



Multiple social risk factors are adversely associated with diabetes management and psychosocial outcomes among adults with diabetes

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ARTICLE INFO

Keywords:

Social risk factors
Food insecurity
Financial insecurity
Housing insecurity
Utility insecurity
Diabetes

ABSTRACT

Adults from structurally marginalized populations have disproportionately higher rates of diabetes, highlighting the importance of addressing social risk factors in diabetes prevention and management. This study examined the correlations among multiple social risk factors and their respective burden on diabetes management and psychosocial health outcomes among adults with diabetes. Data came from the baseline assessment of an ongoing randomized controlled trial evaluating approaches to addressing unmet social needs among 579 adults with diabetes. Four social risks (food insecurity, financial insecurity, housing insecurity, and utility insecurity) were assessed, dichotomized and summed to create a score of cumulative social risk factors. The outcomes of interest were: hemoglobin A1c, cost-related non-adherence for diabetes, diabetes distress, and anxiety or depression. Multivariate regression models were used to examine the associations between cumulative social risk factors and health outcomes, adjusting for sociodemographic characteristics and diabetes duration. Approximately 18% of study participants reported one social risk, 18% reported two social risks, and 23% reported three or four social risks. After multivariate adjustment, adults with three or four social risk factors had a greater likelihood of cost-related non-adherence (OR 2.81, 95% CI 1.95, 4.06), diabetes distress (OR 3.03, 95% CI 2.13, 4.31), and anxiety or depression (OR 5.36, 95% CI 3.39, 8.47), compared to adults with no social risk factors. Significant dose-response relationships were observed with greater social risk factors and poorer diabetes-related outcomes. These findings support efforts to address systemic contributors to diabetes management and care to better promote individual and population health.

1. Introduction

An estimated 34.1 million (13.0 %) U.S. adults have diabetes (2020). People with low socioeconomic position and from minoritized racial/ethnic groups have disproportionately higher rates of diabetes and diabetes-related complications (U.S. Department of Health and Human Services, 2020; Brown et al., 2005; Gaskin et al., 2014). Such inequities reinforce the importance of addressing social risk factors for diabetes prevention and management (Ogunwale and Golden, 2021).

Social determinants of health encompass social, economic, and environmental factors, including economic stability, the neighborhood environment, and other contextual factors, that can influence individual behaviors and health outcomes (Hill-Briggs et al., 2020). When these conditions adversely affect health, they represent social risk factors that can exacerbate health disparities through inequities in material needs

(2017; Alderwick and Gottlieb, 2019). A key example of this is food insecurity, defined as inadequate food availability and access (Coleman-Jensen et al., 2021). Food insecurity disrupts regular dietary behaviors and intake, which in turn, adversely affects diabetes management (Seligman et al., 2012). Another important social risk factor is housing, which can range from difficulties to paying rent/mortgage to homelessness, and has been associated with poorer self-management of diabetes (Vijayaraghavan et al., 2011). Energy or utility insecurity refers to the inability to meet household energy needs, and may also negatively affect health and social outcomes (Hernandez, 2016). Financial insecurity, or the inability to afford food, housing, and other material needs, is inextricably tied to other social risk factors and can exacerbate diabetes complications due to the high cost of diabetes medications, supplies, and healthy food (Ngo-Metzger et al., 2012). In one nationally representative study, nearly half of adults with diabetes reported

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<https://doi.org/10.1016/j.pmedr.2022.101957>

Received 19 April 2022; Received in revised form 21 July 2022; Accepted 14 August 2022

Available online 19 August 2022

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experiencing financial stress (Patel et al., 2016).

Although social risks are often correlated, few studies to date have examined their coexistence in relation to health outcomes among individuals with diabetes. This study contributes to this knowledge gap by examining the correlations among multiple social risk factors and their respective burden on diabetes management and psychosocial health outcomes among adults with diabetes.

2. Methods

2.1. Study population

Data came from an ongoing randomized controlled trial evaluating approaches to addressing unmet social needs among adults with diabetes. Recruitment of the study sample has been previously described (Patel et al., 2020). Briefly, 600 study participants were recruited from Michigan Medicine electronic health records and the University of Michigan Diabetes Research Registry. Eligibility criteria included: 1) 18–75 years, 2) prior diagnosis of type 1 or type 2 diabetes, 3) elevated hemoglobin A1c ($\geq 7.5\%$) within the past 6 months, 4) a positive report of financial burden or cost-related non-adherence, and 5) access to a mobile phone.

Data for the present study came from the baseline assessment, which included an interviewer-assisted survey of demographic and health factors (June 2019 to February 2022) and baseline hemoglobin A1cs. After excluding individuals with missing information on demographic characteristics ($n = 18$), diabetes duration ($n = 9$), and material insecurities ($n = 2$), the analytic sample was comprised of 571 study participants. The trial is registered as clinicaltrials.gov as NCT03950973. All study procedures were approved by the University of Michigan Institutional Review Board.

2.2. Measures

Four social risk factors were assessed: food insecurity, financial insecurity, housing insecurity, and utility insecurity. Food insecurity was assessed using the validated two-item screener adapted from the U. S. Household Food Security Survey Module (Gundersen et al., 2017). Financial insecurity was assessed using the COST-FACIT (Functional Assessment of Chronic Illness Therapy), a widely used measure of financial toxicity specific to chronic disease (de Souza et al., 2017). Housing insecurity was assessed with a single question on whether the participant currently “worried...about not being able to pay rent, mortgage, or other housing costs.” Utility insecurity was assessed with a single question on whether the participant experienced a shut-off of utilities (electric, gas, oil, or water) in the past 12 months. Each measure was dichotomized and summed to create a score of cumulative social risk factors ranging from 0 to 4. Due to few participants experiencing all four social risks ($n = 40$), responses of experiencing three and four social risk factors were combined for analysis.

Hemoglobin A1c (HbA1c) was measured with the DCA Vantage Analyzer for study participants who completed in-person visits ($n = 173$), by the A1c Now home test kits for participants who completed telephone visits ($n = 311$), using the most recent measure from their electronic health record ($n = 34$), or self-reported ($n = 3$). Hemoglobin A1c values were statistically calibrated to account for the collection method.

Cost-related non-adherence for diabetes was assessed through six questions on taking smaller doses of medication, skipping doses, delaying filling prescription, delaying seeing a health care provider, and not seeing a health care provider in the past year, as a result of “out-of-pocket costs with managing your diabetes” (Patel et al., 2016).

Diabetes distress was assessed using the two-item Diabetes Distress Scale (Fisher et al., 2008). Items were rated on a scale of not a problem (1) to serious problem (6), and the mean of both items was categorized as no distress (< 3) and moderate or high distress (≥ 3).

Anxiety or depression were assessed using the Patient Health Questionnaire-4, a clinically validated screener assessing two anxiety symptoms and two depressive symptoms on a scale of not at all (0) to nearly every day (3) (Kroenke et al., 2009). A score of ≥ 6 was used to categorize moderate or severe anxiety and depression.

2.3. Statistical analysis

We estimated demographic and health characteristics for the entire sample and stratified by the number of social risk factors. Correlations among the four social risk factors were estimated using tetrachoric correlation coefficients. A cumulative social risk factors score (0–4) was created by summing the indicators for food, financial, housing, and utility insecurities. Multivariable linear and logistic regression models were used to examine the associations between cumulative social risk factors and health outcomes, adjusting for age, sex, race/ethnicity, educational attainment, household income, marital status, and year of diabetes diagnosis. Statistical analyses were conducted using SAS software 9.4. Statistical tests were two-sided and significance was considered at $P < 0.05$.

3. Results

At baseline, 57 % of study participants were aged 45–64 years, 56 % were male, and 69 % identified as non-Hispanic white (Table 1). The majority of study participants had some years of college education or more (87 %), reported total household income at or below \$60,000 (60 %), and were married or partnered (56 %). The average duration of diabetes diagnosis was 16.3 (SD 11.2) years.

Among participants in the sample, 42 % reported experiencing food insecurity, 42 % housing insecurity, 26 % financial insecurity, and 21 % utility insecurity. The bivariate correlations between material insecurities were: food and financial, 0.58; food and housing, 0.65; food and utility, 0.56; financial and housing, 0.62; financial and utility, 0.40; and, housing and utility, 0.67.

Approximately 18 % of study participants reported one social risk, 18 % reported two social risks, and 23 % reported three or four social risks (Table 2). Compared to those with no social risks, individuals with three or four social risks had marginally higher mean HbA1c ($\beta = 0.36$, 95 % CI $-0.01, 0.72$, P -trend = 0.08) and significantly greater likelihood of cost-related non-adherence (OR 2.81, 95 % CI 1.95, 4.06, P -trend < 0.0001), diabetes distress (OR 3.03, 95 % CI 2.13, 4.31, P -trend < 0.0001), and anxiety or depression (OR 5.36, 95 % CI 3.39, 8.47, P -trend < 0.0001), after adjusting for sociodemographic characteristics and diabetes duration.

4. Discussion

In this sample, there was substantial overlap among food, housing, utility, and financial insecurities, such that more than one in five adults with diabetes experienced three or four social risk factors. This suggests that social risk factors are correlated and can often co-exist within the same individual. Second, in fully adjusted models, there was a dose–response relationship between social risk factors and poorer diabetes outcomes, indicating that social risks cumulatively affect diabetes-related outcomes independent of other socioeconomic factors.

Results of the present study corroborate the few previous studies that have examined the impact of social risk factors on diabetes-related outcomes. One study found that across domains of food, housing, employment, English proficiency, and other socioeconomic factors, multiple social risk indicators were associated with lower odds of routine HbA1c monitoring among adults with and without diabetes (Kim et al., 2021). Another study using nationally representative data found that each additional social risk factor was associated with a 41 % higher risk of mortality among adults with a dual diagnosis of diabetes and chronic kidney disease (Ozieh et al., 2021). Similarly, a

Table 1
Demographic and health characteristics of individuals with diabetes.

	Total (n = 571)		0 material insecurities (n = 234)		1 material insecurity (n = 102)		2 material insecurities (n = 103)		3–4 material insecurities (n = 132)	
	n	%	n	%	n	%	n	%	n	%
Age category										
<44 years	123	21.5	51	21.8	26	25.5	20	19.4	26	9.7
45–64 years	324	56.7	113	48.3	56	54.9	66	64.1	89	67.4
≥65 years	124	21.7	70	29.9	20	19.6	17	16.5	17	12.9
Sex										
Male	321	56.2	106	45.3	62	60.8	68	66.0	85	64.4
Female	250	43.8	128	54.7	40	39.2	35	34.0	47	35.6
Race/Ethnicity										
Non-Hispanic White	395	69.2	173	73.9	79	77.5	68	66.0	75	56.8
Non-Hispanic Black	99	17.3	26	11.1	10	9.8	22	21.4	41	31.1
Other	77	13.5	35	15.0	13	12.8	13	12.6	16	12.1
Educational attainment										
High school diploma or fewer	75	13.1	19	8.1	7	6.9	22	21.4	27	20.5
Some college	255	44.7	100	42.7	52	51.0	38	36.9	65	49.2
College graduate	241	42.2	115	49.2	43	42.2	43	41.8	40	30.3
Total household income										
≤\$60,000	344	60.3	89	38.0	57	55.9	80	77.7	118	89.4
>\$60,000	227	39.8	145	62.0	45	44.1	23	22.3	14	10.6
Marital status										
Single	252	44.1	81	34.6	48	47.1	52	50.5	71	53.8
Married	319	55.9	153	65.4	54	52.9	51	49.5	61	46.2
Diabetes duration, years (mean ± SD)	16.4 ± 11.2		16.3 ± 10.7		17.1 ± 11.4		16.7 ± 11.4		15.7 ± 11.6	
Hemoglobin A1c (mean ± SD)	8.0 ± 1.5		7.8 ± 1.4		8.0 ± 1.4		8.0 ± 1.6		8.3 ± 1.6	
Cost-related non-adherence (diabetes)	190	35.2	40	17.8	42	43.8	44	5.4	64	52.5
Diabetes distress	204	35.7	44	18.8	36	35.3	43	41.8	81	61.4
Anxiety or depression	160	28.1	23	9.8	33	32.4	35	34.0	69	52.7

Table 2
Associations between material insecurities and diabetes-related outcomes.

	n	%	HbA1c		Cost-related non-adherence		Diabetes distress		Anxiety or depression	
			beta	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Total material insecurities										
0	234	41	Ref.		Ref.		Ref.		Ref.	
1	102	17.9	0.15	−0.20, 0.50	2.50	1.74, 3.60	1.84	1.26, 2.68	3.29	2.04, 5.30
2	103	18.0	0.10	−0.27, 0.47	2.46	1.69, 3.59	2.09	1.44, 3.02	3.31	2.04, 5.36
3 or 4	132	23.1	0.36	−0.01, 0.72	2.81	1.95, 4.06	3.03	2.13, 4.31	5.36	3.39, 8.47
<i>P-trend</i>			0.08		<0.0001		<0.0001		<0.0001	

Adjusted for age, sex, race/ethnicity, educational attainment, total household income, marital status, and diabetes duration.

Massachusetts-based study found that greater material insecurities (including food, cost-related medication underuse, housing, and energy insecurity) were associated with poor glycemic control and more health care utilization among adults with diabetes mellitus (Berkowitz et al., 2015).

Our study reinforces the need for interventions to more holistically support multiple social risk factors within the same individual. Health care systems have increasingly scaled up efforts to screen for and address social needs within their patient populations (Boch et al., 2020). While there have been several models of interventions focused on addressing food insecurity, e.g., providing referrals to community food providers, assistance with applications for the Supplemental Nutrition Assistance Program, there are fewer health care systems-based interventions focused on financial, housing, and utility insecurities (Barnard et al., 2015). Furthermore, the underlying mechanisms of the observed associations have not been extensively studied, which is important to inform the development of appropriate interventions. For example, if these associations are primarily driven by material hardships, then increasing linkages between health care systems and community-based organizations to better connect patients with diabetes to existing programs are warranted. On the other hand, if these associations are mediated by psychological distress or lack of social support, then interventions that improve psychosocial well-being and social connectedness will also be necessary to buffer the negative associations between social risk factors

and diabetes outcomes. Results of the randomized controlled trial, from which the present study is based, will help to fill a knowledge gap on the extent to which providing resources for unmet social needs can improve patients' diabetes outcomes (Patel et al., 2020).

The primary limitation of the study is the cross-sectional data, precluding the ability to make causal inferences about the observed associations and understanding the mechanistic pathways underlying these associations. The data are embedded in an ongoing randomized controlled trial which will provide important insight on the impact of addressing unmet social needs among adults with diabetes on subsequent outcomes. Second, our study was not able to capture through existing validated measures other potentially important social risk factors, such as transportation, health care, child care. Qualitative research approaches would contribute contextual understanding to which unmet social needs are most concerning for adults managing chronic conditions and how specific social risks influence disease management. Finally, the study population consisted of individuals with diagnosed diabetes from a large academic medical center in Michigan; individuals without consistent access to health care may have been excluded from the sample, potentially resulting in selection bias. Similarly, the results may not be generalizable to individuals with other chronic conditions and from other states.

5. Conclusion

The present study contributes to a growing body of research highlighting the cumulative, adverse effects of social risk factors on diabetes-related outcomes. Given the immense public health burden of diabetes, efforts to address the systemic contributors to diabetes outcomes are critically important, particularly among populations with low incomes and from minority racial/ethnic groups. Interventions to address social risk factors should consider addressing multiple needs simultaneously in order to yield a greater benefit to individuals and public health.

CRedit authorship contribution statement

Cindy W. Leung: Conceptualization, Formal analysis, Writing – original draft. **Michele Heisler:** Writing – review & editing, Funding acquisition. **Minal R. Patel:** Conceptualization, Data curation, Writing – review & editing, Project administration, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgments

This project was funded by grants (R01DK116715, PI: Patel), and (P30DK092926, PI: Heisler & Piatt) (Michigan Center for Diabetes and Translational Research) from the National Institute for Diabetes and Digestive and Kidney Diseases.

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