had a predicted mean PDQS score of 39.5, which was lower than the predicted mean PDQS score of 40.7 for United States adults experiencing FS/NS ($\beta = -1.3$; 95% CI: −2.1, −0.47). Adults with FI/NS had a mean PDQS score of 39.5, which was lower than the predicted mean PDQS score of 40.7 for adults with FS/NS ($\beta = -1.2$; 95% CI: −2.1, −0.3). There was no significant difference in PDQS score for those experiencing FS/NI compared with FS/NS ($\beta = -0.24$; 95% CI: −1.8, 1.3). In model 3, the multivariate-adjusted joint exposure model for the SNAP participant sample, SNAP participants with FI/NI had a mean rPDQS score of 24.3, which was lower than the predicted mean rPDQS score of 25.3 for adults with FS/NS ($\beta = -1.1$; 95% CI: −1.9, −0.24). There were

TABLE 2
Weighted participant characteristics for the national SNAP participant sample ($N = 1440$).

Overall	Overall *n* (weighted %)	Food secure, nutrition secure *n* (weighted %)	Food insecure, nutrition secure *n* (weighted %)	Food secure, nutrition insecure *n* (weighted %)	Food insecure, nutrition insecure *n* (weighted %)
	1440	347 (24.3)	397 (27.5)	20 (1.6)	675 (46.6)
Age					
18–29	325 (22.5)	73 (21.1)	94 (23.6)	1 (6.2)	156 (23.2)
30–44	410 (28.5)	72 (20.8)	96 (24.1)	8 (40.9)	234 (34.6)
45–59	293 (20.3)	74 (21.3)	77 (19.4)	7 (35.5)	135 (20.0)
60+	412 (28.6)	128 (36.8)	131 (32.9)	4 (17.3)	150 (22.3)
Sex					
Male	646 (44.9)	174 (50.1)	189 (47.5)	12 (60.4)	272 (40.2)
Female	793 (55.1)	173 (49.9)	208 (52.5)	8 (39.6)	404 (59.8)
Race and ethnicity					
Asian-Pacific Islander	45 (3.1)	7 (1.9)	15 (3.8)	1 (3.0)	22 (3.3)
Hispanic	415 (28.8)	99 (28.6)	109 (27.5)	9 (44.9)	198 (29.3)
Non-Hispanic Black	309 (21.5)	86 (24.6)	88 (22.1)	6 (30.2)	130 (19.2)
Non-Hispanic White	573 (39.8)	133 (38.4)	167 (42.1)	4 (17.6)	270 (39.9)
Other[1]	97 (6.7)	22 (6.5)	18 (4.5)	1 (4.2)	56 (8.3)
Education					
Bachelor's degree or higher	141 (9.8)	41 (11.9)	42 (10.6)	1 (6.9)	56 (8.3)
High school or less	898 (62.3)	215 (62.0)	232 (58.4)	11 (56.1)	439 (65.0)
Some college	401 (27.9)	91 (26.1)	123 (31.0)	8 (37.0)	180 (26.7)
Household size					
1 person	280 (19.5)	85 (24.5)	68 (17.1)	3 (13.2)	125 (18.5)
2-3 people	514 (35.7)	125 (35.9)	155 (39.2)	5 (25.6)	228 (33.8)
4+ people	645 (44.8)	137 (39.6)	174 (43.8)	12 (61.2)	322 (47.7)
Income					
<$25,000	818 (56.8)	187 (53.9)	226 (57.0)	13 (62.6)	392 (58.0)
$25,000–$49,999	416 (28.9)	107 (30.8)	114 (28.8)	7 (33.3)	188 (27.8)
$50,000–$99,999	206 (14.3)	53 (15.3)	56 (14.2)	1 (4.0)	96 (14.2)
Marital status					
Married[2]	397 (27.6)	95 (27.3)	95 (23.9)	9 (43.9)	198 (29.4)
Unmarried[3]	1043 (72.4)	252 (72.7)	302 (76.1)	11 (56.1)	477 (70.6)
Employment status					
Employed	633 (43.9)	169 (48.8)	151 (38.1)	12 (60.1)	300 (44.4)
Unemployed[4]	807 (56.1)	177 (51.2)	246 (61.9)	8 (39.9)	376 (55.6)
Region					
Northeast	274 (19.0)	66 (19.1)	75 (18.9)	2 (7.9)	131 (19.3)
Midwest	256 (17.8)	59 (17.0)	75 (18.8)	4 (22.1)	117 (17.4)
South	596 (41.4)	159 (45.8)	156 (39.4)	13 (65.0)	268 (39.6)
West	314 (21.8)	63 (18.1)	91 (22.9)	1 (5.0)	160 (23.7)

Abbreviation: SNAP, Supplemental Nutrition Assistance Program.
[1] Other race includes Middle Eastern or North African, Native American and other.
[2] Married includes married and living with a partner.
[3] Unmarried includes widowed, divorced, separated, and never married.
[4] Unemployed includes looking for work, stay-at-home parent/caregiver, retired, disabled, and other.

no significant differences in overall rPDQS score for those experiencing FS/NI ($\beta = -0.45$; 95% CI: −3.9, 3.0) and FI/NS ($\beta = -0.69$; 95% CI: −1.7, 0.28) compared with FS/NS.

Discussion

This study tested the association between joint and individual food and nutrition status with diet quality among a national sample of United States adults and a nationally representative sample of SNAP participants. We found that food and nutrition status were moderately correlated. Food insecurity was associated with worse diet quality in both samples, whereas there was no difference in diet quality by nutrition security status in either sample. FI/NI was associated with the lowest diet quality compared with the other food and nutrition security categories in both samples.

Although the first hypothesis was partially supported, discordance represented by FI/NS and FS/NI created an unclear relationship between diet quality and food and nutrition security status. FS/NI was expected to be common, but in both samples, this was the least common category. There were no statistically significant differences in diet quality scores between the FS/NI and FS/NS groups. FI/NS was expected to be uncommon. However, >1 in 4 SNAP participants and nearly 1 in 7 United States adults were FI/NS. This discordance has been found in other studies using the HNS [19,20]. This raises a puzzling question: what does it mean to have sufficient access to healthy food, but insufficient access to food more broadly? This may occur if individuals with limited financial resources have access to and choose more expensive healthy food, limiting their ability to acquire enough food, or access to low-cost nutritious food, but an insufficient quantity to meet their needs. This does not align with prior knowledge

TABLE 3
Unadjusted overall and component mean scores of PDQS for United States adults by joint food and nutrition security status[1].

Component	Food secure, nutrition secure $N = 2292$		Food insecure, nutrition secure $N = 712$		Food secure, nutrition insecure $N = 183$		Food insecure, nutrition insecure $N = 1155$	
	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
PDQS score[2]	44.6	44.2, 45.0	41.8[3]	41.0, 42.5	43.1	41.7, 44.5	41.2[3]	40.6, 41.7
Foods to consume more of[4]								
Whole grains	1.6	1.6, 1.7	1.5	1.4, 1.6	1.7	1.5, 1.9	1.5	1.4, 1.6
Poultry	1.3	1.3, 1.4	1.4	1.3, 1.5	1.7[3]	1.5, 1.8	1.4[3]	1.4, 1.5
Fish	0.5	0.5, 0.5	0.5	0.4,0.5	0.6	0.4, 0.7	0.5	0.5, 0.6
Beans, peas and soy products	0.8	0.8, 0.9	0.8	0.7, 0.9	1.0	0.9, 1.2	0.9[3]	0.9, 1.0
Low fat dairy	1.4	1.3, 1.5	1.2	1.1, 1.3	1.4	1.2, 1.7	1.3[3]	1.2, 1.3
Dark green leafy vegetables	1.2	1.2, 1.3	1.1[3]	1.0, 1.2	1.2	1.0, 1.4	0.9[3,5]	0.9, 1.0
Cruciferous vegetables	1.0	0.9, 1.0	0.9	0.8, 1.0	1.1	0.9, 1.3	0.9[3,5]	0.8, 0.9
Deep orange vegetables	0.7	0.7, 0.8	0.6[3,6]	0.5, 0.7	0.8	0.7, 1.0	0.7	0.6, 0.7
Other vegetables	1.4	1.4, 1.5	1.3[3]	1.2, 1.4	1.3	1.1, 1.5	1.2[3]	1.1, 1.3
Citrus fruit	0.9	0.9, 1.0	1.0	0.9, 1.1	1.1	0.9, 1.3	1.0	0.9, 1.1
Deep orange fruit	0.4	0.4, 0.4	0.5	0.4, 0.6	0.7[3]	0.5, 0.8	0.5[3]	0.5, 0.6
Other fruit	1.5	1.4, 1.6	1.2[3]	1.1, 1.3	1.5	1.3, 1.7	1.2[3]	1.2, 1.3
Nuts and seeds	1.3	1.2, 1.4	1.0[3]	0.9, 1.0	1.1	0.9, 1.3	1.0[3]	0.9, 1.1
Liquid oils	1.2	1.1, 1.2	1.2	1.1, 1.3	1.2	1.0, 1.4	1.1	1.1, 1.2
Foods to consume less of[7]								
Processed meat	4.5	4.4, 4.5	4.3[3]	4.2, 4.4	4.1[3]	3.9, 4.3	4.1[3]	4.0, 4.2
Red meat	4.1	4.1, 4.2	4.0	3.9, 4.1	3.8[3]	3.6, 4.0	3.9[3]	3.9, 4.0
Sugar-sweetened beverages	4.2	4.2, 4.3	3.5[3]	3.3, 3.6	3.6[3]	3.3, 3.9	3.3[3]	3.1, 3.4
Refined grains	3.7	3.7, 3.8	3.6	3.5, 3.8	3.5	3.3, 3.8	3.6	3.5, 3.6
Sweets and desserts	3.9	3.8, 4.0	3.8	3.7, 3.9	3.6	3.4, 3.9	3.8	3.7, 3.9
Fried foods away from home	4.8	4.8, 4.9	4.4	4.3, 4.5	4.2	4.0, 4.4	4.3	4.2, 4.4
White roots and tubers	3.9	3.9, 4.0	4.0	3.9, 4.1	3.9	3.7, 4.1	3.9	3.8, 4.0

Abbreviations: CI, confidence interval; PDQS, prime diet quality score screener.
[1] Means and CIs were calculated using analysis of variance; pairwise differences were assessed using Tukey's post hoc test.
[2] Possible scores range from 0 to 126. Higher score indicates better diet quality.
[3] Significantly different from food-secure, nutrition-secure group.
[4] Scores range from 0 to 6 where 0 indicates 1 time per month or less, 1 indicated 2 to 3 times per month, 2 indicates 1 to 2 times per week, 3 indicates 3 to 4 times per week, 4 indicates 5 to 6 times per week, 5 indicates once per day, and 6 indicates 2 times per day or more.
[5] Significantly different from food-secure, nutrition-insecure group.
[6] Significantly different from food-insecure, nutrition-secure group.
[7] Scores range from 0 to 6 where 0 indicates 2 or more times per day, 1 indicates once per day, 2 indicates 5 to 6 times per week, 3 indicates 3 to 4 times per week, 4 indicates 1 to 2 times per week, 5 indicates 2 to 3 times per month, and 6 indicates 1 time per month or less.

about the food environment or food consumption of individuals facing food insecurity [30,31]. The FI/NS group did not have a higher diet quality than the FI/NI group in either sample, making it less clear what aspect of diet quality and food access the HNS was capturing for these participants.

The second hypothesis, nutrition insecurity would be a stronger predictor of low diet quality than food insecurity, was not observed in either sample. In adjusted regression models, only food security status differentiated diet quality scores. Although neither food nor nutrition security measures are intended to measure diet quality, according to the Seligman framework, a healthy diet is a subconstruct of nutrition security [15]. Capturing access to healthy foods was a key motivator for developing a measure of nutrition security. Therefore, nutrition-secure individuals were expected to have higher diet quality. The current findings support that validated food security measures, such as the HFSSM, already captures differences in diet quality and does so better than the HNS. Future studies should confirm these findings with the reference standard dietary assessment methods, such as 24-hour recalls, and objective biomarkers to understand how food and nutrition security status relates to nutritional status, a subconstruct of nutrition security [15].

In both the United States adult and SNAP participant samples, experiencing food insecurity and nutrition insecurity jointly was associated with lower diet quality. This supports the third hypothesis. On average, all individuals, regardless of food security or nutrition security status, had a low-quality diet driven by infrequent consumption of foods to consume more of, such as fruits, vegetables, whole grains, beans, nuts, and fish. However, as discussed above, only a small fraction of individuals who have enough food to eat reported having a difficult time getting enough healthy food, by screening as FS/NI.

These findings raise questions about the utility of the HNS, because food insecurity is already established as a risk factor for poor diet quality [3,4]. The dietary questions asked in the HNS validation study may not have been robust enough to assess the relationship between HNS overall diet quality. These weak correlations, along with the findings of this analysis, suggest that the HNS is not a good proxy for dietary quality. Because food insecurity measures, like the HFSSM, is already associated with diet quality, it is unclear if the additional burden of collecting HNS data in social service and health care settings is worth the cost and effort when there is a clear need for population-level polices and interventions that support healthy dietary

TABLE 4
Weighted unadjusted overall and component mean scores of rPDQS for SNAP participants by joint food and nutrition security status[1].

Component	Food secure, nutrition secure $n = 347$		Food insecure, nutrition secure $n = 397$		Food secure, nutrition insecure $n = 20$		Food insecure, nutrition insecure $n = 675$	
	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
rPDQS score[2]	28.1	27.5, 28.6	27.2	26.7, 27.7	26.4	23.5, 29.3	25.7[3,4]	25.3, 26.2
Foods to consume more of[5]								
Whole grains	1.4	1.2, 1.5	1.4	1.2, 1.5	1.2	0.7, 1.6	1.2	1.2, 1.3
Beans, lentils, and tofu	1.0	0.9, 1.1	1.0	0.9, 1.1	1.1	0.6, 1.6	1.0	0.9, 1.0
Vegetables	2.0	1.9, 2.1	2.0	1.9, 2.1	1.8	1.3, 2.4	1.8[3,4]	1.7, 1.8
Fruit	2.1	1.9, 2.2	1.9	1.8, 2.0	2.0	1.5, 2.5	1.5[3,4]	1.5, 1.6
Nuts	1.4	1.3, 1.5	1.4	1.3, 1.5	1.4	0.9, 1.9	1.4	1.3, 1.5
Fish	0.8	0.7, 0.8	0.7	0.6, 0.8	0.9	0.4, 1.3	0.7	0.6, 0.7
Foods to consume less of[6]								
Processed meat	3.1	3.0, 3.2	2.9	2.8, 3.0	3.0	2.6, 3.3	2.6[3,4]	2.5, 2.7
Red meat	2.7	2.6, 2.8	2.7	2.6, 2.8	2.7	2.3, 3.1	2.7	2.6, 2.8
Full-fat dairy	2.3	2.1, 2.4	2.2	2.1, 2.3	2.5	2.0, 3.0	2.3	2.2, 2.4
Fast food	3.3	3.2, 3.4	3.2	3.2, 3.3	3.0	2.6, 3.4	3.0[3,4]	2.9, 3.1
Sugar-sweetened beverages	2.9	2.7, 3.0	2.7	2.6, 2.9	2.5	2.0, 3.1	2.6[3]	2.5, 2.7
Refined grains	2.7	2.6, 2.8	2.5	2.4, 2.6	2.2	1.7, 2.7	2.2[3,4]	2.1, 2.3
Sweets and desserts	2.6	2.5, 2.7	2.6	2.5, 2.7	2.2	1.7, 2.6	2.7	2.6, 2.8

Abbreviations: CI, confidence interval; rPDQS, rapid prime diet quality score screener; SNAP, Supplemental Nutrition Assistance Program.
[1] Means and CIs were calculated using analysis of variance; pairwise differences were assessed using Tukey's post hoc test.
[2] Possible scores range from 0 to 52. Higher score indicates better diet quality.
[3] Significantly different from food-secure, nutrition-secure group using the Tukey Honestly Significant Difference (HSD) test.
[4] Significantly different from food-insecure, nutrition-secure group using the Tukey HSD test.
[5] Scores range from 0 to 4 where 0 indicates less than once per week, 1 indicates once per week, 2 indicates 2–4 times per week, 3 indicates near daily or daily, and 4 indicates twice per day or more.
[6] Scores range from 0 to 4 where 0 indicates twice per day or more, 1 indicates nearly daily or daily, 2 indicates 2–4 times per week, 3 indicates once per week, and 4 indicates less than once per week.

TABLE 5
Association between food security status and nutrition security status separately and jointly and diet quality in United States adult and weighted SNAP participant samples.

	United States adults ($n = 4342$)			SNAP participants ($n = 1440$)		
	Predicted mean diet quality score	β	95% CI	Predicted mean diet quality score	β	95% CI
Model 1: food security status only[1]						
Food secure	40.7	Reference		25.3	Reference	
Food insecure	39.5	−1.2	−1.9, −0.54	24.4	−0.92	−1.7, −0.14
Model 2: nutrition security status only[1]						
Nutrition secure	40.2	Reference		25	Reference	
Nutrition insecure	39.5	−0.7	−1.4, 0.00	24.3	−0.7	−1.4, −0.03
Model 3: joint food and nutrition security status[1]						
Food secure, nutrition secure	40.7	Reference		25.3	Reference	
Food insecure, nutrition secure	39.5	−1.2	−2.1, −0.32	24.7	−0.69	−1.7, 0.28
Food secure, nutrition insecure	40.5	−0.24	−1.8, 1.3	24.9	−0.45	−3.9, 3.0
Food insecure, nutrition insecure	39.5	−1.3	−2.1, −0.47	24.3	−1.1	−1.9, −0.24

Abbreviations: CI, confidence interval; SNAP, Supplemental Nutrition Assistance Program.
[1] Multivariate regression models adjusted for age, sex, race and ethnicity, employment status, educational attainment, household size, income, marital status, and region.

choices for more than just those who screen nutrition insecure. Alternative measures of nutrition security have been proposed, including Tuft's 2-item Nutrition Security Screener and using food security status combined with self-rated diet [32,33]. The relationship between these measures and diet quality should be explored.

Although a recent confirmatory analysis revealed that the HNS did not exhibit differential item functioning across populations, modifications may be needed to better align the measure with the nutrition security definition, conceptual frameworks, and objective measures of diet quality [34]. The lack of association between the HNS and diet quality could be due to inconsistent definitions of a healthy diet among participants. One strategy to address this could be to define "foods that were not good for my health and well-being" and "healthful food" in the HNS to provide all participants with a shared definition based on the Dietary Guidelines for Americans [20]. This may reduce unwanted heterogeneity in participants' responses due to individuals' beliefs or knowledge about healthy eating and strengthen the measure's ability to predict diet quality. Although nutritions ecurity includes more than

diet quality, a useful measure should be associated with objective diet quality to accurately identify individuals whose dietary patterns place them at an increased risk of diet-related conditions and are in need of resources and support.

Strengths of this study include using 2 different adult populations to test a conceptual framework of nutrition security. The SNAP participant sample was nationally representative, and the United States adult sample used quotas for race, ethnicity, income, and region to be representative of the national population, supporting its generalizability to the general population and lower-income populations at increased risk of food insecurity. There are several other limitations of this analysis. First, we relied on self-report data for SNAP participation, household income, and other covariates. Second, there was a small proportion of both populations with FS/NI. Although this has been found in several different populations, this may have reduced our power to see significant differences in diet quality and biased the results toward the null [19,20,35]. Third, the recall periods differed across measures and samples. In the United States adult sample, food security and diet quality were assessed over the past 30 d, whereas nutritions ecurity was assessed over the past 12 mo. In the SNAP sample, both food and nutrition security were assessed over the past 12 mo, whereas diet quality was assessed over the past 30 d. This may have reduced alignment between when the food and nutrition insecurity were experienced and when dietary intake was measured. Fourth, the PDQS and rPDQS are dietary screeners intended to rank individuals based on consumption of foods found to be protective or increase the risk of diet-related chronic disease. These measures are not intended to capture the full dietary intake of individuals, and are not able to detect differences in total energy intake, macronutrient, or micronutrient consumption. There may have been misclassification of true dietary intake using these measures. Future research is needed with multiple 24-h recalls or a more comprehensive food frequency questionnaire with aligned recall periods for food and nutrition security to better understand the impact of nutrition insecurity on diet quality.

This study found that the HNS is only moderately correlated with food insecurity and that food insecurity is more strongly associated with poor diet quality than nutrition insecurity. These findings underscore the need for caution before expanding the use of the HNS, as its performance does not align with the Seligman nutrition security conceptual model or objective diet quality measures. Given the prevalence of poor diet quality in the United States, a nutrition security measure could provide valuable insights into the effectiveness of various nutrition programs and help monitor the nutrition status of populations. For this measure to be useful, it should predict objective diet quality more strongly.

Author contributions

The authors' responsibilities were as follows – ES, ACT, MNL, JAW, CWL: designed research; ACT, AU, CMW, JAW, CWL: conducted research; ES: analyzed data and had primary responsibility for the final content; and all authors: wrote the paper, read and approved the final manuscript.

Conflict of interest

All authors report no conflicts of interest.

Funding

This research was supported by the National Institute on Nursing (R01NR021098, PI: Leung) and the National Institute of Diabetes and Digestive and Kidney Diseases (K01DK119166, PI: Wolfson). ACT was supported by Grant Number T32 HL007024 from the National Heart, Lung, and Blood Institute, National Institutes of Health, and by Grant Number T32DK062707 from the National Institute of Diabetes and Digestive and Kidney Diseases. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The funders had no involvement in the collection, analysis, and interpretation of data.

Data availability

Data described in the manuscript, code book, and analytic code will be made available upon request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ajcnut.2025.101141.

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