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Food Insecurity is Associated with Hypoglycemia and Poor Diabetes Self-Management in a Low-Income Sample with Diabetes

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Abstract

More than 14% of the American population is *food insecure*, or at risk of going hungry because of an inability to afford food. Food-insecure (FI) adults often reduce food intake or substitute inexpensive, energy-dense carbohydrates for healthier foods. We hypothesized these behaviors would predispose FI adults with diabetes to impaired diabetes self-management and hypoglycemia. We therefore assessed whether food insecurity was associated with multiple indicators of diabetes self-management (self-efficacy, medication- and glucose-monitoring adherence, hypoglycemia, or glycemic control) among 40 low-income adults with diabetes. Mean self-efficacy score was lower among FI than food-secure (FS) participants (34.4 vs. 41.2, $p=.02$). Food-insecure participants reported poorer adherence to blood glucose monitoring (RR=3.5, $p=.008$) and more hypoglycemia-related emergency department visits (RR=2.2, $p=.007$). Mean hemoglobin A1c was 9.2% among FI and 7.7% among FS participants ($p=.08$). Food insecurity is a barrier to diabetes self-management and a risk factor for clinically significant hypoglycemia.

Keywords

Hunger; diabetes; self care; hypoglycemia

In 2008, 14.6% of households in the United States (more than 49 million people) were food insecure, or at risk of going hungry because of an inability to afford food.¹ Food insecurity exists whenever “the availability of nutritionally adequate and safe foods or the ability to

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acquire acceptable foods in socially acceptable ways [e.g., without resorting to emergency food supplies, scavenging, stealing or other coping strategies] is limited or uncertain.”²[p.1560] There are a number of ways in which food insecurity might impair diabetes self-management. First, to maintain caloric intake, food-insecure adults often shift their diets toward energy-dense, nutritionally-poor foods (such as refined carbohydrates, added sugars, and added fats), which diabetic patients are counseled to avoid in order to optimize glycemic control. Such foods are less expensive than equicaloric portions of fruits, vegetables, and dairy products.^{3,4} Second, daily caloric and carbohydrate intake may fluctuate widely in response to food availability, making blood glucose levels unpredictable and complicating the development of optimal medication and insulin regimens.^{5,6} Finally, the cost of food among those with food insecurity may present a competing demand with costs of diabetes medication and supplies. Prior research has shown that food insecurity is associated with suboptimal glycemic control among adults with diabetes,^{7,8} but mechanisms for this association have not been studied. We hypothesized that the association between food insecurity and suboptimal glycemic control is due to increased difficulty with diabetes self-management and more frequent episodes of clinically significant hypoglycemia (which may encourage clinicians to relax glycemic targets).

Methods

Setting and participants

This study of patients with diabetes is nested within a larger study examining the association between health literacy and cardiovascular disease. Patients were recruited for the larger study between July 2006 and August 2007. To be eligible for the larger study, patients had to have a diagnosis of hypertension documented in the medical record, be taking antihypertensive medication, be over 18 years of age, and be seeking care at one of four primary care safety net clinics in Chicago, Illinois or Shreveport, Louisiana. Clinics in Chicago (n=2) were affiliated with federally qualified health centers; one clinic in Shreveport was a community health center and the other a public hospital ambulatory care clinic. Patients were ineligible if they did not speak English or if the clinic nurse determined (by interaction or chart documentation) that they were too ill to participate or were cognitively impaired. While most participants receive free or low-cost medications through their clinics, access to blood sugar testing supplies is more variable.

Nurses identified 377 potentially eligible patients, of whom 334 provided informed consent. Patients were subsequently excluded because they did not take blood pressure medication (n=15) or did not complete the interview (n=4), leaving a total of 315 patients. Using American Association for Public Opinion Research standards,⁹ 87.5% of approached, eligible patients participated in the study.

At six-month follow-up, we reached 116 of the 315 patients for a brief telephone survey (a 37% follow-up rate after five call attempts). We included in this analysis all participants who participated in the telephone survey and reported a diagnosis of diabetes (n=40). We confirmed self-reported diagnoses of diabetes by a medical chart review, with diabetes defined as a recorded diabetes diagnosis, one or more hemoglobin A1c measurements, and current use of diabetes medications. The institutional review boards at each location approved the study procedures.

Data collection and analysis

Study personnel conducted baseline in-person interviews. At the baseline interview, we determined demographic characteristics, insurance coverage, physical activity level, and tobacco use by self report. We measured self-efficacy using a five-item chronic illness

general self-efficacy scale.¹⁰ A trained chart abstractor abstracted the most recent hemoglobin A1C from the medical record. During the six-month telephone survey, we measured food security using the six-item Food Security Survey Module, a well-validated measure of food insecurity which asks about access to food over the previous 12 months (Box 1).¹¹ Two or more affirmative answers indicate food insecurity. We also asked participants questions about adherence to medication and blood glucose testing, lifetime experience with hypoglycemia, attribution of hypoglycemia to the inability to access food, and trade-offs between food and medications.¹²

Our main outcome was lifetime experience with hypoglycemia. Secondary outcomes included self-efficacy, medication and glucose-monitoring adherence, food-money trade-offs, and glycosylated hemoglobin value (or HbA1c, a measure of glycemic control). Self-efficacy refers to one's confidence in their abilities to carry out the necessary actions to control their medical illness, and is associated in prior studies with self-care behaviors and diabetes outcomes.¹³ A higher score indicates greater self-efficacy. A higher HbA1c indicates poorer glycemic control.

We compared outcomes between food-insecure and food-secure participants using Fisher's exact and t-tests. We used Poisson regression with robust standard errors to compute relative risks with 95% confidence intervals. We do not report adjusted results because demographic characteristics of food-insecure and food-secure participants were similar.

Results

Of the eligible participants (n=40), 35% were male, 83% African American, 85% with an income below 200% of the federal poverty level, and 55% unemployed. Eighteen (45%) were food-insecure. There were no statistically significant differences between food-insecure and food-secure participants by gender, race, marital status, insurance, employment status, tobacco use, or level of physical activity. There was also no difference in household income between food-secure and food-insecure participants, which likely reflects the very low household income of the entire sample (49% with household income below \$10,000 per year, 28% with household income \$10,000–15,000 per year, and 23% with household income >\$15,000 per year).

Mean self-efficacy score was 34.4 among food-insecure participants and 41.2 among food-secure participants (mean score 38.9, SD 8.6; $p=0.02$). We observed statistically significant relationships between food insecurity and indicators of diabetes self-management, including poor adherence to blood glucose monitoring and lifetime history of hypoglycemia-related emergency department visits (Table 1). Food-insecure participants reported being more likely to put off paying for testing supplies (44.4% vs. 4.6%, RR 2.76, $p<.001$) and diabetes medications (38.9% vs. 9.1%, RR 2.19, $p=.01$) so that they would have enough money to buy food; similarly, they reported being more likely to put off buying food in order to have enough money for testing supplies (33.3% vs. 9.1%, RR 2.00, $p=.03$) and diabetes medicines (55.6% vs. 18.2%, RR 2.32, $p=.01$). Mean HbA1c among the 37 patients with an available value was 9.1% among food-insecure participants and 7.7% among food-secure participants ($p=.08$).

Discussion

This is the first study to assess food insecurity as a barrier to successful diabetes self-management. We identified statistically significant associations between food insecurity and various indicators of self-management, including self-efficacy, medication and blood glucose testing adherence, and hypoglycemia. This study specifically asked participants

about hypoglycemic reactions that required a visit to the emergency room. Although our findings must be considered preliminary due to the small sample size, the association we observed between food insecurity and severe hypoglycemia suggests a major patient safety issue and the urgent need to confirm our findings in larger samples.

The average food-insecure household cycles through adequate and inadequate food supplies seven times each year.¹ This cycle of food insecurity may help explain how food insecurity may be associated with both hyperglycemia and hypoglycemia. Hypoglycemia may occur when meals are skipped or caloric intake is reduced in response to inadequate food supplies. Hyperglycemia may result from the inability to afford diabetes-appropriate foods, overconsumption during food adequacy (a behavior often observed among adults exposed to episodic food scarcity), reduced medication adherence, or lack of medication intensification by clinicians because of frequent hypoglycemic episodes or unpredictable dietary intake.⁶⁻¹⁴ Food-insecure patients are also more likely to have to choose between food and diabetes medication or supplies, a choice that is also likely to predispose patients to either hypoglycemia (if medications are taken instead of food) or hyperglycemia (if food is eaten instead of medications).¹⁵⁻¹⁶ Our findings confirm the clinical impact of these difficult budget decisions.

In addition to the small sample size, this study was limited by its cross-sectional nature and our inability to adjust for diabetes duration and medication regimen. We cannot definitively determine whether food insecurity causes poor self-management, or is simply a marker for poverty. However, it is likely that food insecurity represents a risk factor for poor self-management beyond poverty because all the patients in our sample had very low household incomes and educational attainment, which did not differ by food insecurity status. In addition, the patient attributions of their hypoglycemic episodes to the inability to afford food supports a causal relationship between food insecurity and hypoglycemia. All the participants in this study had hypertension as well as diabetes, so our findings may not be generalizable to patients with diabetes only. In addition, our findings may not be generalizable to non-English speaking patients, who were excluded from this analysis. Future research should replicate these results in larger populations and also estimate the extent to which food insecurity contributes to well-known socioeconomic inequalities in glycemic control.

The very high rate of food insecurity in this clinical population suggests that clinicians providing care to low-income patients with diabetes should screen for food insecurity, both to tailor treatment decisions and identify increased risk of hypoglycemia. A single screening question has acceptable sensitivity and specificity for this purpose: “In the past month, was there any day when you or anyone in your family went hungry because you did not have enough money for food?”¹⁷ Dietary counseling provided to food-insecure patients with diabetes should emphasize cost-neutral strategies, such as reduced portion sizes, rather than food substitutions. Treatment regimens should emphasize use of medications that carry a lower risk of hypoglycemia when food access is unpredictable. For example, metformin and sulfonylureas with short half-lives carry a very low risk of hypoglycemia. Finally, glycemic targets may need to be adjusted upward to mitigate the elevated hypoglycemia risk associated with food insecurity.

FOOD SECURITY SURVEY MODULE

Question	Response Options
The next questions are about the food eaten in your family. People do different things when they are running out of money for food to make their food or their food money go further.	

Question	Response Options
In the last 12 months, did you ever cut the size of your meals or skip meals because there wasn't enough money for food?	Yes ^a , no
[If yes] How often did this happen? Would you say ...	Almost every month, some months but not every month ^a , or only in 1 or 2 months
In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?	Yes ^a , no
In the last 12 months, were you ever hungry but didn't eat because you couldn't afford enough food?	Yes ^a , no
Now I'm going to read you 2 statements that people have made about their food situation. For these statements, please tell me whether the statement was often, sometimes, or never true for you or other members of your household in the last 12 months.	
The first statement is "The food that I bought just didn't last, and I didn't have money to get more."	Often true, sometimes true ^a , never true
"I couldn't afford to eat balanced meals."	Often true, sometimes true ^a , never true

^a Affirmative responses are indicated in bold.

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Table 1**ASSOCIATION BETWEEN FOOD INSECURITY AND DIABETES SELF-MANAGEMENT (N=40)**

		Food Secure, %	Food Insecure, %	RR (95% CI)
Medication Adherence	Missed taking any of your diabetes pills in the last week	18.2	33.3	1.50 (0.76–2.95)
	Ever take less medicine than prescribed because could not afford to buy more	13.6	38.9	1.91 (1.02–3.58)
Glucose- monitoring Adherence	Missed checking your blood sugar in the last week	13.3	69.3	3.48 (1.39–8.70)
	Ever check blood sugar less frequently than supposed to because couldn't afford supplies	9.1	33.3	2.00 (1.09–3.67)
Hypoglycemia	Ever been to the Emergency Room because your blood sugar was too low	4.6	27.8	2.18 (1.24–3.83)
	Blood sugar ever gotten too low because you couldn't afford enough food	4.6	33.3	2.36 (1.36–4.09)

RR = Respiratory Rate

CI = Confidence Interval