Household Food Insecurity Is Associated with Adult Health Status[1–3]

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ABSTRACT The prevalence of household food security, which reflects adequacy and stability of the food supply, has been measured periodically in the United States and occasionally in high-risk groups or specific regions. Despite a plausible biological mechanism to suggest negative health outcomes of food insecurity, this relation has not been adequately evaluated. This study was conducted in the Lower Mississippi Delta region to examine the association between household food insecurity and self-reported health status in adults. A two-stage stratified cluster sample representative of the population in 36 counties in the Delta region of Arkansas, Louisiana, and Mississippi was selected using list-assisted random digit dialing telephone methodology. After households were selected and screened, a randomly selected adult was interviewed within each sampled household. Data were collected to measure food security status and self-reported mental, physical, and general health status, using the U.S. Food Security Survey Module and the Short Form 12-item Health Survey (SF-12). Data were reported on a sample of 1488 households. Adults in food-insecure households were significantly more likely to rate their health as poor/fair and scored significantly lower on the physical and mental health scales of the SF-12. In regression models controlling for income, gender, and ethnicity, the interaction between food insecurity status and race was a significant predictor of fair/poor health and lower scores on physical and mental health. Household food insecurity is associated with poorer self-reported health status of adults in this rural, high-risk sample in the Lower Mississippi Delta. J. Nutr. 134: 2330–2335, 2004.

KEY WORDS: • *community nutrition* • *food insecurity* • *health status*

Household food insecurity has been defined by national experts as "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways" (1–3). The most recent national U.S. Household Food Security Survey documented that 11.1% of U.S. households were food insecure in 2002, with food insecurity rates of >35% for households with family incomes below the federal poverty level (4). Food insecurity, as measured by the U.S. Food Security Scale, has been increasingly used in research as a measure of the adequacy and stability of a household's food supply. On an individual level, potential biological and stress mechanisms have been proposed to explain a relation among food insecurity, poor nutrition, and poor physical health and poor mental health. On a household level, presence of food insecurity suggests a high degree of vulnerability to a broad spectrum of consequences including poor health status (5).

Collectively, previous studies report an association of food insecurity or food insufficiency with decreased dietary intake in adults (6–9), psychosocial dysfunction in children (10), increased body weight in women (11), hypoglycemia in diabetics (12), compromised health status in the elderly (13), and sociofamilial problems (14). Most recently, Siefert et al. (15) analyzed the relationship between food insufficiency measured by a scale derived from National Health and Nutrition Examination Survey III (16) and self-reported physical and mental health status measured by the Short Form 36-item Health Survey (SF-36)[5] (17). Among a random sample of 724 single

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[5] Abbreviations used: FOODS 2000, Foods of Our Delta Study 2000; LMD, Lower Mississippi Delta; NIRI, Nutrition Intervention Research Initiative; SF-12, Short Form 12-item Health Survey; SF-36, Short Form 36-item Health Survey.

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female welfare recipients in northern Michigan, food insufficiency was significantly associated with poor or fair self-reported health and physical limitations. To our knowledge, no study has examined the relation between food insecurity as measured by the U.S. Food Security Survey Module (18) and self-reported physical and mental health status in a population-based, representative sample.

The Lower Mississippi Delta (LMD) region of Arkansas, Louisiana, and Mississippi has high prevalence rates of poverty and low education (19). In addition, data from a recent survey in a sample representative of 36 LMD counties and parishes estimated the prevalence of food insecurity to be twice that of the United States (20). Factors such as low family income, limited access to quality grocery stores (21), and higher food prices in rural areas (22) likely contribute to food insecurity. Moreover, a review of existing data suggested higher rates of nutrition-related chronic diseases in the LMD than in the United States (23,24). This was later documented by findings from the first health survey in the Lower Delta that reported high self-reported rates for high cholesterol, diabetes, obesity, and hypertension (25). Increased risk of families who live in poverty to physical and mental health, limited access to medical care in rural areas, and the high prevalence of poor health and food insecurity imply food insecurity and health could be closely interrelated. Therefore, using a representative sample of adults who live in the LMD regions of Louisiana, Arkansas, and Mississippi, this report examines the association between household food insecurity measured by the U.S. Food Security Survey Module and self-reported physical and mental health measured by the Short Form 12-item Health Survey (SF-12). The extent to which these associations persist after adjusting for important demographic variables is also determined.

METHODS

Study population. Foods of Our Delta (FOODS 2000) is one part of the comprehensive research plan of the Lower Mississippi Delta Nutrition Intervention Research Initiative (Delta NIRI) (24) to assess the nutrition and health status of a representative sample of the Lower Mississippi Delta. FOODS 2000 was a cross-sectional telephone survey of a representative sample of the population 3 y of age and older in 36 Delta NIRI counties and was conducted between January and June 2000. A two-stage stratified cluster sampling plan was used to assign the 36 Delta NIRI counties to 9 strata according to population size, percentage of population who are black, and percentage living below the federal poverty level. Eighteen counties (2 counties from each stratum) were selected with probability proportional to size to represent that stratum in the telephone sample. List-assisted random digit dialing methodology (26) was used to select a random sample of telephone numbers from the eligible blocks of numbers in these counties. Of the 3455 eligible households, 1293 or 37.4% refused to participate. A total of 1751 adults completed the first follow-up interview (health survey data), and 1662 completed the next interview (food security survey); 1488 participants had complete data for study variables needed to compute food security and health status scores.

Verbal consent to participate in the study was obtained from all participants at their initial interview contact. Approval was obtained from the Institutional Review Board of each participating institution.

Data collection. A computer-assisted telephone interview was conducted to determine the eligibility of the household. Characteristics of an eligible household included the following: at least 1 member 18 y of age or older; the telephone number was not for business use only; and the household was located in 1 of the 18 Delta NIRI sample counties. During this initial interview, information on age, sex, ethnicity, and the presence of children in the household was determined. All members of the household were enumerated and 1 adult per household was selected randomly using Kish's tables (27). A second nonscheduled telephone call was made to collect information using a 2-part questionnaire, which included a dietary intake interview, and a series of trailer questions about usual intake, water consumption, height, weight, the presence of selected chronic health conditions, and general self-reported health using the SF-12 (28) for adults. Approximately 1 to 2 weeks later, the adult in the household who had completed the dietary interview was interviewed again with questions including the food security status of the household (18).

Assessment of food security. In this survey, food security status was evaluated using the 18-question U.S. Food Security Survey Module (18,29). The responses to the 18-item food security survey module were used to construct the 12-mo food security scale and to classify households into 3 categories of food security status according to the U.S. food security scale: (18):

- food secure: households that show no or minimal evidence of food insecurity;
- food insecure without hunger: food insecurity is evident in the household concerns and in adjustments to household food management, including reduced quality of diets. Little or no reduction in household members' food intake was reported;
- food insecure with hunger: the food intake for adults and children in the household has been reduced to the extent that they have repeatedly experienced the physical sensations of hunger.

For the present analysis, food security status was collapsed to a dichotomous variable (food secure and food insecure) because the 3-level variable when cross-tabulated with levels of other variables resulted in few responses in some cells.

General health status. Overall physical and mental health status was evaluated using the SF-12 (28), a briefer instrument with 12 items based on the SF-36 (30). Ware et al. (31) demonstrated that the SF-12 summary scales were highly correlated with SF-36 scales. Two summary scores of the SF-12 were created as complementary descriptions of overall health: physical component summary and mental component summary. Scales were coded, summed, and linearly transformed to form a range from 0 (worse health) to 100 (best health possible); creation of scores and coding was completed according to the standardization recommended by the developers of the instrument (28).

Categorization of variables. The following outcome variables and covariates used in the analysis were categorized. Self-reported general health was converted into 3 categories (very good to excellent; good; and fair to poor), and for logistic regression analysis health was categorized into 2 levels, good to excellent and fair to poor. Food security status was reported by 2 categories, food secure or food insecure. Total household income for the previous 12 mo was self-reported in increments of $5000 or $10,000 ranging from less than $5000 to $50,000 or more. From these increments, a continuous variable for income was formed from the midpoints of income category (from $2500 to $60,000). Age was categorized into 3 categories: 18 to 44, 45 to 64, and 65 y and older. Ethnic groups were whites and blacks of non-Hispanic origin.

Analysis. A household base weight equal to the inverse of the probability of selection to each sampled telephone number was used. Data were adjusted to compensate for telephone numbers with unknown residential status or eligibility, the number of residential telephone numbers in the household, and nonresponse to the screener interview. To account for nonresponse in the second interview, the weight of the nonparticipants was distributed to the participants within adjustment cells defined by age, race, and sex. Finally, estimates were calibrated to Census Bureau (1990) (32) estimates of the total households by state. Standard error adjustment factors were generated using WesVar (33) to account for the clustering effect within counties. The standard errors of the estimates generated by WesVar were then applied to the standard error adjustment factor calculated for each question.

The statistical association between food security status and health was conducted using Cochran-Mantel-Haentzel χ^2 analyses. Logistic regression analyses were conducted with health status as the dependent variable (2 categories, good to excellent versus fair to poor) and control variables were age, income, sex, and interaction between race and food security status. A categorical variable for the 4 combinations of race and food security was used rather than indicator variables for race and food security to take account of the interaction. A quadratic term for income and number of people supported by income were

TABLE 1

Demographic characteristics of free-living adults in Lower Mississippi Delta[1]

Characteristic	*n* (%)[2]
Sex	
Male	547 (46.0)
Female	941 (54.0)
Race	
Black	743 (55.1)
White	745 (44.9)
Household income	
<$14,999	477 (27.9)
$15,000–$29,999	408 (27.1)
>$30,000	603 (45.0)
Age, *y*	
18–44	721 (53.3)
45–64	480 (33.3)
65+	287 (15.4)
General health status	
Excellent or very good	646 (45.2)
Good	513 (34.6)
Fair or poor	329 (20.2)
Scores[3]	
Mean score, physical SF-12	48.0 ± 0.5
Mean score, mental SF-12	50.0 ± 0.5
Total	1488

[1] Estimates are from Foods of Our Delta Survey, 2000 (20). All variables are self-reported.
[2] Weighted percentages.
[3] Values are means ± SEM, $n = 1488$.

considered, but terms were not significant. Linear regression analyses were conducted with physical score or mental score as the dependent variable and the same independent variables used for logistic regression. SUDAAN V8.0 (34) was utilized to compute appropriate statistical tests accounting for survey design.

RESULTS

The present analysis of the FOODS 2000 sample is composed of 1488 households. More than a fifth of the households were food insecure (20.3%), 27.9% had income < $14,999, and 20.2% reported poor health status (**Table 1**). Over half of the sample was female, black, and between the ages of 18 and 44 y. The final sample reflected the demographic characteristics of the target population.

Results of the association between self-reported health status and household food security status are presented in **Table 2**. Compared with adults in food-secure households, a greater proportion of the adults in food-insecure households reported their health status as fair/poor ($P < 0.0001$). Adults in food-insecure households also had lower SF-12 scores for physical and mental scales than their secure counterparts ($P < 0.0001$), indicating poorer physical or mental health, respectively.

The effect of food security status and other variables on SF-12 physical scores is shown by the regression coefficients, which are adjusted for all variables (**Table 3**). First, younger persons tended to have higher SF-12 physical scores ($P < 0.0001$). Income level had a moderate but significant effect on the SF-12 physical scores; as income increased by $10,000 SF-12 physical score increased only by 0.85 points. The effect of food security status on SF-12 physical scores was dependent on race. The adjusted least-square means ± SEM for these groups were as follows: secure and black 49.7 ± 0.5, secure and white 49.6 ± 0.4, insecure and black 48.0 ± 0.8, and insecure and white 43.7 ± 1.4.

The effect of food security status and other variables on SF-12 mental scores is shown by the regression coefficients, which are adjusted for all variables(**Table 4**). First, younger persons tended to have higher SF-12 mental scores ($P = 0.329$). Income level had a moderate but significant effect on the SF-12 mental scores; as income increased by $10,000 SF-12 mental score increased only 0.55 points. The effect of food security status on SF-12 mental scores was dependent on race. The adjusted least-square means ± SEM for these groups were as follows: secure and black 52.3 ± 0.4, secure and white 53.6 ± 0.3, insecure and black 47.6 ± 1.0, and insecure and white 47.0 ± 1.4.

The associations of food security status and other variables to general health status are displayed in **Table 5**. After adjustment for age, sex, income, food security, and race, the likelihood of having good health was higher in younger persons than in older persons ($P < 0.001$). Income level had a moderate but significant effect on good health; as income increased by $10,000, the likelihood of good health increased moderately. The association of food security to general health status was dependent on race. The likelihood of good health for secure status (white or black) was higher than that for people with insecure status and black, whereas for people with insecure status and white the likelihood of good health was lower than for people with insecure status and black.

TABLE 2

Self-reported health for adults by household food security status

Measure	Food secure ($n = 1163$)		Food insecure ($n = 325$)		*P* value
General health status[1]					
Excellent/very good, %	49.3 ± 1.7	561	29.3 ± 3.0	85	0.0001[a]
Good, %	34.8 ± 1.8	402	33.9 ± 2.9	111	
Fair/poor, %	16.0 ± 1.2	200	36.8 ± 2.9	129	
Mean summary score[2]	Food secure ($n = 1124$)[3]		Food insecure ($n = 312$)[3]		
Physical	50.0 ± 0.3		45.7 ± 0.8		0.0001[b]
Mental	53.4 ± 0.2		46.5 ± 0.8		0.0001[b]

[1] Values are means ± SEM. [a] Probability that the distribution in levels of health status differed by food security status. [b] Probability of difference in scores between food security status.
[2] Measured by SF-12 (31).
[3] $n = 1436$ (data for some subjects are missing some SF-12 component values).

TABLE 3

Food security and other factors influencing SF-12 physical score in adults (multivariate regression)[1]

Variable	Levels	Regression coefficient	*P* value
Intercept		41.06	<0.0001
Age,[2] *y*	18 to 44	6.33	<0.0001
	45 to 64	1.86	0.0929
Sex[3]	Male	0.64	0.1618
Income[4]	Continuous	0.085	<0.0001
Food security × race[5]	Secure, white	1.64	0.0951
	Insecure, white	−4.24	0.0012
	Secure, black	1.77	0.0467

[1] $R^2 = 0.14$, $P < 0.0001$.
[2] Reference category for age: >65 y.
[3] Reference category for sex: female.
[4] Income unit: $1000.
[5] Reference category for food security × race: insecure, black. $P < 0.0008$ for food security × race interaction term.

DISCUSSION

Despite plausible biological mechanisms to suggest negative health outcomes of food insecurity, this relation has not been adequately evaluated in a representative probability sample using the U.S. Food Security Survey Module and self-reported health status. This study is one of the first to examine this relationship using standardized sampling techniques. In a random representative population sample of adults of the 36 counties of the Delta region of Arkansas, Louisiana, and Mississippi, food insecurity was associated with poorer self-rated general health status and lower scores on physical and mental health scales. Two previous reports (35,36) utilized the full U.S. Household Food Security Survey Module and reported association with lower self-reported health status but in smaller, convenient, nonrepresentative samples. In the first report, Tarasuk (35) found that food-insecure women had long-standing health problems and activity limitations. In the second report, based on a health survey of respondents in a clinical or nonclinical setting in Appalachia, Pheley et al. (36) found that food-insecure respondents had poorer functional status on all SF-36 scales compared to food-secure respondents. Although another report (5) demonstrated an association between food insufficiency and health in a large national survey using a complex survey design, the U.S. Food Security Survey Module was not used.

In the present study, the effect of food security on physical scores and mental scores is notable. Although these effect sizes are considered "small," they are nonetheless clinically meaningful and consistent with health status reported by individuals experiencing prostatitis (37), myocardial infarction (38), and dyspepsia (39).

Our findings are also confirmed by 3 earlier studies where food sufficiency status and general health status were measured. First, in a random sample of 724 single women, who were welfare recipients in northern Michigan, Siefert et al. (15) analyzed the relationship between physical and mental health measured by the SF-36 and food insufficiency (16). Food insufficiency was significantly associated with poor or fair self-reported health and physical limitations and other measures of mental functioning, depression, and mental disorders. In the subsample from the Women's Health and Aging Study, Klesges et al. (40) evaluated the relationship between food insufficiency (measured by the 1-variable food sufficiency question) and 3 classes of health status, measured by the Patrick scale (41). Women reporting difficulty getting food were more depressed and had a poorer quality of life and physical performance. In a comprehensive health survey of 80,000 Canadians (5), measures of food insufficiency (16) were significantly associated with a range of health conditions: poor health, poor functional health, restricted activity and health conditions, major depression, and poor social support. Importantly, measures of food insufficiency in these 3 studies estimate only the quantity dimension of food insecurity. The U.S. Food Security Scale, as used in our study, also measures the quality, uncertainty, or psychological components of food insecurity and therefore offers more precision for examining these relationships to health and related outcomes (35).

In the present study for all outcome measures, the food-secure individuals scored better than those who were insecure. Furthermore, within the food-insecure group, physical scores and general health were reported to be higher in the blacks than in the whites. Several explanations may account for the

TABLE 4

Food security and other factors influencing SF-12 mental score in adults (multivariate regression)[1]

Variable	Level	Regression coefficient	*P* value
Intercept		45.99	<0.0001
Age,[2] *y*	18 to 44	−1.03	0.15
	45 to 64	−1.33	0.095
Sex[3]	Male	1.98	0.0004
Income[4]	Continuous	0.055	0.0003
Food security × race[5]	Secure, white	6.00	<0.0001
	Insecure, white	−0.68	0.69
	Secure, black	4.68	<0.0001

[1] $R^2 = 0.12$, $P < 0.0001$.
[2] Reference category for age: >65 y.
[3] Reference category for sex: female.
[4] Income unit: $1000.
[5] Reference category for food security × race: insecure, black. $P < 0.0001$ for food security × race interaction term.

TABLE 5

Adjusted odds ratio for excellent/good health status among adults by food security status and other characteristics[1]

Variable	Level	OR (CI)
Intercept	Intercept	0.78 (0.48, 1.27)
Age,[2] *y*	18 to 44	3.24 (1.65, 6.37)
	45 to 64	1.21 (0.77, 1.90)
	65+	1
Income[4]	Continuous	1.025 (1.015, 1.036)
Sex[3]	Male	0.97 (0.73, 1.28)
	Female	1
Food security × race[5]	Secure, white	2.08 (1.17, 3.68)
	Secure, black	1.39 (0.66, 2.92)
	Insecure, white	0.45 (0.23, 0.87)
	Insecure, black	1

[1] OR and 95% CI, adjusted for age, income, sex, food security status, and race.
[2] Reference category for age: >65 y.
[3] Reference category for sex: female.
[4] Income unit: $1000.
[5] $P < 0.0001$ for food security × race interaction term.

different effets of food security status on health by race. First, some research suggests that minority and rural populations may view chronic illness as a condition to be accepted rather than as amenable to intervention (42). An alternative explanation for the ethnic differences in responses to study questions on nutrition and health problems is a methodological one. Previous studies have found systematic differences in the way members of varying racial/ethnic groups respond to questionnaires and scales. Race/ethnicity was found to be associated with response patterns on Likert response scales, with African Americans more likely to have acquiescent response styles (43–45). In the present study, African Americans may have had health-enhancing resources, social support, and religious involvement that improved their outcome (46). Finally, in the study reported by Siefert et al. (15) on the effect of food insufficiency and on physical and mental health in low-income women, African-American women were found less likely to report poor physical health than Caucasian women. Further research is needed to ascertain whether these differences persist in other studies in other regions.

Although the development of instruments to measure and estimate the prevalence of food security began in the 1980s, a critical gap in its understanding still remains, and our study addressed that gap. Initially, efforts were begun to define the meaning of food insecurity (1,16,47), to develop survey instruments (48–50), and to measure the extent of the problem in the United States (4,51,52) in states (3,11), regions (53), and selected high-risk groups. Limited studies allude to the outcomes of food insecurity (12,54,55), including the behavior and emotional problems in children (10). In an initial conceptual model of food security, Campbell (54) proposed that food security performs both as an outcome variable (from economic inadequacy) and as a determinant variable (for other conditions such as poorer health), but few studies fully investigated these interrelationships. As explained by Dwyer and Cook (56), the future direction for food insecurity research must go beyond monitoring to link it with biological/medical and related outcomes including physical and mental health status. The objective of the present study meets this requirement.

While we are not able to establish a causal relationship between food insecurity and poor health, there are a number of plausible biological mechanisms whereby food insecurity and poor nutrition lead to poor health. Malnutrition exacerbates disease, increases disability, decreases resistance to infection, and extends hospital stays. Other reports suggest that stress and anxiety (which may accompany food insecurity) induce high blood pressure and produce hormonal imbalances, and these together with additional factors can stimulate weight gain, obesity, and insulin insensitivity (57). The explicit reverse causation hypothesis is that poor health (especially disability) increases food insecurity. However, since income was well controlled, the association between food insecurity and poor health argues, to some extent at least, against the reverse causal path. Of course, poor health can also increase household expenses, so the reverse causation cannot be entirely ruled out.

In low-income and rural areas, such as the Mississippi Delta, a number of additional obstacles to health care and health care access could also contribute to poor health status (58). Rural Americans face a unique combination of factors that create disparities in health care not found in urban areas: economic factors, cultural and social differences, and educational shortcomings. About half as many physicians are in rural areas as urban areas to serve a given population base, and rural residents are less likely to have employer-provided health care coverage or prescription drug coverage. Collectively, these and other economic factors contribute to poorer health status.

This study was limited by several factors. First, both predictor and outcome variables were based on self-reported conditions. On the other hand, both instruments have high validity and reliability measures. Second, the cross-sectional design makes it impossible to establish causality. For example, we cannot say exactly how physical and mental health scores change and whether physical and mental health status limits the ability to earn a productive income that sustains food security and overt hunger. Recently, Vozoris and Tarasuk (5) reported striking findings from a comprehensive health survey on the association of food insufficiency across a broad spectrum of physical, mental, and social health indicators. Because of the rigorous statistical design in selecting a representative sample across Canada, the findings from this Canadian study demonstrate that the interrelationship of food insufficiency with health is unlikely condition-specific. Longitudinal data are needed to ascertain the directionality of the associations.

In conclusion, an association between food insecurity and adults' poor health and mental status, regardless of the causal direction, demonstrates the harmful risks that poor Americans face. In this representative sample of adults who live in the Delta region of Arkansas, Louisiana, and Mississippi, taking into account possible associations with age, gender, ethnic group, and income category, food insecurity is associated with lower self-reported general health status and lower physical and mental summary scores on the SF-12. These findings demonstrate the need to continue efforts to prevent food insecurity and to ensure that efforts that all are adequately fed become a priority to improve the health of this region and nation.

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