Food Insecurity and Cost-Related Medication Underuse Among Nonelderly Adults in a Nationally Representative Sample

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Food insecurity refers to "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways."[1(p6)] Food insecurity is associated with poor health status and risk factors such as obesity, metabolic conditions, and chronic diseases, potentially attributable to intake of poor-quality diets, which increase the risk for obesity and cardiometabolic diseases.[2–5] Studies of diabetic patients living in food-insecure households have shown poor outcomes such as poor glycemic control and increased physician use.[6,7] Moreover, there is evidence that people living in food-insecure households are more likely to have poor mental health outcomes,[8,9] use alcohol,[10] and smoke cigarettes[11]—factors also associated with poor health status.

Recent research suggests that people living in food-insecure households may adjust their behaviors in ways that are potentially detrimental to their health. Ivers and Cullen suggest that the vulnerability of food insecurity puts individuals at risk for engaging in coping strategies (e.g., withdrawal of children from school, theft, and risky sexual behaviors), particularly among women who tend to be children's primary caregivers.[12] One set of behaviors that has received relatively little attention as a potential coping mechanism for food insecurity until recently is reducing, skipping, delaying, or using lower-cost medications to compensate for lack of household resources to purchase food. These behaviors have been described as cost-related medication underuse.[13,14]

Studies have demonstrated the relationship between cost-related medication underuse and poor health outcomes,[15–19] but, to our knowledge, only 1 study has examined the relationship between food insecurity and cost-related medication underuse in the United States in a nationally representative sample.[13] This

Objectives. We investigated whether nonelderly US adults (aged 18–64 years) in food-insecure households are more likely to report cost-related medication underuse than the food-secure, and whether the relationship between food insecurity and cost-related medication underuse differs by gender, chronic disease, and health insurance status.

Methods. We analyzed data from the 2011 and 2012 National Health Interview Survey (n = 67 539). We examined the relationship between food insecurity and cost-related medication underuse with the χ^2 test and multivariate logistic regression with interaction terms.

Results. Bivariate and multivariate analyses showed a dose–response relationship between food insecurity and cost-related medication underuse, with an increasing likelihood of cost-related medication underuse with increasing severity of food insecurity ($P < .001$). This association was conditional on health insurance status, but not substantially different by gender or chronic disease status. Being female, low-income, having no or partial health insurance, chronic conditions, functional limitations, or severe mental illness were positively associated with cost-related medication underuse.

Conclusions. Using food insecurity as a risk factor to assess cost-related medication underuse could help increase identification of individuals who may need assistance purchasing medications and improve health for those in food-insecure households. (*Am J Public Health.* 2015;105:e48–e59. doi:10.2105/AJPH.2015.302712)

study, which was restricted to individuals with chronic diseases, found that those living in food-insecure households were more likely to report cost-related medication underuse. Similar findings have been demonstrated from smaller studies in different parts of the country among people with diabetes, people with HIV/AIDS, and patients presenting at emergency departments.[20–24]

We extend the literature on behaviors individuals living in food-insecure households may adopt to save money for food by examining the relationships between food insecurity and cost-related medication underuse in a nationally representative sample of nonelderly adults living in the United States. The objective of this analysis was to determine whether nonelderly adults (aged 18–64 years) living in food-insecure households in the United States are more likely to report cost-related

medication underuse. We also examined whether the relationship between food insecurity and cost-related medication underuse differs by gender, chronic disease status, and health insurance status.

METHODS

We analyzed data from a combined sample of the 2011 and 2012 National Health Interview Survey (NHIS), a nationally representative, annual, cross-sectional survey that provides data on the health of the noninstitutionalized, civilian population in the United States. The NHIS has a high total household response rate—82% in 2011 and 78% in 2012. The NHIS methodology is described in detail elsewhere.[25–28] All variables come from the publicly available NHIS data.

The total sample was 33 014 for 2011 and 34 525 for 2012, producing a combined sample of 67 539. Because of the important relationship between food insecurity and income, we worked only with observations with complete income data, a total of 57 547; income data were missing for about 15% of the sample. Missing values on other key variables reduced the analytic sample to 54 975—81% of the full sample. Of the 54 975 adults, 44 574 (81%) were aged 18 to 64 years and 10 401 (19%) were aged 65 years and older. Initial analyses showed that the association between food insecurity and our outcomes differed significantly for those younger than 65 years and those aged 65 years and older. This finding is consistent with previous research on disabilities and food insecurity that found that disabilities were more strongly associated with food insecurity for working-age adults (aged 18−64 years) than for elderly adults (≥ 65 years).[29] Therefore, we conducted separate analyses for these 2 age groups. The analysis presented here is restricted to adults aged 18 to 64 years (n = 44 574). We used Stata version 12 (StataCorp LP, College Station, TX) for data analysis.

Description of Variables

The focal relationship for this analysis was that between food insecurity and cost-related medication underuse.

Outcome variables. We considered a person to have cost-related medication underuse if they responded "yes" to any of 5 items that asked if, in the past 12 months they

1. skipped medication doses to save money,
2. took less medication than prescribed to save money,
3. delayed filling a prescription to save money,
4. could not afford prescription medicine because of cost, or
5. asked a doctor for lower-cost medication to save money.

These are validated items adapted from the Medical Expenditure Panel Survey.[30] Previous studies on cost-related medication underuse used only the first 3 or 4 items,[13,14] but we included the fifth item because it was correlated with the other items in the group. It also captures a potentially positive coping behavior without negative health implications

if a cheaper alternative is available. We examined these variables individually and as a group (i.e., whether the respondent responded "yes" to any of the 5 questions).

Focal independent variable. We measured food security as a 4-category variable obtained from the 10-item, US Adult Food Security Survey Module, examining the household food situation in the past 30 days. We scored responses based on guidelines from the US Department of Agriculture to create a raw food-security score. We then used this to categorize respondents into 4 groups: high food security, marginal food security, low food security, and very low food security. Low and very low food security are often combined to represent food insecurity. We used all categories because there were important differences among them. More information about standard procedures for measuring food insecurity in the United States can be found in Bickel et al.[1] and Coleman-Jensen et al.[31]

Control variables. On the basis of previous literature, we controlled for several factors that are potentially associated with food insecurity and cost-related medication underuse to rule out spuriousness and alternative explanations.[32] The demographic variables we controlled for included age, gender, marital status, family type, race/ethnicity, and citizenship. We also controlled for family socioeconomic status: family income (examined here in terms of the income-to-poverty ratio, a ratio of reported family income to the federal poverty threshold); education (family member with the highest education); proportion of household adults working full time, part time, looking for work, and not in the labor force; and home tenure status. We controlled for access to health care, including individual health insurance coverage, coded as "no coverage (no health insurance for any period in the past 12 months)," "partial coverage (health insurance for some months but not all in the past 12 months)," and "full coverage (health insurance in all months in the past 12 months)." In addition, we controlled for physical and mental health status and health behaviors: whether the individual had a diagnosed chronic condition (including hypertension, cardiovascular disease, diabetes, asthma, or arthritis), a functional limitation, or a severe mental illness (measured with the Kessler nonspecific distress scale).[33] We

captured lifestyle behaviors by body mass index (defined as weight in kilograms divided by the square of height in meters), smoking, and alcohol use. We also controlled for family health status by using the proportion of adult family members reporting needing help with activities of daily living, with health-related work limitations and being limited in any way, and with self-rated health status of excellent, very good, fair, and poor.

Statistical Analysis

We calculated univariate statistics and then examined bivariate associations between food insecurity and dependent variables with the χ^2 test. We examined the relationship between food insecurity and the dependent variables net of the control variables by using multivariate logistic regression, including interaction terms between food insecurity and gender, chronic disease, and health insurance status to examine for the presence of conditional effects.

We divided the sample weight provided by 2 to obtain individual-level weights for the pooled data (2011 and 2012) as described in the NHIS documentation.[25] We then applied these weights in all analyses to account for the complex sample design.

RESULTS

Twenty-six percent of respondents reported engaging in at least 1 cost-related medication underuse behavior in the preceding 12 months (Table 1). About half of these (13%) engaged in only 1 behavior with the other half engaging in 2 or more. The most frequently reported behavior was asking a doctor for lower-cost medication to save money (20%), and the least frequent behavior was skipping medication doses to save money (8%). Nine percent reported taking less medicine to save money; delaying filling a prescription and not being able to afford prescription medicine were each reported by 11%. Fifteen percent of respondents were in food-insecure households with 8% having low food security and 7% very low food security. Nine percent had marginal food security.

Bivariate Results

The results showed a dose–response relationship between food insecurity and cost-related

TABLE 1—Weighted Distribution of Key Study Variables Among US Adults Aged 18–64 Years (n = 44 574): National Health Interview Survey, 2011 and 2012

Variables	No.	Proportion (95% CI)
Dependent variables		
Cost-related medication underuse measures		
Skipped medication	3 814	0.083 (0.080, 0.086)
Took less medication	4 031	0.087 (0.084, 0.091)
Delayed filling prescription	4 962	0.108 (0.105, 0.112)
Lower-cost medication	8 753	0.202 (0.197, 0.207)
Could not afford medication	4 990	0.107 (0.104, 0.111)
At least 1 of the 5 above	11 625	0.262 (0.257, 0.267)
Key independent variable		
Food security		
High	32 980	0.760 (0.754, 0.766)
Marginal	4 302	0.090 (0.087, 0.093)
Low	3 901	0.079 (0.076, 0.082)
Very low	3 391	0.072 (0.068, 0.075)
Control variables		
Female	23 964	0.519 (0.514, 0.525)
Age, y		
18–24	5 679	0.136 (0.128, 0.145)
25–44	20 271	0.442 (0.435, 0.449)
45–64	18 624	0.422 (0.415, 0.429)
Marital status		
Separated	1 815	0.037 (0.035, 0.039)
Divorced	7 106	0.158 (0.154, 0.162)
Married	19 513	0.440 (0.432, 0.449)
Single or never married	14 986	0.340 (0.331, 0.348)
Widowed	1 154	0.025 (0.023, 0.027)
Family type		
1 adult, no children	13 466	0.313 (0.303, 0.323)
Multiple adults, no children	13 329	0.312 (0.306, 0.319)
1 adult, ≥ 1 children	3 749	0.075 (0.071, 0.078)
Multiple adults, ≥ 1 children	14 030	0.300 (0.293, 0.307)
Race/ethnicity		
Hispanic	8 687	0.139 (0.133, 0.144)
Non-Hispanic White	25 518	0.674 (0.666, 0.683)
Non-Hispanic Black	6 981	0.131 (0.125, 0.136)
Non-Hispanic Asian	2 916	0.047 (0.045, 0.050)
Non-Hispanic other	472	0.009 (0.007, 0.010)
US citizenship		
US citizen	39 504	0.917 (0.913, 0.921)
Non-US citizen	5 070	0.083 (0.079, 0.087)
Income-to-poverty ratio		
< 1.00	9 290	0.188 (0.180, 0.196)
1.00–1.99	8 748	0.181 (0.176, 0.185)
2.00–2.99	6 780	0.151 (0.147, 0.155)
3.00–3.99	5 442	0.127 (0.123, 0.131)
≥ 4.00	14 314	0.354 (0.345, 0.363)

Continued

medication underuse (Table 2), with an increasing likelihood of engaging in all the behaviors with increasing severity of food insecurity. For example, among the food secure, fewer than 5% reported skipping medication to save money, compared with 11% among those with marginal food security, 19% among those with low food security, and 30% among those with very low food security. A higher prevalence of cost-related medication underuse was found among those who were female; aged 45 to 64 years; separated, widowed, or divorced; single parents with children; with no health insurance coverage; with a diagnosed chronic condition; with a functional limitation; with a severe mental condition; obese persons; or current smokers.

Non-Hispanic Asians and non-US citizens were less likely to report cost-related medication underuse than were other racial/ethnic groups and US citizens, respectively, but the differences were small. The prevalence of cost-related medication underuse decreased with increasing income and education.

Multivariate Results

Most of the relationships identified in bivariate analyses persisted in the multivariate analyses.

Net of other factors, food insecurity was still positively associated with cost-related medication underuse (Table 3). Compared with those with high food security, those with very low food security had about 4 times higher odds of cost-related medication underuse. The dose–response relationship between food security and cost-related medication underuse behaviors was also present net of other factors. For example, compared with those with high food security, the odds of skipping medications to save money was 1.7 times for those with marginal food security, 2.5 times for low food security, and 3.7 times for very low food security. Compared with high food security, those with very low food security had about 3 times higher odds of engaging in at least 1 of the behaviors (odds ratio [OR] = 1.7 for marginal food security, 2.2 for low food security, and 3.1 for very low food security; all $P<.001$). Odds ratios for associations with food insecurity decreased somewhat from the bivariate model to the multivariate model. For example, for skipping medications, the OR for marginal food security decreased by 35% from

TABLE 1—Continued

Highest family member education		
< high school	4 226	0.077 (0.073, 0.081)
High-school graduate or GED	9 104	0.193 (0.187, 0.198)
Some college or associate's degree	15 434	0.349 (0.341, 0.357)
≥ college grad	15 810	0.382 (0.372, 0.391)
Home tenure status		
Owned/being bought	23 576	0.556 (0.544, 0.567)
Rented	19 745	0.416 (0.405, 0.427)
Other arrangement	1 253	0.028 (0.025, 0.032)
Health insurance coverage		
No coverage	10 276	0.206 (0.201, 0.212)
Partial coverage	2 342	0.053 (0.050, 0.055)
Full coverage	31 956	0.741 (0.735, 0.747)
Diagnosed with a chronic condition	19 899	0.450 (0.443, 0.456)
Has a functional limitation	13 706	0.307 (0.301, 0.313)
Severe mental illness	1 846	0.040 (0.038, 0.042)
BMI category (kg/m^2)		
Underweight (< 18.5)	684	0.016 (0.014, 0.017)
Normal weight (18.5–24.99)	15 453	0.356 (0.350, 0.363)
Overweight (25–29.99)	14 957	0.333 (0.328, 0.339)
Obese (30–39.99)	11 178	0.245 (0.240, 0.251)
Severely obese (≥ 40)	2 302	0.050 (0.047, 0.052)
Smoking		
Current	9 855	0.226 (0.220, 0.231)
Former	7 862	0.186 (0.181, 0.190)
Never	26 857	0.588 (0.582, 0.595)
Alcohol use		
Lifetime abstainer	8 422	0.166 (0.160, 0.171)
Former drinker	5 845	0.127 (0.122, 0.131)
Infrequent, light, or moderate	27 775	0.646 (0.640, 0.652)
Current heavy	2 532	0.062 (0.059, 0.065)
US region of residence		
Northeast	6 872	0.165 (0.157, 0.173)
Midwest	9 613	0.244 (0.235, 0.254)
South	16 227	0.366 (0.356, 0.376)
West	11 862	0.225 (0.216, 0.233)
Year of survey		
2011	21 924	0.509 (0.502, 0.515)
2012	22 650	0.491 (0.485, 0.498)

Note. BMI = body mass index; CI = confidence interval; GED = general equivalency diploma.

the bivariate to the full model, by 47% for low food security, and by 58% for very low food security.

Other factors that were consistently and significantly associated with higher odds of engaging in all 5 of the cost-related medication underuse behaviors were being female; low income; having no or partial health coverage; having a chronic condition, a functional limitation, or severe mental illness; and having a high proportion of family members with some limitation (Table 3). All income groups had higher odds of skipping medications than those with the highest (≥ 4) income-to-poverty ratio (ORs from 1.5 to 1.9). However, the ORs for those in the middle-income groups (≥ 1–2.99)

were larger than the lowest group (< 1). The odds of skipping medication to save money among those with no insurance was about 3 times that of those with full coverage (OR = 3.0). Those with partial insurance had 2.5 times as high odds of skipping medications compared with those with full coverage. The odds of skipping medication among those with a diagnosed chronic condition was about 2 times those with no chronic condition (OR = 2.1), and close to 2 for those with a functional limitation (OR = 1.8) or a severe mental illness (OR = 1.9) compared with those without these conditions.

Effects of the other variables were less consistent across the outcomes, but being separated or divorced and being a single parent with 1 or more children were generally associated with higher odds of reporting 1 or more of the cost-related medication underuse behaviors (Table 3). When we controlled other factors, non-Hispanic Blacks were significantly less likely to engage in all the behaviors than were non-Hispanic Whites, except for not being able to afford medications, for which there was no difference between them and non-Hispanic Whites. The only significant difference between Hispanics and non-Hispanic Whites was in asking for lower-cost medications, with Hispanics less likely to ask for lower-cost medication (OR = 0.85). Only Asians were less likely than non-Hispanic Whites to not be able to afford medication (OR = 0.77). Unlike the bivariate association in which higher education was associated with a lower likelihood of engaging in the behaviors, there was a reversal in the multivariate analysis with higher odds of cost-related medication underuse with highly educated family members (OR = 1.29, 1.47, and 1.57 for less than high school, high school, and college and above, respectively). Having a high proportion of family members with fair or poor health status, being obese or severely obese, being a current or former smoker, and currently drinking alcohol were associated with higher odds of engaging in 1 or more of the cost-related medication underuse behaviors.

Conditional Effects

Among the interactions examined, only that between food security and health insurance

TABLE 2—Cross-Tabulation of Selected Independent Variables by Cost-Related Medication Underuse Measures Among US Adults Aged 18–64 Years (n = 44 574): National Health Interview Survey, 2011 and 2012

Variables	Dependent Variables, Weighted Proportions				
	Skipped Medications (n = 3814)	Took Less Medication (n = 4031)	Delayed Filling Prescription (n = 4962)	Lower-Cost Medication (n = 8753)	Could Not Afford Medication (n = 4990)
Independent variables					
Food security					
High	0.047	0.051	0.064	0.169	0.055
Marginal	0.113	0.114	0.153	0.251	0.166
Low	0.189	0.199	0.239	0.297	0.271
Very low	0.303	0.319	0.375	0.386	0.407
Control variables					
Gender					
Female	0.101	0.107	0.136	0.241	0.128
Male	0.063	0.066	0.079	0.159	0.085
Age, y					
18–24	0.042	0.043	0.060	0.116	0.075
25–44	0.080	0.085	0.111	0.194	0.110
45–64	0.099	0.104	0.121	0.237	0.115
Marital status					
Separated	0.153	0.160	0.195	0.252	0.209
Divorced	0.134	0.139	0.166	0.265	0.164
Married	0.067	0.070	0.089	0.207	0.078
Single or never married	0.069	0.073	0.094	0.155	0.103
Widowed	0.129	0.147	0.166	0.274	0.170
Family type					
1 adult, no children	0.091	0.097	0.117	0.195	0.119
Multiple adults, no children	0.077	0.081	0.096	0.217	0.099
1 adult, ≥ 1 children	0.121	0.126	0.163	0.229	0.154
Multiple adults, ≥ 1 children	0.070	0.075	0.098	0.187	0.092
Race/ethnicity					
Hispanic	0.091	0.095	0.112	0.167	0.133
Non-Hispanic White	0.080	0.084	0.105	0.215	0.098
Non-Hispanic Black	0.096	0.107	0.137	0.197	0.145
Non-Hispanic Asian	0.048	0.047	0.053	0.126	0.046
Non-Hispanic other	0.119	0.122	0.145	0.216	0.148
US citizenship					
US citizen	0.084	0.088	0.111	0.209	0.107
Non-US citizen	0.073	0.077	0.082	0.122	0.107
Income-to-poverty ratio					
< 1.00	0.126	0.134	0.157	0.205	0.194
1.00–1.99	0.135	0.136	0.169	0.244	0.183
2.00–2.99	0.098	0.102	0.128	0.228	0.114
3.00–3.99	0.065	0.071	0.099	0.212	0.075
≥ 4.00	0.033	0.037	0.047	0.163	0.031

Continued

status was significant for skipping medication, using less medication, delaying prescriptions, and not being able to afford medications. The interactions between food security and gender, and food security and chronic disease, were weak and not statistically significant. This suggests that the association between food insecurity and cost-related medication underuse does not differ substantially between men

TABLE 2—Continued

Highest family education					
< high school	0.113	0.119	0.136	0.185	0.168
High-school graduate or GED	0.110	0.115	0.135	0.215	0.145
Some college or associate's degree	0.098	0.104	0.132	0.221	0.130
≥ college grad	0.049	0.052	0.068	0.181	0.055
Home tenure status					
Owned/being bought	0.068	0.073	0.087	0.206	0.078
Rented	0.101	0.105	0.135	0.196	0.144
Other arrangement	0.101	0.104	0.127	0.199	0.150
Health insurance coverage					
No coverage	0.167	0.174	0.204	0.252	0.251
Partial coverage	0.147	0.162	0.214	0.284	0.222
Full coverage	0.055	0.058	0.074	0.182	0.059
Diagnosed chronic condition					
No	0.045	0.048	0.062	0.136	0.066
Yes	0.129	0.136	0.165	0.282	0.158
Functional limitation					
Not limited in any way	0.048	0.050	0.065	0.149	0.065
Has a functional limitation	0.162	0.173	0.207	0.321	0.202
Severe mental illness					
No	0.072	0.076	0.097	0.192	0.095
Yes	0.334	0.355	0.394	0.443	0.417
BMI category (kg/m^2)					
Underweight (< 18.5)	0.083	0.089	0.090	0.187	0.098
Normal weight (18.5–24.99)	0.066	0.069	0.088	0.170	0.086
Overweight (25–29.99)	0.075	0.081	0.096	0.192	0.098
Obese (30–39.99)	0.102	0.108	0.136	0.239	0.133
Severely obese (≥ 40)	0.162	0.163	0.205	0.317	0.199
Smoking					
Current	0.132	0.135	0.166	0.243	0.183
Former	0.085	0.092	0.115	0.236	0.108
Never	0.063	0.068	0.084	0.175	0.078
Alcohol use					
Lifetime abstainer	0.079	0.081	0.097	0.162	0.097
Former drinker	0.126	0.135	0.158	0.266	0.158
Infrequent, light, or moderate	0.076	0.080	0.102	0.200	0.100
Current heavy	0.081	0.082	0.106	0.190	0.112
US region of residence					
Northeast	0.066	0.066	0.081	0.145	0.081
Midwest	0.081	0.081	0.105	0.215	0.101
South	0.093	0.100	0.126	0.235	0.124
West	0.081	0.089	0.103	0.176	0.106
Year of survey					
2011	0.089	0.093	0.116	0.208	0.114
2012	0.077	0.082	0.100	0.195	0.100
Total	0.083	0.087	0.108	0.202	0.107

Note. BMI = body mass index; GED = general equivalency diploma. All differences were significant at $P < .001$ except that for citizenship status, which was significant at $P < .05$ for skipping medications ($P = .03$) and less medications ($P = 02$); year of survey, which was significant at $P < .01$ for lower-cost medication ($P = .009$); citizenship status, which was not significant for cannot afford medications ($P = .94$); and home tenure, which was not significant for lower-cost medication ($P = .12$).

TABLE 3—Weighted Multivariate Logistic Regressions of Cost-Related Medication Underuse on Food Security and Relevant Controls Among US Adults Aged 18–64 Years (n = 44 574): National Health Interview Survey, 2011 and 2012

Predictors	Skipped Medication, OR (95% CI)	Took Less Medication, OR (95% CI)	Delayed Filling Prescription, OR (95% CI)	Lower-Cost Medication, OR (95% CI)	Could Not Afford Medication, OR (95% CI)	At Least 1 of the 5, OR (95% CI)
Food security						
High (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
Marginal	1.66*** (1.45, 1.91)	1.58*** (1.40, 1.79)	1.77*** (1.58, 1.99)	1.54*** (1.39, 1.70)	1.91*** (1.68, 2.17)	1.67*** (1.52, 1.82)
Low	2.51*** (2.21, 2.85)	2.54*** (2.25, 2.86)	2.62*** (2.32, 2.96)	1.74*** (1.58, 1.92)	2.94*** (2.63, 3.28)	2.22*** (2.04, 2.42)
Very low	3.71*** (3.25, 4.23)	3.80*** (3.36, 4.30)	4.03*** (3.58, 4.54)	2.15*** (1.93, 2.39)	4.27*** (3.76, 4.85)	3.07*** (2.78, 3.40)
Gender						
Female (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
Male	0.62*** (0.56, 0.68)	0.61*** (0.56, 0.68)	0.55*** (0.51, 0.60)	0.59*** (0.56, 0.63)	0.62*** (0.57, 0.68)	0.57*** (0.54, 0.60)
Age	1.01** (1.00, 1.01)	1.01** (1.00, 1.01)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00* (0.99, 1.00)	1.00 (1.00, 1.00)
Marital status						
Married (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
Never married	0.87* (0.76, 1.00)	0.9 (0.79, 1.03)	0.82* (0.73, 0.93)	0.72*** (0.66, 0.79)	0.91 (0.80, 1.05)	0.75*** (0.69, 0.82)
Separated or divorced	1.15* (1.00, 1.32)	1.15* (1.00, 1.31)	1.07 (0.94, 1.21)	0.95 (0.86, 1.04)	1.25* (1.09, 1.43)	0.97 (0.89, 1.07)
Widowed	0.9 (0.70, 1.15)	1.01 (0.79, 1.28)	0.91 (0.72, 1.15)	0.86 (0.71, 1.03)	1.15 (0.92, 1.44)	0.87 (0.73, 1.03)
Family type						
1 adult, no children (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
Multiple adults, no children	1.01 (0.88, 1.16)	0.99 (0.87, 1.13)	0.92 (0.81, 1.05)	1.03 (0.94, 1.13)	1.16* (1.02, 1.33)	1.04 (0.96, 1.14)
1 adult, ≥1 children	1.24* (1.05, 1.47)	1.21* (1.03, 1.43)	1.23* (1.05, 1.44)	1.07 (0.95, 1.21)	1.06 (0.91, 1.23)	1.07 (0.96, 1.19)
Multiple adults, ≥1 children	1.11 (0.95, 1.30)	1.12 (0.97, 1.30)	1.12 (0.97, 1.28)	0.99 (0.90, 1.10)	1.13 (0.97, 1.31)	1.01 (0.92, 1.11)
Race/ethnicity						
Non-Hispanic White (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
Hispanic	0.98 (0.86, 1.12)	0.95 (0.83, 1.08)	0.96 (0.86, 1.07)	0.85*** (0.78, 0.93)	1.09 (0.96, 1.22)	0.89** (0.83, 0.96)
Non-Hispanic Black	0.79*** (0.70, 0.88)	0.85** (0.76, 0.96)	0.87* (0.79, 0.97)	0.73*** (0.67, 0.80)	0.97 (0.87, 1.08)	0.78*** (0.72, 0.84)
Non-Hispanic Asian	1.03 (0.80, 1.31)	0.92 (0.74, 1.15)	0.84 (0.68, 1.04)	0.88 (0.76, 1.01)	0.77* (0.63, 0.94)	0.81** (0.71, 0.92)
Non-Hispanic other	1.02 (0.65, 1.62)	0.97 (0.61, 1.53)	0.94 (0.60, 1.49)	0.85 (0.59, 1.21)	0.96 (0.59, 1.55)	0.81 (0.60, 1.10)
US citizenship						
US citizen (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
Non-US citizen	0.89 (0.76, 1.05)	0.9 (0.77, 1.06)	0.75*** (0.65, 0.88)	0.72*** (0.64, 0.81)	0.85* (0.74, 0.99)	0.77*** (0.69, 0.85)
Income-to-poverty ratio						
< 1.00	1.49*** (1.24, 1.80)	1.39*** (1.17, 1.66)	1.28* (1.09, 1.50)	1.02 (0.91, 1.15)	2.03*** (1.70, 2.43)	1.13* (1.01, 1.27)
1.00–1.99	1.83*** (1.56, 2.14)	1.59*** (1.36, 1.86)	1.61*** (1.39, 1.87)	1.28*** (1.15, 1.42)	2.12*** (1.80, 2.48)	1.34*** (1.21, 1.48)
2.00–2.99	1.88*** (1.60, 2.21)	1.70*** (1.45, 1.99)	1.74*** (1.51, 2.00)	1.35*** (1.22, 1.49)	1.90*** (1.63, 2.21)	1.40*** (1.27, 1.54)
3.00–3.99	1.55*** (1.31, 1.83)	1.50*** (1.26, 1.77)	1.70*** (1.45, 1.98)	1.31*** (1.18, 1.46)	1.69*** (1.41, 2.03)	1.33*** (1.19, 1.47)
≥ 4.00 (Ref)	1.00	1.00	1.00	1.00	1.00	1.00

Continued

TABLE 3—Continued

Highest family education						
<high school (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
High-school graduate/GED	1.29** (1.10, 1.52)	1.30** (1.11, 1.52)	1.30** (1.12, 1.50)	1.27*** (1.12, 1.44)	1.21** (1.06, 1.38)	1.19** (1.06, 1.34)
Some college/associate's degree	1.47*** (1.25, 1.72)	1.49*** (1.28, 1.73)	1.62*** (1.40, 1.88)	1.46*** (1.30, 1.64)	1.52*** (1.32, 1.74)	1.40*** (1.26, 1.56)
<college grad	1.57*** (1.31, 1.89)	1.52*** (1.27, 1.80)	1.69*** (1.45, 1.98)	1.66*** (1.46, 1.89)	1.59*** (1.36, 1.86)	1.62*** (1.44, 1.82)
Proportion adult family members[a]						
Working part time	0.89 (0.77, 1.03)	0.87 (0.75, 1.00)	0.89 (0.79, 1.01)	0.95 (0.86, 1.04)	0.96 (0.83, 1.11)	0.94 (0.85, 1.03)
Not in the labor force	0.55*** (0.48, 0.64)	0.53*** (0.47, 0.61)	0.54*** (0.48, 0.62)	0.65*** (0.59, 0.73)	0.67*** (0.58, 0.77)	0.60*** (0.55, 0.66)
Home tenure status						
Owned/other (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
Rented	1.05 (0.96, 1.15)	1.03 (0.93, 1.13)	1.17*** (1.07, 1.28)	0.96 (0.89, 1.02)	1.14*** (1.04, 1.25)	1.01 (0.95, 1.07)
Health insurance coverage						
No coverage	3.04*** (2.76, 3.35)	3.05*** (2.76, 3.36)	2.97*** (2.71, 3.24)	1.63*** (1.52, 1.75)	4.62*** (4.22, 5.07)	2.44*** (2.28, 2.61)
Partial coverage	2.46*** (2.09, 2.89)	2.67*** (2.27, 3.15)	2.88*** (2.47, 3.35)	1.72*** (1.53, 1.95)	3.68*** (3.19, 4.24)	2.20*** (1.95, 2.48)
Full coverage (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
Diagnosed with chronic condition	2.07*** (1.85, 2.31)	1.99*** (1.79, 2.21)	2.09*** (1.91, 2.28)	1.77*** (1.66, 1.89)	1.92*** (1.76, 2.10)	1.90*** (1.79, 2.02)
Has a functional limitation	1.78*** (1.60, 1.99)	1.90*** (1.72, 2.10)	1.88*** (1.72, 2.07)	1.57*** (1.46, 1.69)	1.79*** (1.64, 1.96)	1.70*** (1.59, 1.82)
Severe mental illness	1.88*** (1.63, 2.17)	2.00*** (1.74, 2.29)	1.87*** (1.63, 2.14)	1.57*** (1.37, 1.79)	1.87*** (1.63, 2.14)	1.90*** (1.68, 2.16)
Proportion adult family members						
Needing help with ADL	0.98 (0.72, 1.33)	0.9 (0.65, 1.24)	0.67* (0.50, 0.90)	0.90 (0.68, 1.19)	0.87 (0.64, 1.17)	0.82 (0.62, 1.08)
With health-related work limitation	0.99 (0.83, 1.19)	0.97 (0.82, 1.15)	1.08 (0.92, 1.28)	1.09 (0.94, 1.26)	1.20 (1.00, 1.46)	1.12 (0.97, 1.30)
Limited in any way	1.15*** (1.06, 1.24)	1.16*** (1.08, 1.25)	1.17*** (1.09, 1.26)	1.11*** (1.05, 1.18)	1.14*** (1.05, 1.23)	1.12*** (1.05, 1.18)
With self-rated health status[b]						
Excellent	0.64*** (0.55, 0.74)	0.59*** (0.52, 0.68)	0.64*** (0.56, 0.74)	0.78*** (0.71, 0.86)	0.62*** (0.54, 0.71)	0.74*** (0.67, 0.81)
Very good	0.71*** (0.62, 0.81)	0.69*** (0.60, 0.78)	0.77*** (0.68, 0.87)	0.88** (0.80, 0.96)	0.68*** (0.59, 0.78)	0.87** (0.80, 0.95)
Fair	1.25*** (1.08, 1.45)	1.17* (1.01, 1.34)	1.24*** (1.06, 1.44)	1.21*** (1.06, 1.37)	1.23*** (1.06, 1.44)	1.29*** (1.15, 1.46)
Poor	1.61*** (1.27, 2.05)	1.51*** (1.19, 1.92)	1.53*** (1.20, 1.96)	1.15 (0.94, 1.43)	1.39*** (1.10, 1.75)	1.24* (1.02, 1.50)
BMI category (kg/m²)						
Underweight (<18.5)	0.9 (0.65, 1.24)	0.96 (0.69, 1.33)	0.70* (0.52, 0.94)	0.95 (0.74, 1.21)	0.73 (0.52, 1.02)	0.91 (0.73, 1.14)
Normal weight (18.5–24.99, Ref)	1.00	1.00	1.00	1.00	1.00	1.00
Overweight (25–29.99)	1.05 (0.94, 1.18)	1.08 (0.97, 1.21)	1.02 (0.92, 1.14)	1.09* (1.00, 1.18)	1.12* (1.01, 1.25)	1.06 (0.99, 1.15)
Obese (30–39.99)	1.06 (0.96, 1.18)	1.06 (0.95, 1.17)	1.08 (0.98, 1.20)	1.14** (1.05, 1.23)	1.13* (1.02, 1.25)	1.09* (1.01, 1.17)
Severely obese (≥ 40)	1.27** (1.07, 1.51)	1.17 (0.97, 1.40)	1.19* (1.01, 1.40)	1.21*** (1.07, 1.37)	1.30** (1.10, 1.53)	1.16* (1.04, 1.31)
Smoking status						
Never smoked (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
Current smoker	1.15* (1.03, 1.28)	1.09 (0.98, 1.20)	1.12* (1.02, 1.24)	1.02 (0.94, 1.10)	1.31*** (1.18, 1.45)	1.09* (1.01, 1.17)
Former smoker	1.08 (0.96, 1.20)	1.08 (0.96, 1.21)	1.15* (1.03, 1.28)	1.13*** (1.04, 1.22)	1.23*** (1.10, 1.37)	1.14*** (1.06, 1.23)

Continued

TABLE 3—Continued

Alcohol use						
Lifetime abstainer (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
Former drinker	1.06 (0.91, 1.25)	1.13 (0.97, 1.31)	1.12 (0.98, 1.29)	1.17* (1.01, 1.35)	1.29*** (1.16, 1.44)	1.29*** (1.16, 1.44)
Current light or moderate	1.08 (0.96, 1.22)	1.13 (1.00, 1.27)	1.16** (1.04, 1.30)	1.27*** (1.13, 1.43)	1.30*** (1.18, 1.42)	1.34*** (1.23, 1.46)
Current heavy	1.02 (0.82, 1.26)	1.00 (0.81, 1.25)	1.09 (0.91, 1.31)	1.20 (0.98, 1.47)	1.18* (1.01, 1.37)	1.26** (1.09, 1.45)
US region of residence						
South (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
Northeast	0.91 (0.80, 1.04)	0.83* (0.71, 0.96)	0.75*** (0.66, 0.86)	0.86* (0.76, 0.98)	0.59*** (0.54, 0.65)	0.65*** (0.60, 0.72)
Midwest	0.94 (0.84, 1.05)	0.85** (0.76, 0.96)	0.85*** (0.77, 0.94)	0.90* (0.81, 1.00)	0.87*** (0.80, 0.94)	0.92* (0.85, 0.99)
West	0.93 (0.83, 1.05)	0.98 (0.87, 1.09)	0.85*** (0.76, 0.94)	0.92 (0.84, 1.01)	0.71*** (0.64, 0.79)	0.81*** (0.75, 0.88)
Year of survey						
2011 (Ref)	1.00	1.00	1.00	1.00	1.00	1.00
2012	0.88** (0.81, 0.95)	0.90* (0.83, 0.98)	0.87*** (0.81, 0.94)	0.89** (0.82, 0.96)	0.95 (0.89, 1.01)	0.93* (0.88, 0.99)
Constant	0.011*** (0.008, 0.017)	0.013*** (0.009, 0.019)	0.021*** (0.015, 0.030)	0.012*** (0.008, 0.017)	.016*** (0.083, 0.137)	0.116*** (0.091, 0.148)

Note. ADL = activities of daily living; BMI = body mass index; CI = confidence interval; GED = general equivalence diploma; OR = odds ratio.

[a]The proportion of family members working full time was omitted because of collinearity; however, when proportion working part time was omitted and the proportion working full time was included, it was not significant in the final model for any of the outcomes. This also applies to proportion looking for work.

[b]The proportion of family members with good health status was omitted from the regression because of collinearity. When the self-rated health status variables were replaced with a binary variable on whether any family member had a self-rated health status of fair or bad, the results were similar to that using the proportions.

*P < .05; **P < .01; ***P < .001.

and women, or between people with and without chronic disease.

However, it does differ by insurance status, for at least some of the behaviors. As shown in Figure 1, the association between food security and delaying prescriptions was present at all levels of insurance—even among people who were fully insured. The magnitude of the change in the odds of reporting cost-related medication underuse for different levels of food security (slopes) was similar for the fully insured and uninsured. However, the slope for partial insurance looks different from the others, with a steeper change between those with marginal food security and low food security. The graphs are similar for skipping medication and using less medication. However, for not being able to afford medications, we found a bigger effect of having no insurance among those with very low food security.

Sensitivity Analysis

Because a large proportion of the sample was missing information on income, a variable closely related to food security, we conducted various sensitivity analyses by using the imputed income files that were provided with NHIS and by recoding variables missing on more than 1% of the sample (which includes income) into separate categories and entering them in the regression as dummy variables. The results from these analyses were very similar to the analyses presented.

The effects of food security on the dependent variables when we used the imputed files and recoded categories were just slightly higher than those presented here (maximum difference of 0.17). Because income is a key confounding variable, we decided to present the unimputed results, which we believe are robust and at worst underestimate the actual effect of food insecurity.

DISCUSSION

When we controlled for other factors, including income, people living in food-insecure households were more likely to report cost-related medication underuse. The odds of engaging in these behaviors increased with increasing severity of food insecurity. Other factors associated with cost-related medication underuse were being female, being a single
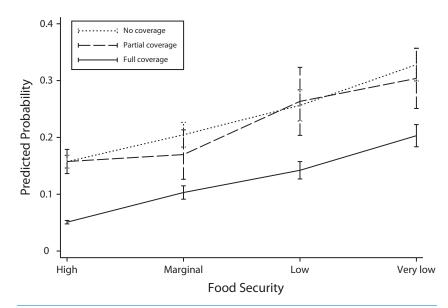
FIGURE 1—Interaction of food security and health insurance on delaying prescription among US adults aged 18–64 years (n = 44 574): National Health Interview Survey, 2011 and 2012.

parent with children, living in a low-income household, having no or partial health care coverage, having a chronic condition, having a functional limitation or other limitation, or having severe mental illness. In addition, the association between food insecurity and cost-related medication underuse did not differ substantially by gender and by having a chronic condition. However, for some of the cost-related medication underuse indicators, it differed by level of health insurance.

Our study contributes to the literature on food insecurity and cost-related medication underuse in several ways. First, previous studies focused on particular population subgroups.[13,20–24,34] Berkowitz et al. found that food insecurity was associated with cost-related medication underuse among persons with chronic disease.[13] Billimek and Sorkin[20] and Seligman et al.[21] also found that food insecurity was associated with delays in filling prescriptions among persons with diabetes. Our findings suggest that the association between food insecurity and cost-related medication underuse is not limited to those with chronic conditions, but is also present in the general population of nonelderly adults, and the association persists after control for chronic conditions. In addition, the effects are not conditional on diagnosis of a chronic condition.

Second, unlike previous studies, we used the detailed food security measure, and found a dose–response relationship in the association between food security and cost-related medication underuse. We also controlled for a larger number of factors that allowed us to rule out alternative explanations for the identified associations.

We also examined interactions between several key factors and food insecurity on cost-related medication underuse. Some correlates of food insecurity such as obesity and risky sexual behaviors may differ by gender, with potentially more adverse effects in women.[12] However, in this analysis, although we found that cost-related medication underuse was more common among women, the association between food security and cost-related medication underuse was not modified by gender.

There was a significant interaction between food security and health insurance status for some of the cost-related medication underuse. The overall association with health insurance status and food security was expected and suggests that even short periods without health insurance may have detrimental consequences on cost-related medication underuse. Across food security status, the odds of delaying a prescription for those with partial insurance

coverage were as high or nearly as high as the odds of those with no insurance coverage. The positive association between food insecurity and cost-related medication underuse, even among the fully insured, suggests that health insurance cannot fully overcome the economic hardships faced by food-insecure households and that out-of-pocket medical expenses may be a problem for even fully insured individuals.

Most of the findings in this analysis are consistent with what one would expect theoretically. However, there are some deviations. First was the lack of a dose–response relationship between poverty and cost-related medication underuse. We found that although groups with income less than 4 times the poverty threshold generally have greater odds of reporting cost-related medication underuse than those with incomes 4 or more times the poverty threshold, those with incomes at or below the poverty threshold tended to have lower odds of reporting cost-related medication underuse than those just above the threshold. There was no difference in asking for lower-cost medication between those with incomes below the poverty threshold and those with incomes 4 or more times the poverty threshold. This finding might be a Medicaid effect, with those in the lowest income groups having more access to public health assistance than those just below the threshold. Berkowitz et al. had similar findings among people with chronic diseases. The similar finding from our analysis adds voice to the vulnerability of people just above the cut-off for eligibility to assistance programs.[13] Respondents with higher proportions of family members not in the labor force are less likely to report cost-related medication underuse, which might also be a protective effect of Medicaid that family members are receiving.

Another exception is the effect of education. The bivariate analysis showed that the likelihood of cost-related medication underuse was lower in households with more highly educated members. However, when we introduced other variables, particularly income and employment variables, we saw a reversal in that association, with odds of cost-related underuse lowest in households in which the most highly educated member completed less than a high-school degree. The results were similar when we used the education of the respondent. Our finding

differs from other studies that found no association between education and cost-related medication underuse.[13,35] The possible reasons for this include the different sample as well as the larger number of covariates, which may explain potential pathways for the effect of education. Berkowitz et al. speculated that the lack of association between education and cost-related medication underuse may be attributable to people with chronic illness and lower education receiving assistance from prescription drug benefit programs.[13] Although this is a possibility, our analysis shows that other factors, especially employment, income, and health insurance, mediate the relationship between education and cost-related medication underuse such that once these were controlled, education had the opposite effect than expected. Perhaps education is related to perceived need to use medication versus trying to use other potentially less-costly approaches such as dietary or behavior changes to treat disease when faced with making tradeoffs because of economic limitations.

Limitations and Strengths

These analyses were based on cross-sectional data. Therefore, our ability to infer causality was limited, which is inherent to cross-sectional data. Participants were not directly asked whether they sacrificed the medications for food; thus, we cannot conclusively say that these behaviors were to increase money for food.[13] However, the hypothesis underlying this study was that rationing of resources between competing needs results in medication underuse when resources are constrained to the extent that food insecurity occurs (i.e., it is not food insecurity per se that causes medication underuse). In terms of causality, reverse causality seems unlikely. A plausible alternative explanation for the observed associations is that other unmeasured material hardships coexist with food insecurity and cause medication underuse. But this does not invalidate the findings here.

Food assistance is likely to reduce medication underuse because it reduces food insecurity and also frees up household resources to meet other competing needs as well as medication costs.[36–40] We did not examine the relationship between participation in food assistance programs here because these models do not account for self-selection into the programs. Households that are having more difficulty meeting their food needs are more likely to participate in food assistance programs and more likely to be food insecure. Methods that account for self-targeting are required to adequately assess the extent to which food and nutrition assistance programs affect food insecurity and cost-related medication underuse. Finally, because the data were based on self-report, the report of both food security and cost-related medication underuse may be subject to social desirability bias, though we have no reason to suspect this has biased our results.[13]

However, the study has major strengths that can be used to strengthen causal inference as well as increase generalizability. The first is the availability and use of a large number of covariates, which allowed us to rule out many alternative factors that may explain the relationship between food security and cost-related medication underuse, such as income, education, employment, and health insurance. In addition, the measures of both food security and cost-related medication underuse were based on well-validated instruments, which increased the reliability of the findings. Finally, we used a nationally representative sample of nonelderly adults and did not restrict the analysis to certain groups, such as those with a chronic disease, which allowed us to examine the effect of having a chronic condition on cost-related medication underuse, and also made the findings applicable to most nonelderly adults in the United States.

Conclusions

These findings have a number of implications. First, previous studies have suggested that food insecurity is associated with poor control of diabetes and other chronic diseases and with risk factors including obesity and smoking.[2–5] Thus, a combination of poor health outcomes and noncompliance with medications because of cost may lead to even worse consequences for individuals in food-insecure households. We cannot state conclusively from this study that people in food-insecure households were using these behaviors as mechanisms to deal with lack of money for food. However, this is a plausible explanation that merits further study. That individuals in food-insecure households were more likely to engage in these behaviors suggests that there is a need for removing cost barriers to accessing medications in this group.

Policies that make medications more available to food-insecure households will not only ensure that they are compliant with medications, but also may increase disposable income for these families.[41,42] We add voice to suggestions for using food insecurity as a risk factor for assessing cost-related medication underuse.[13] This could potentially help increase the identification of individuals who may need assistance purchasing medications as well as improve health outcomes for individuals living in food-insecure households. ∎

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Human Participant Protection

Institutional review was not required because it was considered exempt by the University of California Los Angeles Office of the Human Research Protection Program on February 13, 2015.

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