The Relationship Between Food Insecurity and Depression, Diabetes Distress and Medication Adherence Among Low-Income Patients with Poorly-Controlled Diabetes

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BACKGROUND: Food insecurity— lack of dependable access to adequate food—may play a role in poor diabetes control.

OBJECTIVE: We aimed to determine the relationship between food security status and depression, diabetes distress, medication adherence and glycemic control.

DESIGN: Secondary analysis of baseline data from Peer Support for Achieving Independence in Diabetes, a randomized controlled trial that enrolled patients from November 2011 to October 2013.

PARTICIPANTS: Participants had poorly controlled type 2 diabetes (A1c $\geq$ 8.0 % on eligibility screen), household income < 250 % of the federal poverty level, were 30–70 years old, and were recruited from a large public hospital, a VA medical center and a community-health center in King County, Washington.

MAIN MEASURES: We measured food insecurity determined by the Department of Agriculture's 6-Item Food Security Module. Depression, diabetes distress and medication adherence measured by PHQ-8, Diabetes Distress Scale and Morisky Medication Adherence Scale, respectively. Diet was assessed through Summary of Diabetes Self-Care Activities and Starting the Conversation tool. Incidence of hypoglycemic episodes was by patient report. Glycemic control was assessed with glycosylated hemoglobin (A1c) values from fingerstick blood sample.

KEY RESULTS: The prevalence of food insecurity was 47.4 %. Chi-square tests revealed participants with food insecurity were more likely to be depressed (40.7 % vs. 15.4 %, p<0.001), report diabetes distress (55.2 % vs. 33.8 %, p<0.001) and have low medication adherence (52.9 % vs. 37.2 %, p=0.02). Based on linear regression modeling, those with food insecurity had significantly higher mean A1c levels (β=0.51; p=0.02) after adjusting for sex, age, race/ethnicity, language, education, marital status, BMI, insulin use, depression, diabetes distress and low medication adherence.

CONCLUSIONS: Almost half of participants had food insecurity. Food insecurity was associated with depression, diabetes distress, low medication adherence and worse glycemic control. Even with adjustment, people with food insecurity had higher mean A1c levels than their food-secure counterparts, suggesting there may be other mediating factors, such as diet, that explain the relationship between food security status and diabetes control.

KEY WORDS: food insecurity; diabetes; glycemic control.
J Gen Intern Med 30(10):1476–80
DOI: 10.1007/s11606-015-3351-1

Received October 3, 2014
Revised February 26, 2015
Accepted March 27, 2015
Published online April 28, 2015

INTRODUCTION

Food insecurity is defined as the lack of dependable access to adequate, safe and nutritious foods necessary for a healthy life.[1] In the United States, one in seven households experienced food insecurity in 2013.[2] For those with diabetes, being food-insecure is associated with poorer glycemic control,[3–5] as well as increased risk of hypoglycemic events and hypoglycemia-related emergency department visits.[6,7] The mechanisms through which food insecurity affects glycemic control are not well understood. We hypothesize that depression, diabetes distress and low medication adherence—risk factors for worse glycemic control—could mediate the relationship between food insecurity and diabetes control.

Among the general population, people with food insecurity report higher levels of depression, stress and anxiety.[8,9] Few studies have assessed this association in people living with diabetes.[10] Depression is associated with poorer glycemic control,[11,12] as well as poorer adherence to diet and medication regimens.[13] Diabetes distress refers to the emotional distress related to the burdens and treatment of diabetes. Seligman et al. found higher levels of diabetes-related emotional distress in patients with food insecurity.[3] This is not surprising, given that the diabetes distress questionnaire measures feelings of doubt and uncertainty regarding one's ability to manage diabetes appropriately, including the ability to follow a good meal plan.[14] By definition, people with food insecurity have limited control over what they eat. This sense of powerlessness over nutrition may lead to diabetes distress. As with depression,

diabetes distress is associated with poorer glycemic control and medication adherence.[15]

Individuals with food insecurity report taking medication less often than prescribed due to costs and deferring paying for medication in order to have money for food.[16,17] Due to competing financial demands, participants with diabetes and food insecurity may have lower medication adherence. This, in turn, may result in higher glycosylated hemoglobin (A1c) values, as medication adherence, in and of itself, is associated with and predictive of glycemic control.[18,19]

The purpose of this study is to evaluate the relationships between food insecurity and depression, diabetes distress and medication adherence, and to determine whether these factors are part of the pathway between food insecurity and glycemic control. A better understanding of the relationship between food insecurity status and diabetes control may identify new intervention targets for patients with poorly controlled diabetes.

METHODS

We analyzed baseline data from the Peer Support for Achieving Independence in Diabetes (Peer-AID) study. Peer-AID is a NIH-funded randomized controlled study evaluating a home-based diabetes self-management intervention delivered by community health workers. The study took place in King County, Washington, with enrollment from November 2011 to October 2013.

Participants were recruited from three healthcare systems: a large public hospital, a VA medical center and a community-health center. Eligible participants had a diagnosis of type 2 diabetes (as documented in the electronic health record) with poor glycemic control (defined as an A1c of 8.0 % or greater during the 3-month period prior to enrollment), a household income of less than 250 % of the federal poverty level (which corresponds to $27,225 or less for an individual in 2011), and were between 30 and 70 years of age, residing in King County. At the time of enrollment, a fingerstick A1c was obtained. Participants whose A1c value had improved to less than 8.0 % at time of enrollment interview (n=79) were still enrolled. Exclusion criteria included participation in another diabetes study, previous formal diabetes education in the past 3 years, being homeless, planning on moving out of King County or having dementia, end-stage renal disease or a terminal illness. Additional details have been previously published.[20]

The institutional review boards of the University of Washington, VA Puget Sound and Sea Mar Community Health Centers approved the study.

Measures

Baseline data included self-reported age, race/ethnicity, primary language, education level, marital status, employment status, insurance status, comorbid medical conditions and insulin use. All participants reported annual household incomes of less than 250 % of the federal poverty level. More detailed income information was not collected.

Food security status was determined using the United States Department of Agriculture's validated Six-Item Short Form Food Security Survey Module.[21] Each response was given a score of 0 or 1. Those with a summed score of 0 or 1 were classified as having food security; those with a summed score of 2 or greater were classified as having food insecurity.

Depressive symptoms were assessed using the PHQ-8, with depression defined as PHQ-8 score of greater or equal to 10.[22,23] Health-related quality of life was measured with the SF-12, with higher scores representing better perceived health.[24] To assess diabetes-related distress, a 17-item validated measure was used. Participants whose scores placed them in the "moderate diabetes distress" or "high diabetes distress" categories were labeled as having diabetes distress, and those with "no or low diabetes distress" were labeled as not having diabetes distress.[14,25] Medication adherence was evaluated through a composite score of an eight-question survey, with participants classified as having low adherence or moderate/high adherence.[26]

We assessed diet through two measures: the Summary of Diabetes Self-Care Activities (SDSCA) diet score and the Starting the Conversation tool, which assesses the quantity and frequency of consumption of specific foods such as fruits, vegetables, fast food and sugary beverages.[27] SDSCA diet score was calculated as the mean number of days in the past week and the mean number of days per week in the past month that the participant reported following a healthful eating plan.[28]

Hypoglycemia was assessed by asking, "In the past 12 months, have you had episodes of very low blood sugar?" Those who responded positively were asked a follow-up question: "Are these episodes related to not being able to afford food?"[29]

Glycemic control was assessed with A1c levels. Baseline A1c values were obtained through a fingerstick blood sample taken during the enrollment interview.[19] Pre-enrollment clinic A1c levels were used if this value was missing [n=29 (10 %)]. Height, weight and blood pressure were measured at the initial visit. Body mass index (BMI) was calculated from measured height and weight. Obesity was defined as a BMI $\geq$30 kg/m^2.

Statistical Analysis

We performed bivariate analyses to examine the differences in sociodemographic and health characteristics between individuals with and without food insecurity, with chi-square tests for categorical variables and t-tests for continuous variables. We performed separate logistic regression models with food security status as the independent variable, and depression, diabetes distress and medication adherence as the dependent variable. We calculated the odds ratio of having depression, diabetes distress or low medication adherence in people with food insecurity. For these regression models, we adjusted for age,

gender, race/ethnicity, language, education, marital status, BMI and insulin use.

We used three separate linear regression models to assess the relationships between glycemic control (dependent variable) and depression, diabetes distress and low medication adherence, respectively. We adjusted for age, gender, race/ethnicity, language, education, marital status, BMI and insulin use.

To model the relationship between food insecurity and glycemic control, we developed five multivariable linear regression models. In the first, we adjusted for age, gender, race/ethnicity, language, education, marital status, BMI and insulin use. In the second, third and fourth, we adjusted for the socio-demographic factors above plus depression, diabetes distress and low medication adherence, respectively. In the final model, we adjusted for sociodemographics, depression, diabetes distress and low medication adherence. We separately tested depression, diabetes distress and low medication adherence using the Sobel-Goodman mediation test to determine to what extent these factors mediate the relationship between food insecurity and glycemic control.[30]

Analyses were conducted using STATA 12.0 (StataCorp. 2011. *Stata Stastical Software: Release 12*. College Station, TX: StataCorps LP).

RESULTS

The prevalence of food insecurity among study participants was 47.4 %. Patient characteristics, grouped by food security status, are reported in Table 1. There were significant differences by gender, race/ethnicity, marital status and employment status, with females, non-white and non-Hispanic participants, unmarried individuals and those unable to work more likely to have food insecurity. Participants with food insecurity had a higher average BMI scores and were more likely to be obese. They also had lower SF-12 scores, indicating worse health status. A greater percent of individuals with food insecurity were prescribed insulin compared to those without food insecurity. In addition, participants with food insecurity experienced hypoglycemic events at higher rates. Notably, only individuals with food insecurity attributed their hypoglycemia to inability to afford food. There were no statistically significant differences in age, education level, health insurance status or diet.

The prevalence of depression, diabetes distress and low medication adherence was significantly higher in the group with food insecurity. Table 2 shows that adjusted odds ratio (OR) for depression, diabetes distress and low medication adherence, respectively, among individuals with food insecurity. Compared to those with food security, individuals with food insecurity had greater odds of being depressed (OR 2.82, 95 % CI1.50-5.31; p=0.001), having diabetes distress (2.32, 95 % CI 1.38-3.91; p=0.002); and having low medication adherence (1.96, 195 % CI 1.15-3.35; p=0.01).

We modeled the relationships between glycemic control and depression, diabetes distress and low medication adherence using linear regression. The β coefficient represents the difference in mean A1c between those with and without depression, diabetes distress and low medication adherence, respectively. We found that depression (β=0.55; p=0.03) and diabetes distress (β=0.64; p=0.003) are both associated with higher mean A1c values. We found no significant association between low medication adherence (β=0.38; p=0.08) and glycemic control.

Table 1 Participant Characteristics by Food Security Status

	Secure (n=151)	Insecure (n=136)	p value
Female (%)	39.1	59.6	**0.001**
Age (mean)	52.6	52.4	0.83
Race/Ethnicity (%)			**0.02**
White, non-Hispanic	20.5	21.3	
Black, non-Hispanic	19.9	30.9	
Other, non-Hispanic	8.6	14.0	
Hispanic, any race	51.0	33.8	
Speaks language other than English at home (%)	53.6	40.4	**0.03**
Education (%)			0.90
Less than High School or GED	35.1	33.3	
High School or GED	25.2	27.4	
More than High School or GED	39.7	39.3	
Marital status (%)			**<0.001**
Married/In relationship	54.3	31.6	
Divorced/Separated	24.5	33.8	
Single	21.2	34.6	
Employment Status (%)			**0.04**
Employed	32.5	24.3	
Unemployed	14.6	14.7	
Student/Homemaker/Retired	20.5	13.2	
Unable to work	32.5	47.8	
Uninsured (%)	46.7	39.4	0.35
BMI (mean)	32.5	34.7	**0.04**
Weight status (%)			**0.001**
Normal (18.5 ≤ BMI < 25)	11.3	13.2	
Overweight (25≤BMI <30)	39.1	18.4	
Obese (BMI≥30)	49.7	68.4	
SF 12 (mean summary score)			
Physical	41.5	37.1	**0.001**
Mental	48.9	44.6	**0.003**
On Insulin (%)	54.1	68.4	**0.01**
Hypoglycemia in Past Year (%)	45.2	57.7	**0.04**
Hypoglycemia due to inability to afford food (%)	0	42.3	**<0.001**
General diet score (mean)	4.11	3.78	0.27
Eats fast food meals/snack at least once/week (%)	58.9	52.9	0.31
Drinks one or more sugary beverages/day (%)	34.4	34.6	0.98
Eats more than 2 servings of fruit/day (%)	42.7	33.3	0.07
Eats more than 2 servings of vegetables/day (%)	34.4	35.3	0.88
Depression	15.4	40.7	**<0.001**
Diabetes Distress	33.8	55.2	**<0.001**
Low Medication Adherence	37.2	52.9	**0.02**

All statistically significant numbers are bolded

Table 2 Increased Odds of Depression, Diabetes Distress and Medication Adherence Among Individuals with Food Insecurity

	OR (95 % CI)	p value
Depression	2.82 (1.50-5.31)	**0.001**
Diabetes distress	2.32 (1.38-3.91)	**0.002**
Low medication adherence	1.96 (1.15-3.35)	**0.01**

All models are adjusted for sex, age, race/ethnicity, language, education, marital status, BMI and insulin use. All statistically significant numbers are bolded

Table 3 displays the associations between food insecurity and glycemic control. The average unadjusted A1c level for individuals with food insecurity was 0.64 % higher than that of participants without food insecurity. When depression, diabetes distress and low medication adherence were individually added to the model, there was a slight attenuation of this relationship. When all three factors were included in the fully adjusted model, the mean A1c level for individuals with food insecurity was 0.51 % higher. Using the Sobel-Goodman mediation tests, depression and diabetes distress mediated 8.3 % and 18.7 % of the total effect, respectively. Low medication adherence was not tested because the association between low medication adherence and A1c was not significant.

DISCUSSION

We found that food insecurity is associated with increased rates of depression, diabetes distress and low medication adherence, confirming previous findings. We additionally confirmed the association between food insecurity and worse glycemic control among low-income patients with diabetes. When we adjusted for depression, diabetes distress and low medication adherence in the linear regression models of food insecurity and A1c, we observed a slight decrease in the difference in glycemic control among people with and without food insecurity. This decrease suggests that these factors are on the pathway between food insecurity and glycemic control. However, the fact that there remains a difference in mean A1c values between individuals with food insecurity and those without despite adjustment suggests there are other factors beyond depression, diabetes distress and low medication adherence mediating the relationship between food insecurity and glycemic control.

The most likely factor is nutrition, specifically the increased consumption of unhealthy foods by people with food insecurity. Among adults with diabetes, food insecurity is associated with lower overall dietary quality and lower consumption of healthy foods.[31] These individuals are limited to cheaper, more calorie-dense and high-sugar foods that promote high blood sugar.[32] In this study, however, we did not find differences in diet between participants with and without food security. This may be due to the fact that the SDSCA diet measure and the Starting the Conversation tool, both of which are based on self-report, do not accurately capture the nutritional quality of the food consumed.

Strengths of our study include recruitment of patients from diverse clinical settings, as well as minimal exclusion criteria, which allow the results to be more generalizable. We used well-validated measures to assess health outcomes. However, our study has limitations. Our ability to determine causal associations is limited by the cross-sectional nature of the analysis. Though we aimed for completeness, we may have lacked data on all the factors that mediate the relationship between food insecurity and glycemic control.

Even if depression, diabetes distress and low medication adherence do not fully explain the relationship between food insecurity and glycemic control, our findings that these variables are more prevalent in patients with food insecurity may have clinical relevance. Currently screening for food insecurity is uncommon in the primary care setting. However, identifying patients with food insecurity through screening may detect patients who are at increased risk for other poor health outcomes and who would benefit from targeted interventions (such as treating depression or addressing difficulties with medication adherence). The value of screening low-income patients with diabetes for food insecurity is an area for future research.

Table 3 Associations between Food Insecurity Status and Glycemic Control

Model	β	p value
Food insecurity and A1c, unadjusted	0.64	**0.003**
Food insecurity and A1c, adjusted*	0.64	**0.003**
Food insecurity and A1c, adjusted* for Depression	0.60	**0.007**
Food insecurity and A1c, adjusted* for Diabetes Distress	0.54	**0.02**
Food insecurity and A1c, adjusted* for and Medication Adherence	0.60	**0.007**
Food insecurity and A1c, adjusted* for and Depression, Diabetes Distress and Medication Adherence	0.51	**0.02**

All statistically significant numbers are bolded
**Adjusted for sex, age, race/ethnicity, language, education, marital status, BMI and insulin use*

Acknowledgements: *This study was supported by the NIH/NIDDK grant 5R18DK088072 to Drs. Nelson and Krieger (co-PIs). The sponsor had no role in designing the study; collecting, analyzing, or interpreting data; writing this manuscript; or in the decision to submit this manuscript for publication. Additional funding was provided by the Veterans Health Administration (VHA) Diabetes Quality Enhancement Research Initiative (QUERI) to support Veteran recruitment efforts. The views expressed in this article are those of the authors and do not necessarily reflect the views of the Department of Veterans Affairs.*
We gratefully acknowledge the participants in this study who gave their time to participate; our community health workers, Michelle DiMiscio and Maria Rodriguez; and our program manager, Nathan Drain. We would like to thank Harborview Medical Center, Sea Mar Clinics and the VA Puget Sound for their collaboration in the project.

Conflict of Interest: *The authors declare that they do not have a conflict of interest.*

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