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Foods for Health: An Integrated Social Medical Approach to Food Insecurity Among Patients With Diabetes

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Abstract

Purpose: Examine a clinic-based approach to improve food security and glycemic control among patients with diabetes.

Design: One-group repeated-measures design.

Setting: Federally Qualified Health Centers in a large Midwest city.

Sample: Of the 933 patients with diabetes who consented at baseline, 398 (42.66%) returned during the follow-up period for a visit that included Hemoglobin A1c (HbA1c) results.

Intervention: Integrated social medicine approach that includes food insecurity screening, nutrition education, and assistance accessing food resources as a standard-of-care practice designed to minimize disruptions in how patients and providers experience medical care.

Measures: HbA1c collected as part of a standard blood panel.

Analysis: Repeated-measure, mixed-effect linear regression models.

Results: There was a decrease in mean HbA1c ($\Delta = -0.22$, $P = 0.01$) over the study period. The model examining change over time, glycemic control (GC), and food security status ($F_{1,\ 352} = 5.80$, $P = 0.02$) indicated that among participants with poor GC (33.12%), food secure (FS) participants exhibited significantly greater levels of improvement than food insecure (FI) participants ($\Delta = -0.55$, $P = 0.04$). Among participants with good GC, changes in HbA1c were not significantly different between FS and FI participants ($\Delta = 0.23$, $P = 0.21$).

Conclusion: Providing nutrition education and food assistance improved HbA1c profiles among FS and FI participants, but FI participants may face social and structural challenges that require additional support from health care teams.

Keywords
diabetes mellitus, community health centers, social medicine, food insecurity, health status disparities

Purpose

The term *social determinants of health* (SDoH) refers to a range of interrelated social, economic, and environmental factors that characterize the places where people live.[1-3] Chief among these determinants are fundamental needs such as basic housing, reliable transportation, access to adequate and acceptable food, and interpersonal safety; these fundamental needs help an individual support themselves and their families and exercise their basic human rights.[4-7] Data suggest that these factors contribute more to positive health outcomes than access to medical care.[8] Accordingly, improving health and achieving health equity require approaches that address the social determinants that influence health.

Food security is a SDoH defined as consistently “having physical, social and economic access to sufficient, safe and nutritious food to meet dietary needs and food preferences for an active and healthy life.”[9] Food insecurity occurs in households where at least some members of the household do not have this access. In 2016, 35% of low-income U.S. households experienced some level of food insecurity.[10]

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Food insecurity complicates self-care among people with diabetes.[11-13] Many food insecure (FI) adults experience financial constraints such as the need to prioritize household bills or medicine and monitoring supplies over food.[14-16] They are more likely to consume less expensive, less healthful diets,[17,18] and having inadequate or inconsistent access to nutritious foods affects their ability to maintain a dietary regimen that manages blood glucose levels.[16,19] As a result, people with diabetes who experience food insecurity are likely to have 5 times more physician encounters than those who can afford to maintain an adequate, diabetes-appropriate diet.[20] The total annualized medical expenditure related to food insecurity among patients with diabetes in the United States is estimated at $77.5 billion in additional health care spending.[21]

Awareness of the importance of assessing social determinants in the health care setting, including national efforts aimed at creating standardized approaches to screening and recording social determinant data, is growing.[22,23] The American Diabetes Association (ADA) recommends that health care providers consider social determinants, including food security, when assessing treatment for patients.[24] They also recommend that providers refer patients to local resources in the community when applicable. Several studies have demonstrated that food security screening in primary care settings serving low-income populations is feasible. One study screened for food security in Veterans Administration clinics serving homeless and formerly homeless veterans using a 1-question query to determine food security status (FSS).[25] Results indicated that the integration of food security screening was well received by health care providers and patients and helped clinic staff members build rapport with patients. Another study found that patients could be successfully screened for food security, offered the opportunity to receive monthly food distributions, and provided assistance with Supplemental Nutrition Assistance Program (SNAP) enrollment.[17] Although the preceding studies demonstrate that screening for food security among a low-income patient population can be accomplished, a recent review of the literature on food security screening found that barriers to screening uptake exist. These barriers include provider concerns about the acceptability of screening questions, lack of provider training, and provider concerns about the availability of community resources to address identified needs.[26]

Few studies to date have looked prospectively at whether food security screening coupled with community resource referrals can improve diabetes-related, clinical outcomes that are important benchmarks for providers and health care systems. Noteworthy exceptions include a pair of studies conducted in food pantries.[27,28] Individuals with diabetes were screened for food security and provided diabetes self-management support and primary care referral. These studies demonstrated that improvements in glycemic control (GC) are possible, but they did not examine the potential benefits of screening for food security in a primary care setting.

This study examines the effects of implementing a social-medical standard-of-care practice (Food for Health) in a federally qualified health center (FQHC) network located in a large, urban city in the midwestern United States. The intervention represents a suite of services offered to patients as part of an integrated model of care designed to address food insecurity and promote a culture of health. The model requires providers to acknowledge that FI patients frequently face tough choices between affording food, medications, and household bills that negatively affect health. Although the intervention is available to all patients receiving care at the FQHC, our review of the literature suggests that those who are most vulnerable (i.e., food insecure patients and those with poor glycemic control) will see the greatest benefit. Accordingly, this study addresses 4 hypotheses. First, that the intervention will improve glycemic control among patients with diabetes as measured by changes in HbA1c (Hypothesis 1). Second, that patients' food security status and baseline levels of glycemic control will independently moderate the effects of the intervention such that FI patients (Hypothesis 2) and patients with poor glycemic control (Hypothesis 3) will show more improvement over time compared to food secure (FS) patients and patients with good glycemic control, respectively. Finally, that patients' food security status and baseline levels of glycemic control will jointly moderate the effects of the intervention (Hypothesis 4).

Methods

Intervention

The Food for Health program is an ongoing, integrated social-medical approach to diabetes care. The program includes screening for FSS and a protocol for addressing food insecurity among a population of low-income, medically underserved patients with diabetes. As a standard of care practice, all patients within the FQHC network are screened for food insecurity using the U.S. Department of Agriculture's Household Food Security Scale (HFSS) (2-item version) with the recommended adaptation for a 30-day recall period at each visit by a medical assistant. The electronic health record alerts providers to patients who screen positive for food insecurity. Patients receive nutrition education based on *Eat Right When Money's Tight*[29] which includes tips and strategies related to meal planning, food acquisition, and storage that support healthy shopping and eating on a limited budget. The care teams also make referrals to local food pantries, mobile produce trucks (available monthly at certain health centers), and other community food resources. Benefits specialists at the health centers provide enrollment assistance to patients who are financially qualified for SNAP. Regional managers and all health center managers received in-person training at the launch of the intervention. The health center managers then trained and oversaw the care teams at their health centers. Additionally, medical providers received training on the intervention with emphasis on the *Eat Right When Money's Tight* educational tool.

When patients check out of a visit, they receive an after-visit summary (AVS), a printout that includes educational information, food pantry locator details, and a "voucher" for the next available fresh produce distribution at specific health centers. Including the food information on the AVS has a normalizing effect; for both the provider and patient, food insecurity is treated as any other health issue.

Design

This study examined the effects of the intervention with a longitudinal, repeated-measures design. Data were obtained at baseline (February 2017–October 2017) and 6 to 9 months later at follow-up (August 2017–July 2018). Because all patients receive the intervention as part of the FQHC's standard-of-care, random assignment was not possible.

Recruitment strategies included posters displayed in health centers, phone referrals from health center staff, and in-person referrals from providers and the health center care team. At baseline, trained bilingual data specialists who were not part of the regular health center staff invited patients to participate in the study. After confirming patient interest, the data specialist read the study consent, including the purpose of the study, potential risks and benefits associated with participating, data sharing protocols, and process for addressing a patient's human subject concerns. The data specialist obtained written consent and provided the patient with a copy of the signed consent form. Baseline survey data were collected on electronic tablets at the health centers at the time of a prescheduled visit; the survey was self-administered or completed with the assistance of a data specialist at the participant's request. Approximately 5 months after the baseline visit, patients received a postcard reminding them to return within the next 4 months for a follow-up visit. Study participants who appeared 6 to 9 months after their baselilne visit for follow-up clinical care that included a food insecurity screening (within 30 days of the follow-up visit) and HbA1c lab results (within 90 days of the follow-up visit) were automatically flagged in the health center's records for a follow-up survey administered through a computer-assisted telephone interview system. To minimize disruption to normal care, we aligned study visits with regularly scheduled visits and lab schedules recommended by the ADA. The Mount Sinai Hospital Institutional Review Board approved all instruments, informed consent materials, and procedures to ensure the rights of study participants.

Sample

Eligible study participants included adults, 18 years of age and older, with a confirmed diagnosis of type 2 diabetes, who were not pregnant, were able to complete the study questionnaire either in English or in Spanish, and who had received patient care that included food insecurity screening (within 30 days of study enrollment) and lab results for HbA1c testing (within 90 days of study enrollment). The study was conducted at 22 health centers that are part of an FQHC network in a large, urban Midwest city. The network comprises 34 health centers that provide care to more than 175,000 patients each year, including approximately 30,000 uninsured patients and close to 25,000 patients with diabetes. The demographics of the network reflect the communities where services are provided: patients are primarily Hispanic (52%) or African American (30%) and 85% live at or below 200% of the 2019 federal poverty level. Several of the largest sites included in this study serve a predominantly Hispanic population.

Measures

The primary outcome measure was the patient's most recent HbA1c, collected as part of the standard blood panel within 90 days of enrolling in the study (baseline) and again within 90 days of the patient's follow-up visit. HbA1c is a test that shows a weighted average of blood glucose levels over the preceding 120 days.[30]

Food insecurity was determined using the 6-item version of the HFSS (the HFSS-6) with the recommended adaptation for a 30-day recall period.[31] The HFSS-6 asks participants how often they ran out of money to buy food, how often they could afford to eat healthy meals, how often they had to cut or skip meals because they could not afford food, and whether they ate less than they thought they should or were hungry but could not afford food. The HFSS-6 was collected as part of the study protocol and used as the indicator of food insecurity rather than the 2-item Hunger Vital Sign[32] because the latter lacked sensitivity in the study population.

Level of GC was defined at baseline as poor (i.e., uncontrolled) for patients with HbA1c $\geq$ 8.5% and as good (i.e., controlled) for patients with HbA1c < 8.5%, based on previous research[19] and guidelines that suggest patients with HbA1c < 8.0% are considered well controlled and those with HbA1c $\geq$ 9.0% are considered uncontrolled.[33,34] This criterion was confirmed by the network's chief medical officer as consistent with the way the network defines controlled vs. uncontrolled diabetes.

A single, dichotomous (yes/no) survey item identified participants who currently used medication to manage their diabetes. Patients who affirmed current medication use also completed the 8-item Adherence subscale of the Adherence to Refills and Medications Scale (ARMS). The ARMS was developed for use in an urban/inner-city primary care clinic population. It has demonstrated high internal consistency with patients who have inadequate to marginal/poor literacy skills ($\alpha = 0.79$ to 0.83) and correlated significantly with the Morisky adherence scale.[35] Participants responded to adherence items (e.g., how often do you miss taking your diabetes medicine when you are feeling better; how often do you forget to take your diabetes medicine) using a 4-point response set ranging from "none of the time" to "all of the time." The scale has a potential range of 8 to 32 points with lower scores indicating better adherence.

Demographic information (age at enrollment, sex, race/ethnicity) was obtained from clinic-based electronic health records at the beginning of the study. A single, dichotomous

Table 1. Characteristics of Patients With Diabetes Participating in the Food for Health Study.

Participant characteristics	Total (n = 933)	Food secure (n = 514)	Food insecure (n = 398)
Sex, n (%)			
Male	334 (35.80%)	212 (41.25%)	118 (29.65%)
Female	599 (64.20%)	302 (58.75%)	280 (70.35%)
Age, mean (SD)	54.04 (12.12)	54.29 (12.99)	53.72 (11.03)
Race/ethnicity, n (%)			
Black/African American	164 (18.06%)	77 (15.34%)	84 (21.71%)
Hispanic	659 (72.58%)	370 (73.71%)	274 (70.80%)
Other/multiracial	35 (3.85%)	20 (3.98%)	15 (3.88%)
White	50 (5.51%)	35 (6.97%)	14 (3.62%)
SNAP participation, n (%)			
Yes	413 (44.41%)	187 (36.45%)	218 (54.91%)
No	517 (55.59%)	326 (63.55%)	179 (45.09%)
HbA1c level, mean (SD)	8.10 (2.02)	8.10 (2.01)	8.08 (2.01)
Glycemic control, n (%)			
Good (<8.5)	624 (66.88%)	342 (66.54%)	269 (67.59%)
Poor (≥8.5)	309 (33.12%)	172 (33.46%)	129 (32.41%)
Taking diabetes medication (n, %)			
Yes	791 (84.78%)	426 (82.88%)	347 (87.19%)
No	142 (15.22%)	88 (17.12%)	51 (12.81%)
Medication adherence[a], mean (SD)	9.91 (2.51)	9.65 (2.33)	10.22 (2.63)

Notes: SD = standard deviation. SNAP = Supplemental Nutrition Assistance Program. Twenty-one participants were excluded from these analyses because they failed or refused to answer one or more food security screening questions.
[a]The medication adherence score is based on the 8-item Adherence subscale of the Adherence to Refills and Medications Scale; the scale has a range of 8 to 32 points with lower numbers indicating greater adherence.

(yes/no) self-reported survey item identified participants enrolled in SNAP.

Analysis

Descriptive statistics summarized participant characteristics and compared patients classified as FI with those classified as FS. The potential influence of attrition on generalizability was investigated via logistic regression.

A series of repeated-measure, mixed-effect linear regression models examined change over time in HbA1c levels. The models were estimated with the SAS GLIMMIX[36] procedure using restricted maximum likelihood (REML) for general linear mixed models and Wald-type statistics (i.e., Type-III F-tests) to assess study hypotheses with statistical significance set at $P < 0.05$. The models assessed the main effect of the intervention as change over time in HbA1c among all participants (Hypothesis 1); the time-by-FSS interaction which determined whether change over time in HbA1c varied between FS and FI participants (Hypothesis 2); the time-by-GC interaction which determined whether change over time in HbA1c varied between participants with good baseline GC and participants with poor baseline GC (Hypothesis 3); and the 3-way interaction between time, FSS and GC which determined whether change over time in HbA1c was jointly influenced by FSS and GC (Hypothesis 4). All models included a variable indexing time (baseline, follow up), dichotomous indicators of GC (good vs. poor) and FSS (FS vs. FI), and baseline fixed effects for participant characteristics (i.e., age, sex, race/ethnicity), SNAP participation, medication use, and medication adherence. We employed post-hoc estimation to disaggregate the 3-way interaction and produce model-based means and standard errors and used t-tests to assess simple main effects.

The study design is supported by a priori sample size calculations for statistical tests assessing the differences of 0.33% or greater in HbA1c between 2 groups of participants (e.g., FS vs. FI) with a sample of 684 participants who completed both baseline and follow-up surveys. These calculations assumed a 2-tailed hypothesis test with a Type I error rate of 0.05 and 80% statistical power. All statistical analyses were conducted using SAS software.[36,37]

Results

The study recruited 933 patients with diabetes who consented to participate (Table 1). At baseline, the sample was primarily female (64.20%) and most identified as Hispanic (72.58%). Forty-three percent of the participants were categorized as FI. Average HbA1c at baseline was 8.10, with approximately one-third of participants classified as poorly controlled (HbA1c ≥ 8.5). Mean HbA1c at baseline and the proportion of participants with poor GC were similar among participants who were FS and those who were FI. Of the 933 participants who consented at baseline, 398 returned to a health center during the follow-up data collection period for a visit that included HbA1c results. An attrition analysis found some statistically significant differences between the sample at baseline and the participants who returned to the health center for a follow-up visit in terms of sex and age. Women were less likely to return to the health center for a follow-up visit at 6 to 9 months post-baseline than

Table 2. Model-Derived Means and Tests Assessing Changes in HbA1c: Main Effects and Interactions.

Model	Baseline (se)		Follow-up (se)		Δ (se)	*P* value
Model 1: Time	8.24 (0.13)		8.01 (0.13)		−0.22 (0.08)	<0.001
	FS (se)	FI (se)	FS (se)	FI (se)		
Model 2: Time*FSS	8.25 (0.14)	8.21 (0.15)	8.02 (0.14)	8.01 (0.15)	0.04[a] (0.16)	0.82
	Good GC (se)	Poor GC (se)	Good GC (se)	Poor GC (se)		
Model 3: Time*GC	6.79 (0.13)	9.83 (0.16)	6.85 (0.13)	9.03 (0.16)	−0.86[b] (0.16)	<0.001
Model 4: Time*GC*FSS						
FSS secure	6.80 (0.15)	9.86 (0.19)	6.96 (0.15)	8.83 (0.19)	−1.19[b] (0.21)	<0.001
FSS insecure	6.78 (0.16)	9.78 (0.21)	6.71 (0.16)	9.30 (0.21)	−0.41[b] (0.25)	0.10

Notes: Mixed-effect linear regression models adjusted for participant's sex, age, race/ethnicity, SNAP participation, whether they are taking diabetes medication, and medication adherence. B = Baseline. FU = Follow up. se = standard error. FSS = food security status. FS = food secure. FI = food insecure. GC = glycemic control. Poor GC ≥ 8.5%.

[a] $\Delta = (FI_{FU} - FI_{B}) - (FS_{FU} - FS_{B})$

[b] $\Delta = (\text{Poor } GC_{FU} - \text{Poor } GC_{B}) - (\text{Good } GC_{FU} - \text{Good } GC_{B})$

men ($P = 0.04$), and older participants were more likely to return to the health center for a follow-up visit than younger participants ($P = 0.04$). Results indicate a trend related to SNAP use: participants not receiving SNAP returned to the health center for a follow-up visit at 6 to 9 months more than participants receiving SNAP ($P = 0.06$).

Table 2 presents model-derived means and post hoc estimation tests (see the online appendix for additional information on the regression models). Model 1 addressing Hypothesis 1 assessed the main effect of time for the Food for Health intervention. Results indicated a statistically significant reduction of 0.22% HbA1c between the baseline and follow-up periods ($F_{1, 355} = 7.29$, $P = 0.005$) across all participants. Models 2 addressing Hypothesis 2 and model 3 addressing Hypotheses 3 examined whether the observed change over time in HbA1c varied based on the participants' FSS or baseline level of GC. Model 2 indicated that changes in HbA1c over the study period were not significantly different between FS participants and FI participants ($F_{1, 354} = 0.05$, $P = 0.82$). Model 3 indicated that change over time was significantly different between GC-good and GC-poor participants ($F_{1, 354} = 28.40$, $P < 0.001$). Specifically, participants with poor baseline GC improved more (−0.80%) than those with good baseline GC (0.06%).

Model 4 addressing Hypothesis 4 examined whether the moderated relationship between HbA1c and time observed in Model 3 is further moderated by FSS (i.e., moderated moderator). Results indicated a statistically significant 3-way interaction between time, GC, and FSS ($F_{1,352} = 5.80$, $P = 0.02$). Disaggregating the 3-way interaction revealed that among FS participants, those with poor GC exhibited greater levels of improvement (−1.03%) than those with good GC (.16%) and this effect was significant, $t(352) = 5.63$, $P < .001$. However, among FI participants, differences in HbA1c change over time between those with poor GC (.16%) and those with good GC (-.07) was not statistically significant, $t(352) = 1.66$, $P = .10$. The 3-way interaction is presented graphically in Figure 1.

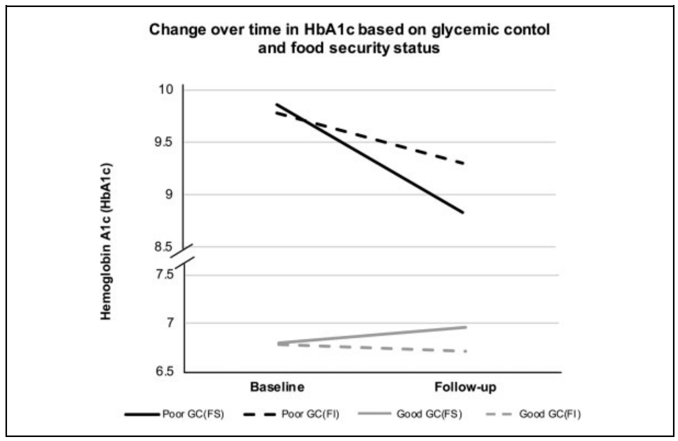

Figure 1. Change in HbA1c based on glycemic control and food security status. Source: Food for Health Survey. Baseline data collected February 2017–October 2017; follow-up data collected August 2017–July 2018. Notes: HbA1c = hemoglobin A1c. FS = food secure. FI = food insecure. GC = glycemic control. Poor GC ≥ 8.5%.

Model fit statistics (i.e., Akaike Information Criteria, Bayesian Information Criteria) confirmed that Model 4 is a better fit to the data than the main effects model (Model 1) or either of the 2-way interaction models (Model 2 and Model 3) Model fit statistics are presented in the online appendix material.

Discussion

Recognition of the importance of examining SDoH such as food security in primary health care settings is expanding.[23,26] To effectively help patients with diet-related chronic disease, understanding the impact of food security issues is critical. Previous studies have shown that interventions using food security screening can improve dietary intake[27,28,38] and contribute to lowering HbA1c[27,39] among patients with diabetes. This study contributes to the existing literature by examining the introduction of a food security screener paired with nutrition education and access to food resources as a standard-of-care practice in community health centers that serve a primarily minority and low-income population. As a standard-of-care practice, patients were screened at intake and clinic staff provided the intervention regardless of food security status. Findings showed that screening patients at intake, educating patients about how to eat healthfully on a budget, and connecting them with food assistance resources can contribute to improved HbA1c profiles, regardless of food security status. This finding may reflect the fact that the study sample was from a medically underserved and low-income community where nutrition information and support connecting with food assistance resources are scarce.

Finding also indicate that the degree of benefit varied based on participants' food security status and initial GC levels. Of the patients with diabetes who agreed to participate, 42.7% reported food insecurity. This number is in line with findings reported in similar studies that have been conducted in health care settings that serve low-income communities.[25] In contrast to some previous studies,[19,39] FI participants did not appear more likely than FS participant to experience poor GC at baseline (32.41% and 33.46%, respectively). Results of this study extend the current literature by showing that the ability of an integrated social medicine intervention to affect HbA1c depends on both a person's food security status and their initial GC level. Both FS and FI participants with good GC (< 8.5%) at baseline demonstrated little change over the study period in HbA1c levels, indicating that these patients were effectively managing their diabetes. In contrast, those with poor GC at baseline significantly lowered HbA1c levels at follow-up by an average of 0.80%. Findings also revealed that improved HbA1c differed based on food security status. Reductions in HbA1c were significantly greater among the FS group than the FI group (1.19% and -0.41%, respectively). Previous studies have reported that people who experience food insecurity tend to have less food in their homes and to eat more food that are calorie dense and low in nutritional quality.[40] Accordingly, the support provided by the Food for Health intervention may not have been enough to overcome habitual dietary practices and monthly fluctuations in access to healthy foods.

The following limitations should be considered. First, this study's observational results need confirmation in a controlled trial. This study did not include a control or comparison group, limiting the inferences that can be drawn from the data. Additionally, validity threats such as history, selection, and secular trends cannot be ruled out. Second, the observed changes among participants with poorly controlled HbA1c may be due to regression to the mean. However, if the observed changes were due solely to regression artifacts, one would expect to see the same degree of regression among both FS and FI participants. Third, this study was conducted in a clinical care setting, and real-world consideration had to be balanced with decisions related to the study protocol. Medical providers and care teams were not blinded to their patients' health status. As part of their routine clinical care, they had access to patients' chart information, including results from recent blood work, and they may have worked more intentionally with patients they recognized as presenting elevated risk to educate them and connect them with food resources. The network was actively working to improve the quality of its diabetes care over the study period, which may have contributed to positive outcomes. To increase the number of qualifying participants, we modified the recruitment criteria following the advice of the network's chief medical officer to allow HbA1c up to 90 days (increased from 30 days) before enrollment. Fourth, data on participants' dietary intake, diabetes-related self-care, and stress have been shown to influence GC[13,41] and may mediate the relationship between food insecurity and GC and should be explored in future research. Fifth, the variables in our regression model (e.g., medication adherence) are self-reported and other variables that may influence glycemic control (e.g., changes in weight, dietary data) were not collected.

So What?

What is already known on this topic?

Interventions that screen for food insecurity can help patients with diabetes improve dietary intake and glycemic control, particularly when the interventions are paired with access to healthy foods.

What does this article add?

This study shows that food security screening coupled with nutrition education and access to community food resources can be implemented as an integrated standard-of-care practice in a health care setting, and it can contribute to improved glycemic control.

What are the implications for health promotion practice or research?

It may be difficult for patients who are food insecure to benefit from social medicine interventions. Health care providers may need to consider additional means to help address the challenges these patients face.

Declaration of Conflicting Interests

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Supplemental Material

Supplemental material for this article is available online.

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