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Food Insecurity and Depression Among Adults With Diabetes: Results From the National Health and Nutrition Examination Survey (NHANES)

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Abstract

Purpose—While both food insecurity and depression have been linked to risk of type 2 diabetes, little is known about the relationship between food insecurity and depression among adults with diabetes.

Research Design and Methods—Cross-sectional analyses of the National Health and Nutrition Examination Survey (2011–2014), a nationally representative, population-based survey. Analytic sample was limited to adults aged ≥ 20 with diabetes determined by either fasting plasma glucose (≥ 126 mg/dL) or self-report ($n = 1724$) and adults age ≥ 20 with prediabetes determined by fasting plasma glucose (100–125 mg/dL) or self-report ($n = 2004$). Food insecurity was measured using the US Food Security Survey Module. Depression was assessed using the Patient Health Questionnaire-9 (PHQ-9). Logistic regression was used to assess the relationship between food insecurity and depression while accounting for sociodemographic characteristics and health behaviors.

Results—Approximately 10% of individuals with diabetes and 8.5% of individuals with prediabetes had severe food insecurity in the past year; an additional 20.3% of individuals with diabetes and 14.3% of those with prediabetes had mild food insecurity. Among individuals with diabetes, both mild and severe food insecurity were associated with elevated odds of depression. These relationships were similar in magnitude among individuals with prediabetes.

Conclusions—Food insecurity is significantly associated with depressive symptoms in people with diabetes and prediabetes. Results point to the need to address economic issues in conjunction with psychosocial issues for comprehensive diabetes care.

Food insecurity is a significant public health issue and is particularly critical for chronic health conditions, like diabetes, that require dietary modification to manage.^{1,2} Food insecurity refers to the lack of a dependable means of obtaining safe, sufficient, and

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nutritious food. In the US, 1 in 7 households was affected by food insecurity in 2013.⁴ Food insecurity involves a range of experiences and behaviors based on its severity, including distress and anxiety about having an insufficient budget for food and changing or reducing usual food intake (ie, cutting down or skipping meals) to adapt to reduced food expenditures.⁵ Individuals with food insecurity are more likely to purchase cheaper, higher calorie foods, which contributes to weight gain and increased susceptibility to chronic diseases.⁶

In 2016, the American Diabetes Association (ADA) Standards of Care noted for the first time that food insecurity impacts diabetes self-management and stated that providers should “evaluate hyperglycemia and hypoglycemia in the context of food insecurity and propose solutions accordingly.”⁷ However, there is relatively little empirical work regarding the impact food insecurity has on self-management or clinical outcomes.^{8–10} Using data from the 2011–2012 National Health and Nutrition Examination (NHANES), Seligman et al⁸ reported the prevalence of diabetes was 10% for individuals with mild food insecurity and 16% for those with severe food insecurity. Among individuals with diabetes, being food insecure is associated with poor diabetes management such as poor glycemic control as well as poorer dietary and medication adherence.¹⁰ However, there has been less attention paid to the psychological impact of food insecurity among those with diabetes.

Food insecurity can induce feelings of worry and distress, particularly for individuals with diabetes, as a result of feeling powerless over their nutrition and self-management of their diabetes.⁸ These feelings of powerlessness and uncertainty may contribute to diabetes-related distress, which is estimated to affect 33% of adults with diabetes.¹¹ Chronic stress is an established risk factor for depression,¹² and the relationship between diabetes and depression is bidirectional.¹³ Both depression and diabetes-related distress are associated with poor glycemic control, worse adherence to diabetes self-care regimens, and risk of diabetes complications.¹⁴ Finally, co-morbid depression goes unrecognized and untreated for approximately two-thirds of people with diabetes.¹⁵

While studies of the general population (primarily women and children) have shown that food insecurity is associated with higher levels of psychological distress and depression,^{16,17} few studies have examined the relationship between food insecurity and depression within a diabetes or prediabetes population.¹⁸ Therefore, the purpose of this study was to (1) estimate the burden of food insecurity among US adults with normoglycemia, prediabetes, and diabetes and (2) examine whether the relationship between food insecurity and major depression differed across these groups. The primary hypothesis was that greater levels of food insecurity will be associated with higher levels of depressive symptoms and that this relationship would be strongest for those with established diabetes relative to other groups.

Research Design and Methods

Sample

Data come from the 2011–2012 and 2013–2014 waves of the NHANES. National Health and Nutrition Examination Survey is a nationally representative, population-based survey to assess the health and nutritional status of adults and children in the US.¹⁹ This survey

combines in-person interviews along with health examinations (eg, phlebotomy, objective physical measures) performed at Mobile Exam Centers (MECs). The MECs are outfitted trailers that essentially serve as traveling clinics to provide an optimal setting for the collection of high-quality clinical data in a standardized environment.¹⁹ The MEC allows NHANES to collect data across the continental US using the same physical instruments across recruitment sites, optimizing reliability of these measures. For the current study, data from 2 cycles (2011–2012 and 2013–2014) were combined to increase sample size. The total sample size of adults from the 2011–2014 assessments was N = 11,441. Additional details of the study design, sampling, and interviewing procedures are described elsewhere.¹⁹

The analytic sample for this study was limited to adults aged ≥20 who (1) answered the food security questionnaire and depression screener, (2) had either self-reported diabetes or borderline/prediabetes or reported taking diabetes medication, or (3) had fasting plasma glucose (fpg) determined diabetes or prediabetes, consistent with ADA guidelines (fpg ≥126 mg/dl for diabetes or fpg = 100 to 125 mg/dl for prediabetes).²⁰ Using these criteria, the analytic sample size for the diabetes group was 1724, and the analytic sample size for the prediabetes group was 2004. Finally, while not the focus of the analysis, the prevalence of food insecurity and its relationship to depression among adults ≥20 with normoglycemia (N = 7713) was also examined.

The NHANES is approved by CDC/NCHS Ethics Review Board, and all participants gave informed consent. This analysis used only publicly available data (available at: <http://www.cdc.gov/nchs/nhanes/>).

Measures

Food Insecurity—Food insecurity was assessed by self-report using a questionnaire based on the US Food Security Survey Module developed by the US Department of Agriculture.²¹ This scale consists of 18 items, 10 of which refer to adults in the household and 8 of which refer to children; because our sample was limited to adults, only the relevant 10 items were used. Each item was recorded in a dichotomous manner (yes/no) and assessed a range of experiences in the past 12 months, including: scarcity of food in the household, worry due to food running out, affordability of eating nutritious balanced meals, hunger, and reduced food intake.^{19,21} From these 10 items, the following groups were created by NHANES: full food security (0 items endorsed), marginal food security (1–2 items endorsed), low food security (3–5 items endorsed), and very low food security (6–10 items endorsed). To maintain sufficient cell size for analysis, the low food security and severely low food security categories were collapsed into a single category indicating severe food insecurity.

Depression—Current depressive symptoms were measured using the Patient Health Questionnaire-9 (PHQ-9). The PHQ-9 is a well-validated (Cronbach's $\alpha = .89$) self-report instrument that assesses depression symptoms (ie, sadness, trouble sleeping, fatigue, problems concentrating) in the past 2 weeks and has moderate concordance with clinical psychiatric interviews.²² The PHQ-9 contains 9 items, with each item being assessed on a 4-point Likert scale ranging from 0 = not at all to 3 = nearly every day, with a total scale range of 0 to 27. A dichotomous variable indicating no depression (PHQ-9 score <10) or elevated

depressive symptoms (PHQ-9 score ≥ 10) was created using this established threshold score of 10.²²

Covariates

Demographic Characteristics—Demographic covariates included age, gender, race/ethnicity, educational attainment, and household income. For analysis, each covariate contained a “reference group” that refers to the specific category of each variable the other categories are compared to when estimating the relative odds. Age was categorized as 20 to 44 years (reference group), 45 to 64 years, or 65+ years. Gender was categorized as male (reference group) and female. Race/ethnicity was categorized as non-Hispanic white (reference group), non-Hispanic black, Mexican American, and other races/multiracial. Education was categorized as less than a high school diploma, high school graduate/GED, some college/AA degree, and college graduate or more (reference group). A categorical variable based on the 2012 federal poverty level (FPL), which reflects income relative to household size, was used as an indicator of socioeconomic status. Income was categorized as $\leq 130\%$ FPL, $>130\%$ to 250% FPL, and $>250\%$ above FPL (reference group).

Physical Activity—Physical activity was assessed by self-report using the Global Physical Activity Questionnaire developed by the World Health Organization.²³ The questionnaire assesses sedentary behavior and physical activity in 3 domains: (1) at work, (2) traveling to and from places, and (3) during recreational activities. These domains were used to create a Metabolic Equivalents Task score (METs). METs are commonly used to express the energy cost and physiological measure of activities.²³ It is estimated that compared to sitting quietly, a person’s caloric consumption is 4 times as high when being moderately active and 8 times as high when being vigorously active.²³ For this study, and consistent with NHANES guidance, a categorical MET score was created that combined data on work-related, transportation, and leisure time physical activity minutes per day and days per week. For this variable, 4 METs are assigned to time spent in moderate activities and 8 METs to time spent in vigorous activities.¹⁹ Due to small cell sizes, the vigorous activity and moderate activity groups were combined to create a dichotomous variable that classified participants as either engaging in light physical activity (<4 METs) or moderate/vigorous physical activity (≥ 4 METs) per week.

Smoking Status—Smoking status was measured by self-report cigarette use; individuals who smoked at least 100 cigarettes in their lifetime were considered “ever” smokers. A 3-level categorical variable was created that classified individuals as either a never smoker, former smoker, or current smoker.

Analysis

Initially, the prevalence of food insecurity among individuals with diabetes, prediabetes, and normoglycemia was estimated, and the characteristics of these groups were compared using the Scott-Rao chi-square test. Next, a series of multiple logistic regression models were fit to assess the relationship between food insecurity and depression. Model 1 was unadjusted. Model 2 was adjusted for demographics characteristics (ie, age group, sex, race, income, and education). Model 3 was adjusted for Model 2 covariates plus physical activity and smoking

status. Absolute model fit was assessed using the C-statistic, which indexes the degree to which the model correctly classifies observations according to the outcome (ie, predictive capability). C-statistic values >0.7 indicate adequate predictive capability.²⁴

Estimates were weighted to be representative of the general adult population. All *P* values refer to 2-tailed tests. All analyses were conducted using SAS 9.4 using survey procedures.

Results

Tables 1 and 2 describe the prevalence of food insecurity and associated characteristics among adults with prediabetes and diabetes. Table 3 shows these relationships for the normoglycemia group. The prevalence of mild and severe food insecurity was 10.2% and 20.3%, respectively, among adults with diabetes. The prevalence of mild and severe food insecurity was 8.5% and 14.3%, respectively, among adults with prediabetes. The prevalence of mild and severe food insecurity among the normoglycemia group was 11.7% and 16.0%, respectively. Regardless of diabetes status, adults with food insecurity were more likely to be non-Hispanic black or Mexican American, have less than a high school education, have low household income, and be a current smoker relative to food secure adults. There was a dose-response relationship between food insecurity and elevated depressive symptoms.

Among adults with diabetes (Table 4), after adjusting for demographic characteristics, mild food insecurity was associated with 2.6 times higher odds (95% CI, 1.0–6.6) of current depression relative to being food secure; severe food insecurity was associated with 3.5 times higher odds (95% CI, 1.9–6.3) of depression. Additional adjustment for smoking status and weekly physical activity did not substantially attenuate these relationships.

Among adults with prediabetes (Table 5), both mild food insecurity (odds ratio [OR] = 2.7; 95% CI, 1.1–6.5) and severe food insecurity (OR = 3.2; 95% CI, 1.7–5.8) were associated with elevated depressive symptoms. These relationships were only slightly attenuated after accounting for smoking status and weekly physical activity.

The results of the parallel analyses in the normoglycemia group are shown in Table 6. Only severe food insecurity was significantly associated with elevated depressive symptoms (OR = 2.0; 95% CI, 1.0–3.9) in the final adjusted model.

Conclusion

The primary findings of this study are that food insecurity is common among adults with prediabetes and diabetes, with approximately 1 in 3 adults with diabetes experiencing severe food insecurity in the past year. Food insecurity is significantly associated with elevated depressive symptoms, particularly among adults with diabetes and prediabetes. The relationship between food insecurity and depression is partially explained by health behaviors such as tobacco use and inadequate physical activity. These findings are consistent with prior reports that have generally reported a positive association between food insecurity and psychological distress in the general population and among adults with poorly controlled diabetes^{25–27} and extend these findings to adults at high risk of developing

diabetes. These findings support the results of Parker et al²⁸ that showed that both mild and severe food insecurity were associated with metabolic syndrome among adults.

Part of the relationship between food insecurity and depression may be explained by diet. Food insecurity is associated with greater consumption of high-fat, high-caloric foods.²⁹ Foods high in trans-fats (eg, fast foods, low-cost bakery items) have been associated with elevated risk of depression.^{30,31} Conversely, diets high in omega-3 fatty acids intake have been associated with higher likelihood of remitting from depression, potentially through anti-inflammatory properties and related pathophysiological effects.³² This is not to discount the role of social and environmental factors (eg, area-level poverty; perceptions of local food availability, safety, and opportunities for physical activity; neighborhood social cohesion), which have also been associated with food insecurity³³ as well as risk of depression^{34,35} and diabetes.³⁶

This research, in conjunction with the recently revised ADA Standards of Care recommendations regarding addressing hypo- and hyperglycemia in the context of food insecurity,⁷ highlight the need for health care professionals as well as community-based diabetes prevention and control programs to consider screening for food insecurity. Some have warned that screening for “social determinants” of health such as food insecurity would have unintended consequences, including harming the patient-provider relationship,³⁷ and there is an ethical imperative to only screen for conditions when a redress can be provided.³⁸ Alternatively, failing to understand the impact factors such as food insecurity has on the psychological correlates of diabetes, such as depression, may lead to incomplete care planning and lower adherence to self-management recommendations.³⁸ Approaches such as the collaborative care model (CCM) have demonstrated efficacy and cost-effectiveness and are improving clinical outcomes for patients with both depression and diabetes.³⁹ Because the CCM involves a health care team and comprehensive approach to diabetes management, it may be an ideal setting to pilot the impact of screening (and addressing) social determinants such as food insecurity for patients with diabetes.

Results should be interpreted in light of study limitations and strengths. While a key strength is the nationally representative nature of the NHANES sample, a consequence of this design is that this sample included only limited numbers of some racial/ethnic minorities (eg, American Indians, Asians, Native Hawaiians), which impacts our ability to generalize the results to these specific groups. In this analysis, clinically identified and undiagnosed (ie, screen-identified) cases of diabetes and prediabetes were combined because relying solely on clinically identified cases would substantially underestimate the number of cases, particularly of prediabetes. Food insecurity was assessed using a reliable questionnaire that accounts for both perceived and objective elements of food insecurity.^{19,40} Finally, this is a cross-sectional study; future work should examine the prospective relationship between food insecurity and diabetes care outcomes.

In summary, food insecurity is prevalent among adults with prediabetes and diabetes and is associated with depression for these groups. Future studies should investigate the possible pathways linking food insecurity and depression such as diet, nutrition education, and neighborhood environment.

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Table 1Characteristics of Adults With Prediabetes by Food Insecurity Status (N = 2004)^a

| | Food Secure | Mild Food Insecurity | Severe Food Insecurity | P Value |
|------------------------|-------------|----------------------|------------------------|---------|
| No. (weighted %) | 1433 (77.2) | 215 (8.5) | 356 (14.3) | |
| Gender | | | | .873 |
| Male | 839 (57.7) | 133 (57.0) | 187 (55.5) | |
| Female | 594 (42.3) | 82 (43.0) | 169(45.5) | |
| Age group | | | | <.001 |
| 20–44 y | 396 (33.2) | 83 (56.3) | 132 (50.0) | |
| 45–64 y | 509 (42.0) | 61 (34.0) | 135 (41.3) | |
| 65+ y | 397 (24.8) | 32 (9.7) | 46 (8.7) | |
| Race | | | | <.001 |
| Non-Hispanic white | 629 (72.5) | 71 (52.8) | 113 (52.9) | |
| Non-Hispanic black | 255 (8.1) | 56 (15.1) | 71 (12.4) | |
| Mexican American | 156 (7.0) | 41 (18.0) | 83 (19.6) | |
| Other ^b | 393 (12.4) | 47 (13.8) | 89 (15.1) | |
| Education | | | | <.001 |
| <High school | 251 (12.5) | 55 (23.1) | 113 (34.9) | |
| High school/GED | 279 (19.8) | 47 (32.0) | 85 (29.5) | |
| Some college/AA degree | 381 (32.4) | 50 (28.3) | 97 (32.0) | |
| College or more | 391 (35.3) | 24 (16.6) | 17 (3.7) | |
| Household income | | | | <.001 |
| 0%–130% FPL | 324 (15.4) | 113 (45.0) | 232 (58.6) | |
| 131%–250% FPL | 282 (18.8) | 50 (27.2) | 72 (26.7) | |
| >250% FPL | 714 (65.8) | 38 (29.9) | 26 (14.7) | |
| Smoking status | | | | <.001 |
| Current | 720 (15.7) | 96 (33.7) | 148 (38.6) | |
| Former | 379 (28.5) | 39 (16.6) | 64 (19.1) | |
| Never | 214 (55.8) | 48 (49.8) | 105 (42.3) | |
| Physical activity/wk | | | | <.001 |
| Light | 897 (70.8) | 119 (61.0) | 210 (57.9) | |
| Moderate/vigorous | 343 (29.2) | 66 (39.0) | 104 (42.1) | |
| Depressive symptoms | | | | <.001 |
| None | 1147 (95.0) | 155 (84.4) | 229 (77.6) | |
| Elevated | 73 (5.0) | 18 (15.6) | 63 (22.4) | |

^aValues are unweighted sample size (weighted percentage).

P values from Scott-Rao chi-square tests. FPL, federal poverty level.

^bIncludes American Indian, Alaska Native, Asian, Native Hawaiian and other Pacific Islander, and other Hispanic.

Table 2Characteristics of Adults With Diabetes by Food Insecurity Status (N = 1,724)^a

| | Food Secure | Mild Food Insecurity | Severe Food Insecurity | P Value |
|------------------------|-------------|----------------------|------------------------|---------|
| No. (weighted %) | 1141 (69.5) | 218 (10.2) | 365 (20.3) | |
| Gender | | | | .06 |
| Male | 619 (54.4) | 103 (45.5) | 157 (42.9) | |
| Female | 522 (45.6) | 115 (54.5) | 208 (57.1) | |
| Age group | | | | <.001 |
| 20–44 y | 112 (12.7) | 33 (15.4) | 84 (24.5) | |
| 45–64 y | 465 (43.1) | 106 (51.5) | 174 (52.5) | |
| 65+ y | 550 (44.2) | 77 (33.1) | 102 (23.0) | |
| Race/ethnicity | | | | .023 |
| Non-Hispanic white | 414 (64.7) | 61 (47.3) | 112 (51.5) | |
| Non-Hispanic black | 318 (12.1) | 77 (24.7) | 107 (17.5) | |
| Mexican American | 137 (7.6) | 45 (15.5) | 60 (14.7) | |
| Other ^b | 272 (15.6) | 35 (12.5) | 86 (16.3) | |
| Education | | | | .005 |
| <High school | 333 (21.7) | 80 (31.4) | 153 (28.5) | |
| High School/GED | 246 (22.7) | 48 (25.5) | 101 (30.9) | |
| Some college/AA degree | 302 (32.5) | 64 (32.5) | 85 (29.9) | |
| College grad or above | 244 (23.1) | 24 (10.7) | 20 (10.7) | |
| Household income | | | | <.001 |
| 0%–130% FPL | 302 (18.7) | 117 (50.6) | 234 (59.4) | |
| 131%–250% FPL | 258 (24.3) | 54 (37.2) | 75 (28.9) | |
| >250% FPL | 476 (57.0) | 36 (12.2) | 32 (11.7) | |
| Smoking status | | | | .002 |
| Current | 589 (10.9) | 102 (16.0) | 171 (23.0) | |
| Former | 400 (35.6) | 72 (33.9) | 97 (27.4) | |
| Never | 139 (53.5) | 43 (50.0) | 93 (49.5) | |
| Physical activity/wk | | | | .013 |
| Light | 879 (85.9) | 164 (73.8) | 250 (78.8) | |
| Moderate/vigorous | 148 (14.1) | 39 (26.2) | 78 (21.2) | |
| Depressive symptoms | | | | <.001 |
| None | 891 (93.1) | 154 (80.6) | 239 (75.6) | |
| Elevated | 110 (6.9) | 44 (19.4) | 82 (24.4) | |

^aValues are unweighted sample size (weighted percentage).

P values from Scott-Rao chi-square tests. FPL, federal poverty level.

^bIncludes American Indian, Alaska Native, Asian, Native Hawaiian and other Pacific Islander, and other Hispanic.

Table 3

Characteristics of Normoglycemic Adults by Food Security Status (N = 7713)

| | Food Secure | Mild Food Insecurity | Severe Food Insecurity | P Value |
|------------------------|-------------|----------------------|------------------------|---------|
| No. (weighted %) | 5248 (72.3) | 954 (11.7) | 1511 (16.0) | |
| Gender | | | | .531 |
| Male | 2433 (42.5) | 420 (41.0) | 712 (45.1) | |
| Female | 2815 (57.5) | 534 (59.0) | 799 (54.9) | |
| Age group | | | | <.001 |
| 20–44 y | 2281 (56.1) | 472 (71.3) | 789 (68.8) | |
| 45–64 y | 1453 (30.5) | 227 (23.5) | 405 (28.4) | |
| 65+ y | 980 (13.4) | 77 (5.1) | 100 (2.7) | |
| Race | | | | <.001 |
| Non-Hispanic white | 2290 (69.5) | 262 (45.2) | 497 (51.8) | |
| Non-Hispanic black | 1077 (9.6) | 301 (22.4) | 459 (21.6) | |
| Mexican American | 487 (6.8) | 164 (17.5) | 258 (11.8) | |
| Other ^b | 1394 (14.0) | 227 (14.8) | 297 (14.7) | |
| Education | | | | <.001 |
| <High school | 671 (11.0) | 206 (23.0) | 415 (28.2) | |
| High school/GED | 890 (16.5) | 210 (23.3) | 331 (21.8) | |
| Some college/AA degree | 1476 (29.5) | 271 (41.0) | 429 (39.4) | |
| College or more | 1675 (43.0) | 89 (12.7) | 119 (10.6) | |
| Household income | | | | <.001 |
| 0%–130% FPL | 1128 (17.6) | 486 (47.2) | 930 (59.9) | |
| 131%–250% FPL | 968 (17.9) | 240 (31.2) | 338 (24.4) | |
| >250% FPL | 2766 (64.5) | 171 (21.6) | 163 (15.6) | |
| Smoking status | | | | <.001 |
| Current | 3009 (14.7) | 441 (26.1) | 651 (37.6) | |
| Former | 1020 (20.5) | 133 (14.3) | 204 (16.1) | |
| Never | 758 (64.8) | 228 (59.6) | 461 (46.3) | |
| Physical activity/wk | | | | .071 |
| Light | 3025 (62.2) | 496 (61.9) | 775 (55.3) | |
| Moderate/vigorous | 1408 (37.8) | 311 (38.1) | 549 (44.7) | |
| Depressive symptoms | | | | <.001 |
| None | 4384 (95.1) | 715 (91.1) | 1071 (85.1) | |
| Elevated | 266 (4.9) | 74 (8.9) | 221 (14.9) | |

^aValues are unweighted sample size (weighted percentage).

P values from Scott-Rao chi-square tests. FPL, federal poverty level.

^bIncludes American Indian, Alaska Native, Asian, Native Hawaiian and other Pacific Islander, and other Hispanic.

Table 4

Relationship Between Food Insecurity and Elevated Depressive Symptoms Among Adults With Diabetes:
National Health and Nutrition Examination Survey (N = 1724)^a

| Variables | Odds Ratio (95% CI) | | |
|--|---------------------|----------------|---------------|
| | Model 1 | Model 2 | Model 3 |
| Food insecurity (reference, food secure) | | | |
| Mild food insecurity | 3.2 (1.4–7.3) | 2.6 (1.0–6.6) | 2.6 (1.0–7.0) |
| Severe food insecurity | 4.3 (2.4–7.7) | 3.5 (1.9–6.3) | 3.1 (1.4–6.7) |
| Sex (reference, male) | | | |
| Female | | 2.5 (1.3–4.6) | 2.9 (1.6–5.4) |
| Age (reference, 20–44 y) | | | |
| 45–64 y | | 1.9 (0.9–4.1) | 1.6 (0.6–4.0) |
| 65+ y | | 0.9 (0.4–2.0) | 0.9 (0.4–2.2) |
| Race (reference, non-Hispanic white) | | | |
| Non-Hispanic black | | 1.0 (0.4–2.3) | 1.2 (0.5–2.9) |
| Mexican American | | 0.9 (0.4–2.1) | 1.1 (0.4–2.8) |
| Other | | 0.9 (0.4–2.3) | 0.8 (0.3–2.0) |
| Education (reference, college or more) | | | |
| <High school | | 3.5 (1.2–10.2) | 3.1 (1.0–9.8) |
| High school/GED | | 2.2 (0.8–5.6) | 1.7 (0.5–5.2) |
| Some college/AA degree | | 2.3 (0.8–6.2) | 2.1 (0.7–6.3) |
| Household income (reference, >250% FPL) | | | |
| 0%–130% FPL | | 1.3 (0.5–3.1) | 1.0 (0.4–2.8) |
| >130%–250% FPL | | 1.2 (0.5–2.7) | 0.9 (0.4–2.0) |
| Smoking status (reference, never) | | | |
| Current | | | 1.3 (0.5–3.1) |
| Former | | | 1.4 (0.8–2.3) |
| Physical activity (reference, moderate/vigorous) | | | |
| Light exercise | | | 1.1 (0.6–2.1) |
| C-statistic | 0.63 | 0.71 | 0.71 |

^aThe outcome is elevated depressive symptoms as measured using the Patient Health Questionnaire-9 (PHQ-9).

FPL, federal poverty level.

Table 5

Relationship Between Food Insecurity and Elevated Depressive Symptoms Among Individuals With Prediabetes: National Health and Nutrition Examination Survey (N = 2,004)^a

| Variable | Odds Ratio (95% CI) | | |
|--|---------------------|---------------|---------------|
| | Model 1 | Model 2 | Model 3 |
| Food insecurity (reference, food secure) | | | |
| Mild food insecurity | 3.5 (1.4–8.4) | 2.7 (1.1–6.5) | 3.1 (1.2–8.3) |
| Severe food insecurity | 5.4 (3.4–8.8) | 3.2 (1.7–5.8) | 3.9 (1.7–9.0) |
| Sex (reference, male) | | | |
| Female | | 2.5 (1.3–4.6) | 2.1 (1.2–3.9) |
| Age (reference, 20–44 y) | | | |
| 45–64 y | | 1.8 (1.0–3.4) | 1.7 (0.9–3.0) |
| 65+ y | | 0.8 (0.4–1.6) | 0.6 (0.3–1.6) |
| Race (reference, non-Hispanic white) | | | |
| Non-Hispanic black | | 0.5 (0.2–1.0) | 0.6 (0.3–1.1) |
| Mexican American | | 0.3 (0.1–0.7) | 0.4 (0.2–0.8) |
| Other | | 0.6 (0.3–1.4) | 0.8 (0.3–1.6) |
| Education (reference, college or more) | | | |
| <High school | | 2.1 (0.8–5.9) | 2.1 (0.8–5.6) |
| High school/GED | | 1.7 (0.7–4.3) | 1.7 (0.7–4.3) |
| Some college/AA degree | | 1.1 (0.4–2.9) | 1.0 (0.4–2.5) |
| Household income (reference, >250% FPL) | | | |
| 0%–130% FPL | | 2.6 (1.5–4.4) | 1.8 (0.8–4.1) |
| >130%–250% FPL | | 1.7 (0.9–3.4) | 1.5 (0.8–3.0) |
| Smoking status (reference, never) | | | |
| Current | | | 1.4 (0.8–2.6) |
| Former | | | 1.7 (0.8–3.4) |
| Physical activity (reference, moderate/vigorous) | | | |
| Light | | | 2.1 (1.2–3.8) |
| C-statistic | 0.65 | 0.75 | 0.75 |

^aThe outcome is elevated depression symptoms as measured using the Patient Health Questionnaire-9 (PHQ-9).

FPL, federal poverty level.

Table 6

Relationship Between Food Insecurity and Elevated Depressive Symptoms Among Adults With Normoglycemia: National Health and Nutrition Examination Survey (N = 7,713)^a

| Variables | Odds Ratio (95% CI) | | |
|--|---------------------|---------------|---------------|
| | Model 1 | Model 2 | Model 3 |
| Food insecurity (reference, food secure) | | | |
| Mild food insecurity | 1.9 (1.0–3.6) | 1.4 (0.7–3.0) | 1.3 (0.7–2.6) |
| Severe food insecurity | 3.4 (2.1–5.5) | 2.2 (1.2–3.9) | 2.0 (1.0–3.9) |
| Sex (reference, male) | | | |
| Female | | 1.0 (0.5–1.8) | 0.9 (0.6–1.9) |
| Age (reference, 20–44 y) | | | |
| 45–64 y | | 1.9 (1.3–2.9) | 1.8 (1.1–3.0) |
| 65+ y | | 2.4 (1.4–4.1) | 2.3 (1.3–4.1) |
| Race (reference, non-Hispanic white) | | | |
| Non-Hispanic black | | 0.6 (0.3–1.2) | 0.7 (0.4–1.3) |
| Mexican American | | 0.4 (0.2–0.9) | 0.4 (0.1–1.1) |
| Other | | 1.0 (0.5–1.8) | 1.0 (0.6–1.9) |
| Education (reference, college or more) | | | |
| <High school | | 1.2 (0.5–3.0) | 0.9 (0.3–2.4) |
| High school/GED | | 1.3 (0.5–3.2) | 1.0 (0.4–2.5) |
| Some college/AA degree | | 2.1 (1.0–4.6) | 1.7 (0.7–3.7) |
| Household income (reference, >250% FPL) | | | |
| 0%–130% FPL | | 3.9 (1.9–7.6) | 3.0 (1.5–6.2) |
| >130%–250% FPL | | 3.1 (1.6–6.2) | 2.7 (1.3–5.3) |
| Smoking status (reference, never) | | | |
| Current | | | 2.1 (1.3–3.4) |
| Former | | | 1.3 (0.7–2.4) |
| Physical activity (reference, moderate/vigorous) | | | |
| Light | | | 1.7 (1.0–2.9) |
| C-statistic | 0.59 | 0.73 | 0.74 |

^aThe outcome is elevated depressive symptoms as measured using the Patient Health Questionnaire-9 (PHQ-9).

FPL, federal poverty level.