Food Insecurity Is Associated With Poorer Glycemic Control in Patients Receiving Free Versus Fee-Based Care

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■ **IN BRIEF** This study examined differences in household food security (HFS), household adult food security (HAFS), and indicators of diabetes management between clients using free and fee-for-service clinics for diabetes care and management. The study's 166 participants (free clinic, $n = 41$; fee-for-service clinic, $n = 125$) had a mean age of 53 ± 16 years and were primarily Caucasian ($n = 147$ [91.9%]). Both HFS ($P < 0.001$) and HAFS ($P < 0.001$) differed between the clinic groups, as did A1C (free clinic $8.7 \pm 1.7\%$; fee-for-service $7.8 \pm 1.6\%$; $P = 0.005$). A1C increased as HFS ($r = 0.293$, $P < 0.001$) and HAFS ($r = 0.288$, $P = 0.001$) worsened.

In 2017, the Centers for Disease Control and Prevention estimated that 30.3 million people in the United States (9.4% of the population) have diabetes (1). Rates are more prevalent in the Diabetes Belt—comprising 644 counties across 15 states in the southern and Appalachian regions of the United States—compared to other U.S. counties (2).

Food insecurity, defined as a lack of consistent, dependable access to enough food for all household members for active, healthy living (3), has been suggested as a risk factor for the development of diabetes, with adults experiencing food insecurity being two to three times more likely to develop diabetes than their food-secure counterparts (4). Gucciardi et al. (5) reviewed the intersection of food insecurity and diabetes and found that food-insecure individuals not only have a greater risk of developing diabetes, but also face substantially more challenges managing diabetes. Berkowitz et al. (6) found that food insecurity was associated with poor glycemic and cholesterol control in patients with type 2 diabetes, even after controlling for numerous demographic, socioeconomic, and clinical factors.

The self-reported rate of diabetes in rural Appalachian Ohio, an area characterized by poverty, is greater than that of the state as a whole (11.3 vs. 7.8%), indicating that low economic status is linked to an increased risk for diabetes (7). During 2010, the timeframe for this study, the U.S. Department of Agriculture (USDA) estimated that 85.5% of U.S. households were food secure, whereas 16.5% (17.2 million households) were food insecure (low food security, 11.1%; very low food security, 5.4%) (8). Some U.S. regions/states may be more prone to food insecurity. For example, among Ohio households, from which our sample was drawn, 16.4% were classified as having low food security and 6.6% had very low food security, exceeding 2010 national estimates (8).

Managing health conditions, especially those with specific dietary implications, becomes increasingly difficult without access to adequate food (9). Individuals with diabetes often must choose between buying medications and supplies needed

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for the management of their disease or purchasing healthy food (10). Consequently, among adults who already have diabetes, food insecurity is associated with poorer glycemic control (11). Compounding this problem is evidence that low-quality diets precipitate the development of concurrent diseases associated with diabetes (12).

Some under- and uninsured individuals turn to low-cost or free clinics for care. There is a paucity of data regarding the effectiveness of these clinics, especially with regard to diabetes management and food insecurity. Those who have health disparities (i.e., the disproportionate rate of diseases in socioeconomically poor populations) are most likely to have health care disparities (limited access to or availability of health care services) (13). Patients in rural areas such as the Appalachian region of Ohio are more likely to be uninsured or underinsured and to need to use free clinics (14). Yet, the availability of free care may not lead to improved health outcomes among individuals

with diabetes (15). Such free care does not come without costs to patients. For example, individuals still must find transportation to attend appointments. Thus, although the care itself is free, many people still struggle to access this care, which often leads to appointment cancellations, lack of attendance, and ultimately inconsistency of care (15).

The purposes of this study were to assess 1) the differences in food security status and indicators of diabetes management/control between clients using free and fee-for-service clinics for diabetes care and management in a rural, Appalachian region and 2) the relationship of food security status to blood glucose control, regardless of clinic type.

Methods
The institutional review board of Ohio University in Athens approved this study.

Participants and Setting
Adult patients with diabetes (n = 166) were recruited from University-based free and fee-for-service clinics in

southeastern Ohio. These clinics provide service for individuals living in Athens, Hocking, Meigs, Morgan, Perry, Vinton, and Washington counties. Table 1 describes the counties from which the participants were drawn.

Participants were recruited and interviewed from July to December 2010. Each prospective participant received a formal briefing regarding the purposes, benefits, and risks of the study. Patients with type 1 or type 2 diabetes were eligible for inclusion; those with other conditions (e.g., gestational diabetes, prediabetes, or other endocrine conditions) were excluded. After the briefing, individuals voluntarily chose to participate in the study and signed the associated consent forms.

Study Design
Patients were administered an 86-item survey. The survey included demographic questions and the 18-item USDA Food Security Survey Module (16). The Food Security Survey Module was used to deter-

TABLE 1. Characteristics of Rural, Appalachian Ohio Counties Where Participants Lived

County	Prevalence of Diabetes in 2011 (%)[a]	Appalachian Regional Commission Designation in Fiscal Year 2011[b]	Poverty Level (%) and USDA Poverty Designation in 2012[c,d]	USDA Rural/Urban Designation[e]
Athens	10.9	Distressed	33.3 (Persistent Poverty)	Non-metro
Hocking	11.4	Transitional	20.1 (No Persistent Poverty)	Metro
Meigs	14.0	Distressed	22.5 (No Persistent Poverty)	Non-metro
Morgan	14.2	Distressed	18.6 (No Persistent Poverty)	Non-metro
Perry	11.7	At-Risk	19.3 (No Persistent Poverty)	Metro
Vinton	12.6	Distressed	21.9 (No Persistent Poverty)	Non-metro
Washington[f]	12.1	Transitional	16.2 (No Persistent Poverty)	Non-metro

[a]Centers for Disease Control and Prevention. CDC county diabetes health data. Available from https://www.cdc.gov/diabetes/data/county.html. Accessed 7 December 2017.

[b]Appalachian Regional Commission. ARC-designated distressed counties, fiscal year 2011. Available from https://www.arc.gov/program_areas/ARCDesignatedDistressedCountiesFiscalYear2011.asp. Accessed 25 January 2018.

[c]U.S. Department of Agriculture. Poverty 2014 (county level data sets). Available from http://www.ers.usda.gov/data-products/county-level-data-sets/poverty.aspx#.U-6496NAJI0. Accessed 15 August 2014.

[d]U.S. Department of Agriculture. Persistent poverty counties (updated 2013). Available from http://www.ers.usda.gov/data-products/county-typology-codes.aspx#.U-68eqNAJI0. Accessed 15 August 2014.

[e]U.S. Department of Agriculture. Rural-urban continuum codes, 2013. Available from http://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx#.U-66yqNAJI0. Accessed 15 August 2014.

[f]County in Diabetes Belt (Centers for Disease Control and Prevention). CDC identifies diabetes belt. Available from https://www.cdc.gov/diabetes/data/county.html. Accessed 25 January 2018.

mine household food security (HFS) and household adult food security (HAFS) status (16,17). Participants' characteristics, including age and diabetes status, as well as medical record information, were collected independent of the survey administration. Medical information included height, weight, BMI, A1C, blood lipids (total, HDL, and LDL cholesterol), systolic and diastolic blood pressure, and type 1 or type 2 diabetes diagnosis. If participants' charts were missing needed medical information, participants were not asked to undergo additional tests for the purpose of the study.

Statistical Analysis

All surveys were analyzed using SPSS version 18.0 (IBM Corp., Chicago, Ill.). Mann-Whitney U tests were used to assess for differences between clinic groups for HFS and HAFS. t Tests were used to determine differences between clinic groups with regard to BMI; A1C; total, LDL, and HDL cholesterol; and systolic and diastolic blood pressure. Pearson r correlations were used to examine the relationship of HFS status and HAFS status to A1C. Furthermore, Mann-Whitney U tests were also used to determine the distribution of HFS and HAFS with regard to type of diabetes. Frequency functions distinguished the number of participating patients with type 1 versus type 2 diabetes, as well as the primary treatment approach to managing diabetes.

Results

Participants (n = 166) were 53 ± 16 years of age and almost entirely Caucasian (91.9%). The majority of participants (65.8%) had type 2 diabetes and some education at the collegiate level or higher (52.8%). Demographic data are summarized in Table 2. Table 3 summarizes participant food security status. Overall, 43.5% of free clinic patients and 13.8% of fee-for-service patients lived in households characterized by low or very low food security.

Table 4 summarizes differences between free clinic and fee-for-service

TABLE 2. Characteristics of Adults With Diabetes Attending Free and Fee-for-Service Clinics in Rural, Appalachian Ohio

Characteristic	n (%)
Race (n = 160)	
Caucasian	147 (91.9)
African American	10 (6.3)
Hispanic	1 (0.6)
Native American or Native Alaskan	1 (0.6)
Native Hawaiian or other Pacific Islander	1 (0.6)
Clinic used for diabetes care (n = 166)	
Fee-for-service clinic	125 (75.3)
Free clinic	41 (25.7)
Diabetes diagnosis (n = 155)	
Type 1 diabetes	53 (34.2)
Type 2 diabetes	102 (65.8)
Highest level of education (n = 163)	
Less than high school	15 (9.2)
High school graduate	62 (38)
Some college or higher	86 (52.8)

TABLE 3. HFS and HAFS Status of Adults With Diabetes Attending Free and Fee-for-Service Clinics in Rural, Appalachian Ohio

Clinic	Food Security Category	n (%)	P[a]
HFS status (n = 162)			
Free	High[b]	12 (30.8)	
	Marginal[b]	10 (25.6)	
	Low[c]	7 (17.9)	
	Very low[c]	10 (25.6)	<0.001
Fee-for-service	High[b]	87 (70.7)	
	Marginal[b]	19 (15.4)	
	Low[c]	10 (8.1)	
	Very low[c]	7 (5.7)	
HAFS status (n = 162)			
Free	High[b]	12 (30.8)	
	Marginal[b]	10 (25.6)	
	Low[c]	6 (15.4)	
	Very low[c]	11 (28.2)	<0.001
Fee-for-Service	High[b]	87 (70.7)	
	Marginal[b]	19 (15.4)	
	Low[c]	10 (8.1)	
	Very low[c]	7 (5.7)	

[a]Mann-Whitney U test.
[b]Food secure.
[c]Food insecure.

TABLE 4. Health Indices of Adults With Diabetes Attending Free or Fee-for-Service Clinics in Rural, Appalachian Ohio

Parameter	Clinic	n	Mean ± SD	P[a]
A1C (%) (n = 143)	Free	35	8.71 ± 1.740	0.005
	Fee	108	7.83 ± 1.551	
BMI (kg/m²) (n = 156)	Free	36	31.48 ± 8.568	0.139
	Fee	120	33.81 ± 8.155	
Systolic blood pressure (mmHg) (n = 159)	Free	36	134.69 ± 29.895	0.226
	Fee	123	128.31 ± 16.215	
Diastolic blood pressure (mmHg) (n = 157)	Free	34	77.24 ± 10.257	0.516
	Fee	123	75.93 ± 10.408	
Total cholesterol (mg/dL) (n = 128)	Free	28	198.71 ±59.594	0.391
	Fee	100	180.79 ± 105.269	
HDL cholesterol (mg/dL) (n = 127)	Free	28	49.32 ± 20.937	0.348
	Fee	99	45.325 ± 14.102	
LDL cholesterol (mg/dL) (n = 123)	Free	25	111.01 ± 52.652	0.109
	Fee	98	94.67 ± 43.121	

[a]*Mann-Whitney* U *test.*

clinic participants. A1C was the only statistically significant discriminating variable, with free clinic users having worse glycemic control during the past 2–3 months compared to fee-for-service clinic users (A1C 8.71 vs. 7.83%, *P* =0.005). Regardless of the type of clinic used, A1C values increased as HFS (*r* = 0.293, *P* <0.001) and HAFS (*r* = 0.288, *P* = 0.001) worsened.

Discussion

Results indicate that individuals using free clinics are less food secure and have worse glycemic control than their counterparts who use fee-for-service clinics. In addition, regardless of clinic type, as food insecurity worsens, blood glucose control also worsens.

Other studies have provided empirical evidence of a higher rate of household food insecurity among populations with diabetes versus those without diabetes (18). This study indicates that those with diabetes who seek free care are prone to food insecurity. In this rural, Appalachian Ohio sample of clients using fee-for-service clinics, HFS status (13.8%) was lower than both the national (14.5%) and Ohio (16.4%)

estimates. However, household food insecurity among those using free clinics (43.5%) was about three times higher than their fee-for-service counterparts, as well as three times higher than national and state estimates. HAFS levels, a proxy for individual or "personal" food security status, were similar. The disparity in food security may also reflect income level, given that U.S. households with income at or below the poverty level had food insecurity levels of 40.2% in 2010, the time frame for this study (8).

A review of other studies underscored that food insecurity may precipitate or be associated with poorer glycemic control (18). These results support the association between food insecurity and poor blood glucose control over the past 2–3 months, also demonstrating how those seeking free care have poorer control than their fee-for-service counterparts. According to Tuerk et al. (19), programs encouraging improved patient self-management practices should be developed because patients' relative self-management skills also account for variance in glycemic control. Yet, in the absence of

adequate access to food, appropriate blood glucose control may prove to be difficult.

Limitations of this study include its small convenience sample drawn from only one rural region of the United States, which limits its generalizability. Participants at the free clinic were only accessible once per month, limiting time to recruit a comparison group. It is possible that the participants do not accurately represent individuals with diabetes in Appalachian Ohio or other rural regions of the United States. Furthermore, this study recruited participants only from a diabetes-specific free clinic, but other patients with diabetes possibly attended the primary care free clinic in the study region. We are unable to infer whether there were differences between these two populations. Finally, people had to qualify for the free clinic, and it is possible that they may have over-reported their food insecurity because of concern about possibly losing access to care.

Successful management of type 1 or type 2 diabetes is complicated by food insecurity. Thus, screening for food insecurity should be completed

at all clinic visits (20). In addition, diabetes educators should consider that patients may not have access to adequate food for successful diabetes management.

This study found that long-term blood glucose control worsens in accord with the severity of food insecurity and thus should serve as a catalyst for improving diabetes education in Appalachian Ohio and similar rural areas. As rural communities grapple with system-level barriers to detecting and managing diabetes (e.g., high rates of poverty; limited access to insurance, specialty medical care, and emergency services; and minimal exposure to diabetes and nutrition education [21]), medical practitioners should articulate self-management practices to patients during potentially infrequent visits, including strategies for dealing with times when patients may lack access to food. Screening for food insecurity and referring clients to community resources may also be prudent.

Many individuals must make sacrificial decisions regarding medicine, food, or medical attention, placing them in a cycle of food insecurity and chronic disease. This is particularly acute among Medicare recipients—one of the fastest-growing medical populations in the United States. This study may increase awareness among health care providers in free and low-cost clinics about the importance of looking for innovative solutions to better help these high-risk patients. This is especially important given recent research finding that food insecurity coupled with diabetes increases health care expenditures (22). Future empirical research in both rural and metropolitan areas to analyze relationships between diabetes-related comorbidities and food insecurity would positively contribute to the dearth of literature available on this topic. In addition, interventions aimed at improving both diabetes management and food security are also warranted.

References

1. Centers for Disease Control and Prevention. National diabetes statistics report, 2017. Available from www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf. Accessed 7 December 2017

2. Centers for Disease Control and Prevention. County data. Available from www.cdc.gov/diabetes/data/county.html. Accessed 7 December 2017

3. U.S. Department of Agriculture. Food Security in the US – Key Statistics and Graphics. Available from www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics. Accessed 7 December 2017

4. Seligman HK, Bindman AB, Vittinghoff E, Kanaya AM, Kushel MB. Food insecurity is associated with diabetes mellitus: results from the National Health Examination and Nutrition Examination Survey (NHANES) 1999–2002. J Gen Intern Med 2007;22:1018–1023

5. Gucciardi E, Vogt JA, Demelo M, Stewart DE. Exploration of the relationship between household food insecurity and diabetes in Canada. Diabetes Care 2009;32:2218–2224

6. Berkowitz SA, Beggett TP, Wexler DJ, et al. Food insecurity and metabolic control among U.S. adults with diabetes. Diabetes Care 2013;36:3093–3099

7. Schwartz FL, Ruhil AV, Denham S, et al. High self-reported prevalence of diabetes mellitus, heart disease, and stroke in 11 counties of rural Appalachian Ohio. J Rural Health 2009;25:226–230

8. Coleman-Jensen A, Nord M, Andrews M, Carlson S. *Household Food Security in the United States in 2010* (Economic Research Report No. 125). Washington, D.C., Economic Research Service, 2011

9. Vozoris NT, Tarasuk VS. Household food insufficiency is associated with poorer health. J Nutr 2003;133:120–126

10. Seligman HK, Davis TC, Schillinger D, Wolf MS. Food insecurity is associated with hypoglycemia and poor diabetes self-management in a low-income sample with diabetes. J Health Care Poor Underserved 2010;21:1227–1233

11. Seligman HK, Schillinger D. Hunger and socioeconomic disparities in chronic disease. N Engl J Med 2010;363:6–9

12. McCullough ML, Feskanich D, Rimm EB, et al. Adherence to the Dietary Guidelines for Americans and risk of major chronic disease in men. Am J Clin Nutr 2010;72:1223–1231

13. Braveman P. Health disparities and health equity: concepts and measurement. Ann Rev Public Health 2006;27:167–194

14. Behringer B, Friedell GH. Appalachia: where place matters in health. Prev Chronic Dis 2006;3:A113

15. Mallow JA, Theeke LA, Barnes ER, et al. Free care is not enough: barriers to attending free clinic visits in a sample of uninsured individuals with diabetes. Open J Nurs 2014;4:912–919

16. Bickel G, Nord M, Price C, Hamilton, Cook J. *Guide to Measuring Household Food Security*. Revised 2000. Alexandria., Va., U.S. Department of Agriculture, Food and Nutrition Service, 2000. Available from hungerfreecommunities.org/wp-content/uploads/2011/04/USDA-guide-to-measuring-food-security.pdf. Accessed 7 December 2017

17. U.S. Department of Agriculture. Survey tools. Available from www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/survey-tools/#household. Accessed 22 January 2018

18. Gucciardi E, Vahabi M, Norris N, et al. The intersection between food insecurity and diabetes: a review. Curr Nutr Rep 2014;3:324–332

19. Tuerk PW, Mueller M, Egede LE. Estimating physician effects on glycemic control in the treatment of diabetes. Diabetes Care 2008;31:869–873

20. Holben DH, Berger-Marshall M. Position of the Academy of Nutrition and Dietetics: food insecurity in the United States. J Acad Nutr Diet 2017;117:1991–2002

21. Massey CN, Appel SJ, Buchanan KL, Cherrington AL. Improving diabetes care in rural communities: an overview of current initiatives and a call for renewed efforts. Clin Diabetes 2010;28:20–27

22. Berkowitz SA, Basu S, Meigs JB, Seligman HK. Food insecurity and health care expenditures in the United States 2011–2013. Health Serv Res 2017. Epub ahead of print (DOI: 10.1111/1475-6773.12730)