Original Investigation

Material Need Insecurities, Control of Diabetes Mellitus, and Use of Health Care Resources

Results of the Measuring Economic Insecurity in Diabetes Study

Seth A. Berkowitz, MD, MPH; James B. Meigs, MD, MPH; Darren DeWalt, MD, MPH; Hilary K. Seligman, MD, MAS; Lily S. Barnard; Oliver-John M. Bright, BA; Marie Schow, BA; Steven J. Atlas, MD, MPH; Deborah J. Wexler, MD, MSc

IMPORTANCE Increasing access to care may be insufficient to improve the health of patients with diabetes mellitus and unmet basic needs (hereinafter referred to as material need insecurities). How specific material need insecurities relate to clinical outcomes and the use of health care resources in a setting of near-universal access to health care is unclear.

OBJECTIVE To determine the association of food insecurity, cost-related medication underuse, housing instability, and energy insecurity with control of diabetes mellitus and the use of health care resources.

DESIGN, SETTING, AND PARTICIPANTS Cross-sectional data were collected from June 1, 2012, through October 31, 2013, at 1 academic primary care clinic, 2 community health centers, and 1 specialty center for the treatment of diabetes mellitus in Massachusetts. A random sample of 411 patients, stratified by clinic, consisted of adults (aged ≥21 years) with diabetes mellitus (response rate, 62.3%).

MAIN OUTCOMES AND MEASURES The prespecified primary outcome was a composite indicator of poor diabetes control (hemoglobin A_{1c} level, >9.0%; low-density lipoprotein cholesterol level, >100 mg/dL; or blood pressure, >140/90 mm Hg). Prespecified secondary outcomes included outpatient visits and a composite of emergency department (ED) visits and acute care hospitalizations (ED/inpatient visits).

RESULTS Overall, 19.1% of respondents reported food insecurity; 27.6%, cost-related medication underuse; 10.7%, housing instability; 14.1%, energy insecurity; and 39.1%, at least 1 material need insecurity. Poor diabetes control was observed in 46.0% of respondents. In multivariable models, food insecurity was associated with a greater odds of poor diabetes control (adjusted odds ratio [OR], 1.97 [95% CI, 1.58-2.47]) and increased outpatient visits (adjusted incident rate ratio [IRR], 1.19 [95% CI, 1.05-1.36]) but not increased ED/inpatient visits (IRR, 1.00 [95% CI, 0.51-1.97]). Cost-related medication underuse was associated with poor diabetes control (OR, 1.91 [95% CI, 1.35-2.70]) and increased ED/inpatient visits (IRR, 1.68 [95% CI, 1.21-2.34]) but not outpatient visits (IRR, 1.07 [95% CI, 0.95-1.21]). Housing instability (IRR, 1.31 [95% CI, 1.14-1.51]) and energy insecurity (IRR, 1.12 [95% CI, 1.00-1.25]) were associated with increased outpatient visits but not with diabetes control (OR, 1.10 [95% CI, 0.60-2.02] and OR, 1.27 [95% CI, 0.96-1.69], respectively) or with ED/inpatient visits (IRR, 1.49 [95% CI, 0.81-2.73] and IRR, 1.31 [95% CI, 0.80-2.13], respectively). An increasing number of insecurities was associated with poor diabetes control (OR for each additional need, 1.39 [95% CI, 1.18-1.63]) and increased use of health care resources (IRR for outpatient visits, 1.09 [95% CI, 1.03-1.15]; IRR for ED/inpatient visits, 1.22 [95% CI, 0.99-1.51]).

CONCLUSIONS AND RELEVANCE Material need insecurities were common among patients with diabetes mellitus and had varying but generally adverse associations with diabetes control and the use of health care resources. Material need insecurities may be important targets for improving care of diabetes mellitus.

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Author Affiliations: Author affiliations are listed at the end of this article.

Corresponding Author: Seth A. Berkowitz, MD, MPH, Division of General Internal Medicine, Massachusetts General Hospital, 50 Staniford St, Ninth Floor, Boston, MA 02141 (saberkowitz@partners.org).

The expansion of health insurance coverage offered by the Patient Protection and Affordable Care Act[1] will increase access to health care for patients with diabetes mellitus. However, recent randomized clinical trial results have demonstrated that increasing access to health care may not improve control of diabetes mellitus[2] among low-income patients. This discrepancy may result from social determinants of health[3,4] that are outside the scope of standard medical interventions,[5] such as difficulty paying for food,[6-9] medications,[10-14] housing,[15] or utilities[16,17] (hereinafter referred to as material need insecurities).

Recognition that social determinants of health may be key to improving health outcomes and optimizing the use of health care resources has led to interest in management strategies that address the relevant material need insecurities of patients.[18-20] However, the knowledge base for this approach within health care systems remains limited. Most prior clinical epidemiologic studies have focused on single needs in isolation[6,8,13] in settings with significant numbers of uninsured patients. In diabetes mellitus, a condition in which successful self-management carries significant out-of-pocket costs, even among patients with insurance,[21,22] the relationship between material need insecurities and outcomes of diabetes mellitus is likely to be complex. Patients with one material need insecurity may have others, and the effect of each may be different when considering clinical outcomes and the use of health care resources. Furthermore, patients' specific needs may offer targets for intervention.

To strengthen the knowledge base regarding material need insecurities and diabetes mellitus, we simultaneously evaluated several potentially modifiable material need insecurities and their relationship with diabetes control and the use of health care resources. Specifically, based on prior work,[10,15] we hypothesized that difficulty paying for food and medications would be associated with poor diabetes control and greater use of health care resources even when accounting for other material need insecurities.

Methods

Study Setting and Sample

The institutional review board of Partners Healthcare approved this study, and all patients provided verbal informed consent. The MEND (Measuring Economic Insecurity in Diabetes) study was conducted among patients linked to 1 of 4 clinics within a practice-based research network,[23] including 2 community health centers (Revere HealthCare Center and Charlestown Health Care Center), 1 academic general internal medicine practice (Internal Medicine Associates at Massachusetts General Hospital), and 1 specialty clinic for the treatment of diabetes mellitus (Massachusetts General Hospital Diabetes Treatment Center), all in the metropolitan area of Boston, Massachusetts. The community health centers are academically affiliated clinics located in 2 different suburbs of Boston and constitute part of the health care safety net for their communities. The academic general internal medicine practice and specialty clinic are hospital based. All clinics accept Medicaid and self-pay patients. Massachusetts has had near-universal health insurance coverage for almost 10 years,[24] with plan coverage requirements similar to those being enacted nationally under the Patient Protection and Affordable Care Act.[1] All adults (aged ≥21 years) with diabetes mellitus, defined by a previously validated electronic algorithm,[25] were eligible to participate. We selected a random sample of patients, stratified by clinic, to complete a survey on material need insecurities. A trained interviewer administered all surveys over the telephone or in person at a regularly scheduled clinic visit. Validated instruments were available only in English and Spanish, so we excluded patients who could not complete the survey in one of those languages along with patients who could not complete it owing to disabling conditions, such as dementia.

Measures of Material Need Insecurities

We collected data using a standardized questionnaire (eAppendix in the Supplement) with previously validated instruments[10,15,16,26-28] on 4 different material need insecurities from June 1, 2012, through October 31, 2013. The 4 insecurities included (1) food insecurity, defined as limited or uncertain availability of food owing to cost[26]; (2) cost-related medication underuse; (3) housing instability, which could include homelessness as an extreme form, evictions, frequent moves, or moving in with friends or relatives to share living expenses in the past 12 months[15,27]; and (4) energy insecurity, defined as difficulty affording household heating or cooling.[16] Although each concept was distinct, the 4 material need insecurities are similar in that each represents difficulties meeting basic needs owing to cost. All scales used the same 12-month "look-back" period for the patient report. Study data were collected and managed using REDCap (Research Electronic Data Capture) tools hosted at Partners Healthcare.[29]

Outcomes

Because a major goal of outpatient care,[30,31] and especially population management programs,[19,20] consists of improving clinical outcomes and optimizing the use of health care resources, we evaluated several outcomes relevant to these goals. We collected data for laboratory and clinical measurements and for use of resources from an electronic data repository[32] during the 12-month look-back period and linked these data to survey responses. The electronic data repository contains data from 18 clinics in a practice-based research network along with emergency department (ED) and inpatient information from Massachusetts General Hospital.

The prespecified primary outcome was a composite measure of poor diabetes control consisting of hemoglobin A_{1c} levels of greater than 9.0%, low-density lipoprotein cholesterol (LDL-C) levels of greater than 100 mg/dL (to convert to millimoles per liter, multiply by 0.0259), systolic blood pressure of greater than 140 mm Hg, or diastolic blood pressure of greater than 90 mm Hg using the most recent values from within the 12-month look-back period. These values were selected because they conferred roughly equivalent risks for complications due to diabetes mellitus[33,34] and because they are used commonly in quality reporting[35] and are endorsed in clinical guidelines.[36] Prespecified secondary clinical outcomes in-

cluded separate evaluation of the components of poor clinical diabetes control.

We also evaluated 3 prespecified outcomes for the use of health care resources, all occurring during the same 12-month look-back period. The first outcome was outpatient visits. The second outcome was a composite of ED visits and inpatient acute care hospitalizations (ED/inpatient visits). We created the combined ED/inpatient indicator because diabetes mellitus is commonly considered a condition for which improving ambulatory care can reduce use of both types of resources.[37-39] We separated the evaluation of outpatient visits and ED/inpatient visits to reflect different priorities for these types of visits within the health care system. Although a goal of long-term disease management is to minimize ED/inpatient visits, this goal may not be appropriate for outpatient visits, especially if extra outpatient visits could prevent an inpatient admission. Despite this goal, if the use of outpatient resources is high and diabetes control is poor or the use of ED/inpatient resources is also high, it may suggest that standard outpatient care is not producing the desired effect of better health. Finally, among the subset of patients who had at least 1 acute care hospital admission in the study period, we examined 30-day readmission rates.

Covariates

We collected information regarding education, nativity, and years living in the United States if born abroad. For health literacy,[40] we considered a response of "extremely" or "quite a bit" to the question "How confident are you filling out medical forms by yourself?" to indicate adequate health literacy. We also asked whether patients had prescription drug coverage and the duration of their diabetes mellitus. From the electronic data repository, we extracted data regarding age, self-reported race/ethnicity, health insurance (commercial, Medicare, Medicaid, Massachusetts Health Safety Net [Free Care, a non-Medicaid health benefit for essential medical care services among Massachusetts residents[41]], and no insurance/self-pay), and Charlson Comorbidity Index using previously validated algorithms.[23] For medications, we constructed binary indicator variables by class for medications to control glycemia, cholesterol levels, and blood pressure, including metformin, sulfonylureas/meglitinides, thiazolidinediones, dipeptidyl peptidase 4 inhibitors, insulin, 3-hydroxy-3-methylglutaryl-CoA reductase inhibitors, thiazide diuretics, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, calcium channel blockers, and β-blockers.

Statistical Analysis

Findings of material need insecurities scales were dichotomized as secure or insecure with scoring similar to that used in prior studies of these needs (eAppendix in the Supplement). For most models, we considered the needs as separate dichotomous variables. Because material need insecurities may cluster and may have an additive effect on health, we also created a variable summing the number of insecurities (which assumes an additive effect). To account for the stratified random sample design, we used inverse probability weighting (weighted by the number of patients with diabetes mellitus in the clinic) to produce prevalence estimates. We used definition 3 of the American Association of Public Opinion Reporting[42] to calculate the response rate, which accounts for eligible patients who decline to participate and patients of unknown eligibility among those who could not be contacted. We compared demographic information of nonresponders with those of responders using the electronic health record data. We conducted unadjusted analyses using χ^2 tests for categorical variables and Wilcoxon rank sum tests for nonnormally distributed continuous variables. We then conducted multivariable logistic regression for our clinical outcomes, which also accounted for the design effect and correlations within each clinic (SAS PROC GENMOD; SAS Institute Inc). For use of health care resources, we conducted multivariable negative binomial regression, again clustered by clinic. When we did not have sufficient events to include all possible covariates in the multivariable regression models, we removed covariates that were not associated with the outcome in bivariable analyses and that did not demonstrate evidence of confounding the effect estimate for any material need insecurity term (change in the β coefficient, <10% when removed). $P < .05$ was taken to indicate statistical significance for the association of a material need insecurity, with the primary composite outcome of poor diabetes control. All analyses were conducted using the same commercially available software program (SAS, version 9.3; SAS Institute Inc).

Results

Overall, 1000 potential participants were identified initially. Of these, 270 patients were found to be ineligible for the survey, 206 could not be contacted, 113 refused to participate, and 411 completed the survey (response rate, 62.3% by American Association for Public Opinion Research definition[42]). Compared with patients who did not participate in the survey, respondents were younger (mean ages, 62.0 vs 65.4 years; $P < .001$) but were similar with regard to sex, insurance coverage, educational attainment, and Hispanic and non-Hispanic black race/ethnicity. The mean age of participants was 62.0 years; 47.5% were women; and 78.6% were non-Hispanic white (**Table 1**). In general, patients with any material need insecurity were more likely to be younger, to be from a racial/ethnic minority group, and to have a low level of health literacy. Reflecting the Massachusetts setting, health insurance coverage was high (only 4.1% had no insurance or were self-pay) and 2.8% reported lacking prescription medication coverage. Overall, prevalence of material need insecurities was high (**Figure**), and the presence of 1 material need insecurity overlapped modestly with the presence of others (eTable 1 in the Supplement).

In unadjusted analyses, patients with food insecurity, cost-related medication underuse, and housing instability were significantly more likely to have poor diabetes control compared with their secure counterparts (**Table 2**). For example, 64.1% of patients reporting food insecurity had poor diabetes control compared with 41.6% of food-secure patients ($P = .001$). The relationship was similar, although the difference did not

Table 1. Demographic Characteristics and Comparisons of Patients With and Without Material Need Insecurities[a]

Characteristic	All (N = 411)	Food Insecurity (n = 80)	Cost-Related Medication Underuse (n = 104)	Housing Instability (n = 44)	Energy Insecurity (n = 72)
Age, mean (SD), y	62.0 (11.0)	56.4 (10.6)[b]	57.4 (11.5)[b]	55.0 (13.5)[b]	57.1 (10.8)[b]
Female sex	47.5	51.3	47.1	52.3	47.2
Race/ethnicity					
Non-Hispanic white	78.6	65.0[b]	65.4[b]	47.7[b]	59.7[b]
Non-Hispanic black	7.8	15.0[b]	14.4[b]	15.9[b]	16.6[b]
Hispanic	9.3	16.3[b]	15.4[b]	34.1[b]	18.0[b]
Asian/other	4.4	3.8[b]	4.8[b]	2.3[b]	5.6[b]
Educational attainment					
<High school diploma	14.4	21.3[b]	26.0[b]	22.7	20.8
High school diploma	26.8	18.8[b]	23.1[b]	27.3	26.4
>High school diploma	58.9	60.0[b]	51.0[b]	50.0	52.8
Insurance					
Commercial	50.6	38.5[b]	38.2[b]	35.7[b]	37.5[b]
Medicare	26.9	29.5[b]	25.5[b]	31.0[b]	26.4[b]
Medicaid	13.3	21.8[b]	22.6[b]	16.7[b]	22.2[b]
Free Care	4.9	7.7[b]	9.8[b]	16.7[b]	9.7[b]
None/self-pay	4.4	2.6[b]	3.9[b]	0.0[b]	4.2[b]
Low health literacy	28.1	38.2[b]	43.3[b]	45.4[b]	33.3
Born outside the United States	20.4	30.0[b]	29.8[b]	40.9[b]	31.5[b]
Spanish speaking	5.1	8.8	7.7	20.5[b]	9.7[b]
Charlson Comorbidity Index, mean (SD)	4.9 (3.0)	5.2 (3.3)	4.8 (2.9)	4.2 (2.8)	5.1 (3.1)
HbA_{1c} testing, No./y, mean (SD)	2.6 (1.1)	2.6 (1.09)	2.6 (1.1)	2.8 (1.1)	2.5 (1.1)
Age at diagnosis of diabetes mellitus, mean (SD), y	50.0 (14.2)	45.9 (14.0)[b]	45.8 (15.1)[b]	43.8 (15.4)[b]	45.6 (10.5)[b]
No. of material need insecurities					
0	60.3	NA	NA	NA	NA
1	17.4	NA	NA	NA	NA
2	12.9	NA	NA	NA	NA
3	7.2	NA	NA	NA	NA
4	2.2	NA	NA	NA	NA

Abbreviations: HbA_{1c}, hemoglobin A_{1c}; NA, not applicable.

[a] Unless otherwise indicated, data are expressed as percentage of respondents. Percentages have been rounded and may not total 100.

[b] Indicates $P < .05$ in the insecure category compared with the secure counterpart.

meet statistical significance, for those with energy insecurity. All 4 material need insecurities were associated with increased outpatient visits, but only cost-related medication underuse was associated with increased ED/inpatient visits.

In multivariable models, including each material need insecurity individually and accounting for age, sex, race/ethnicity, educational attainment, insurance, health literacy, survey language, nativity, duration of diabetes mellitus, medications, and clustering by clinic (**Table 3**), food insecurity was associated with poor diabetes control (odds ratio [OR], 1.97 [95% CI, 1.58-2.47]; food-secure patients served as the reference group) and increased outpatient visits (incidence rate ratio [IRR], 1.19 [95% CI, 1.05-1.36]) but not increased ED/inpatient visits (IRR, 1.00 [95% CI, 0.51-1.97]) (full models are given in eTables 2-7 in the Supplement). By contrast, cost-related medication underuse was associated with poor diabetes control (OR, 1.91 [95% CI, 1.35-2.70]; no cost-related medication underuse served as the reference group) and increased ED/inpatient visits (IRR, 1.68 [95% CI, 1.21-2.34]) but not increased outpatient visits (IRR, 1.07 [95% CI, 0.95-1.21]).

In multivariable models accounting for the same covariates but considering the cumulative number of material need insecurities, an increasing number of insecurities was associated with increased odds of poor diabetes control, that is, a 39% increase in the odds of poor diabetes control for each additional material need insecurity (OR, 1.39 [95% CI, 1.18-1.63]) (eTable 3 in the Supplement). Results were similar for the rates of outpatient visits (9% increase; IRR, 1.09 [95% CI, 1.03-1.15]) (eTable 5 in the Supplement) and ED/inpatient visits (22% increase; IRR, 1.22 [95% CI, 0.99-1.51]) (eTable 7 in the Supplement) for each additional material need insecurity.

In multivariable analyses looking at the individual components of diabetes control (**Table 4** and full models in eTables 8-10 in the Supplement), food insecurity was associated with poor glycemic control (OR, 2.04 [95% CI, 1.61-2.60]) and poor control of LDL-C levels (OR, 1.49 [95% CI, 1.13-1.98]). Food in-

security was not associated with poor blood pressure control (OR, 1.58 [95% CI, 0.66-3.76]). Cost-related medication underuse was associated with increased odds of poor glycemic control (OR, 2.08 [95% CI, 1.11-3.88]), poor control of LDL-C levels (OR, 1.80 [95% CI, 1.60-2.02]), and poor blood pressure control (OR, 1.82 [95% CI, 1.03-3.22]). Models including all 4 material need insecurities together are presented in eTables 11 through 16 in the Supplement.

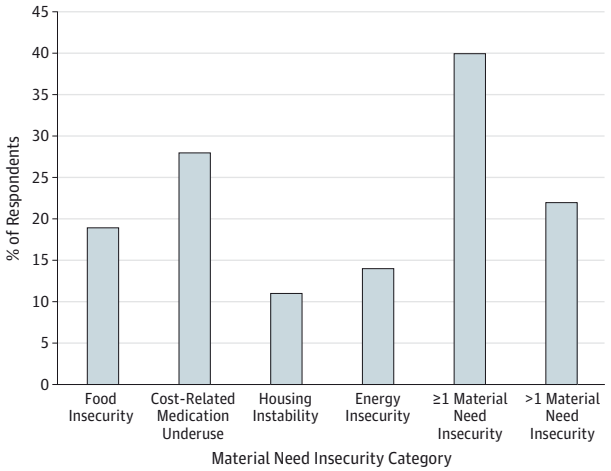
Finally, in unadjusted analyses among patients with at least 1 inpatient admission, food insecurity (20.1% in those with food insecurity vs 7.3% in those who were food secure; $P < .001$) and housing instability (20.3% in patients with unstable housing vs 8.0% in those with stable housing; $P = .03$) were associated with increased 30-day readmissions. Cost-related medication underuse and energy insecurity were not associated with similar increases. Too few events were available to produce adjusted models for this outcome.

Discussion

Material need insecurities were common among the respondents in this study despite high levels of overall health insurance and prescription drug coverage. Although all material need insecurities had some generally moderate association with poor clinical diabetes control or the increased use of health care resources, no single insecurity was associated with all outcomes. For example, food insecurity was strongly and independently associated with glycemic control and outpatient visits, whereas cost-related medication underuse was associated with poor control of glycemia, LDL-C levels, and blood pressure along with increased ED/inpatient visits. In addition to their individual associations, an increasing number of material need insecurities was associated with worse clinical outcomes and use of health care resources. These results support the hypothesis that food insecurity and cost-related medication underuse are independently associated with poor diabetes control and increased use of health care resources. Furthermore, they support the hypothesis that an additive relationship exists among multiple material need insecurities in the care of diabetes mellitus.

Educational attainment, income, or both are often used to indicate socioeconomic status in health research to capture aspects of prestige, power, and economic resources.[43] In this study, we measured and adjusted for educational attainment in our analyses, but, rather than measuring income, we measured specific material need insecurities. We did this because a given level of income may be sufficient for one person but insufficient for another based on factors such as wealth, expenses, number of people supported and their needs, and the local cost of living. Determining specifically what a patient cannot afford and relating that to health and use of health care resource outcomes

Figure. Prevalence of Material Need Insecurities



Material need insecurities are defined as difficulty meeting basic material needs owing to cost.

Table 2. Unadjusted Comparisons of Material Need Insecurities With Control of Diabetes Mellitus and Use of Health Care Resources

	Prevalence of Poor Diabetes Control, %[a]	*P* Value	Outpatient Visits, Median (IQR)	*P* Value	ED/Inpatient Visits, Median (IQR)	*P* Value
Food						
Insecure	64.1	.001	8 (5-11)	.003	0 (0-1)	.05
Secure	41.6		6 (4-10)		0 (0-1)	
Cost-related medication underuse						
Insecure	62.0	.001	8 (5-11)	.047	0 (0-1)	.02
Secure	40.2		7 (4-10)		0 (0-1)	
Housing instability						
Insecure	60.5	.04	9 (6-13)	.003	0 (0-2)	.16
Secure	43.9		7 (4-10)		0 (0-1)	
Energy						
Insecure	56.7	.06	8 (5-11)	.01	0 (0-1)	.20
Secure	43.5		7 (4-10)		0 (0-1)	

Abbreviations: ED, emergency department; IQR, interquartile range.

[a] Indicates composite of hemoglobin A_{1c} levels greater than 9.0%, low-density lipoprotein cholesterol levels of greater than 100 mg/dL (to convert to millimoles per liter, multiply by 0.0259), or blood pressure of greater than 140/90 mm Hg.

Table 3. Adjusted Comparisons of Material Need Insecurities With Control of Diabetes Mellitus and Use of Health Care Resources

	Poor Diabetes Control, OR (95% CI)[a]	IRR for Visits (95% CI)[b]	
		Outpatient	ED/Inpatient
Food			
Insecure	1.97 (1.58-2.47)[c]	1.19 (1.05-1.36)[c]	1.00 (0.51-1.97)
Secure	1 [Reference]	1 [Reference]	1 [Reference]
Cost-related medication underuse			
Insecure	1.91 (1.35-2.70)[c]	1.07 (0.95-1.21)	1.68 (1.21-2.34)[c]
Secure	1 [Reference]	1 [Reference]	1 [Reference]
Housing instability			
Insecure	1.10 (0.60-2.02)	1.31 (1.14-1.51)[c]	1.49 (0.81-2.73)
Secure	1 [Reference]	1 [Reference]	1 [Reference]
Energy			
Insecure	1.27 (0.96-1.69)	1.12 (1.00-1.25)[c]	1.31 (0.80-2.13)
Secure	1 [Reference]	1 [Reference]	1 [Reference]

Abbreviations: ED, emergency department; IRR, incidence rate ratio; OR, odds ratio.

[a] Poor diabetes control indicates composite of hemoglobin A_{1c} levels of greater than 9.0%, low-density lipoprotein cholesterol levels of greater than 100 mg/dL (to convert to millimoles per liter, multiply by 0.0259), or blood pressure of greater than 140/90 mm Hg. Values are adjusted for age, sex, race/ethnicity, educational attainment, insurance, health literacy, survey language, nativity, duration of diabetes mellitus, use of medications to lower glycemia or cholesterol levels or antihypertensives, and clustering by clinic.

[b] Adjusted for age, sex, race/ethnicity, educational attainment, insurance, health literacy, survey language, nativity, duration of diabetes mellitus, Charlson Comorbidity Index, and clustering by clinic.

[c] Indicates $P < .05$ in the insecure category compared with the secure counterpart.

Table 4. Adjusted Comparisons of Material Need Insecurities and Components of Control of Diabetes Mellitus

	OR (95% CI)		
	Hemoglobin A_{1c} Level >9.0%[a]	LDL-C Level >100 mg/dL[b]	Blood Pressure >140/90 mm Hg[c]
Food			
Insecure	2.04 (1.61-2.60)[d]	1.49 (1.13-1.98)[d]	1.58 (0.66-3.76)
Secure	1 [Reference]	1 [Reference]	1 [Reference]
Cost-related medication underuse			
Insecure	2.08 (1.11-3.88)[d]	1.80 (1.60-2.02)[d]	1.82 (1.03-3.22)[d]
Secure	1 [Reference]	1 [Reference]	1 [Reference]
Housing instability			
Insecure	1.77 (0.64-4.88)	0.99 (0.47-2.10)	0.93 (0.63-1.37)
Secure	1 [Reference]	1 [Reference]	1 [Reference]
Energy			
Insecure	1.16 (0.60-2.23)	1.11 (0.75-1.64)	1.29 (0.76-2.21)
Secure	1 [Reference]	1 [Reference]	1 [Reference]

Abbreviations: LDL-C, low-density lipoprotein cholesterol; OR, odds ratio.

SI conversion factor: To convert LDL-C to millimoles per liter, multiply by 0.0259.

[a] Adjusted for age, sex, race/ethnicity, educational attainment, insurance, Charlson Comorbidity Index, survey language, nativity, duration of diabetes mellitus, insulin use, and clustering by clinic.

[b] Adjusted for age, sex, race/ethnicity, educational attainment, insurance, health literacy, survey language, nativity, Charlson Comorbidity Index, statin use, and clustering by clinic.

[c] Adjusted for age, sex, race/ethnicity, educational attainment, insurance, health literacy, survey language, nativity, use of antihypertensives, and clustering by clinic.

[d] Indicates $P < .05$ in the insecure category compared with the secure counterpart.

gives clinicians greater understanding of their patients' circumstances and helps to guide interventions with more precision than measuring income would allow. For example, knowing that a patient's income is below a poverty threshold suggests only that income assistance, such as a cash transfer, may be useful and may miss patients whose income is greater than a poverty threshold yet is nevertheless insufficient to meet his or her needs. However, if a patient reports food insecurity, a clinician knows that resources are insufficient, whatever the level of income, Furthermore, this finding suggests additional areas for intervention beyond cash transfers, including providing resources that can only be used for food (such as Supplemental Nutrition Assistance Program–like assistance or nutritional prescriptions), direct provision of food, or education- and skill-building programs to use available food resources more effectively. Moreover, without identifying and addressing food insecurity, simple referral for medical

nutritional therapy for people with uncontrolled diabetes mellitus, a current standard of care,[36] is likely to be fruitless.

The differential associations we observe between material need insecurities and several components of high-value health care suggest that the relationship with health and health care outcomes is nuanced and complex. In the future, approaches that consider only global indicators of economic distress, such as poverty, or only single needs in isolation may be less useful for improving health in patients with material need insecurities. Instead, we advocate approaches that build on prior work to examine multiple material need insecurities simultaneously.[28,44] Such approaches may be particularly relevant when creating population health programs. High levels of outpatient visits by patients with poorly controlled diabetes mellitus may point to a group of patients with several material need insecurities for whom the health care system is currently underprepared to intervene; the efforts of patients and clinicians could be futile when social needs remain unaddressed.

This study is consistent with and expands on prior investigations. Previous studies have established an association between food insecurity[6-8] and cost-related medication underuse[11-13] with diabetes control when examining their specific unmet need of interest in isolation. This study builds on these previous investigations by examining material need insecurities in a broader context of competing material need insecurities and noneconomic social circumstances, including health literacy and nativity. This approach more closely approximates the real-world conditions faced by clinicians when attempting to improve care for vulnerable patients.

In addition, the differential associations we observe suggest possible mechanisms that may help to refine our understanding of how adverse economic circumstances affect health, the quality side of the value equation. We observe that food insecurity was more strongly associated with LDL-C levels and glycemic control than with blood pressure levels, which is consistent with prior observations regarding the importance of improving the diets of patients with very high blood glucose levels[45] and with results of factor analysis suggesting that similar physiological processes underlie insulin resistance and dyslipidemia, with blood pressure linked to different metabolic mechanisms.[46] Similarly, the association between cost-related medication underuse and blood pressure control suggests that medication adherence may be of primary importance for this outcome. Furthermore, unstable access to medication could lead to acute episodes, such as hypoglycemic and hyperglycemic crises or cardiovascular events, which result in ED visits or hospitalizations.[47] These possible mechanisms are speculative but may provide direction for future research in this area.

In addition to suggesting possible mechanisms, this study has several implications for future interventions. First, multifactorial interventions addressing different material need insecurities may be more effective than interventions addressing a single insecurity. For example, addressing access to food and to medication together may be important to improve clinical diabetes control. Several evidence-based strategies might be used for this improvement. Health care systems could seek to increase linkages among their system, government programs, and community resources,[48] and community health worker and peer support interventions may help patients to improve their use of available resources.[49,50] Second, making key medications available at very low or no out-of-pocket cost for patients through a value-based insurance design may improve clinical outcomes[47] and disparities.[51] For diabetes mellitus care, development of a cost-effective bundle of selected medications, such as metformin, generic statins, and generic angiotensin-converting enzyme inhibitors, available without out-of-pocket cost for patients with diabetes mellitus, may be a successful approach to reducing cost-related medication underuse. Next, direct supplementation of healthy foods may reduce food insecurity and improve clinical outcomes. The PREDIMED (Prevención con Dieta Mediterránea) study,[52] although not conducted with the goal of reducing food insecurity, demonstrated that direct supplementation of healthy food was effective in reducing cardiovascular events in a population with high rates of diabetes mellitus. Finally, with increasing attention paid to 30-day readmissions, some of the material need insecurities we identified may be useful to consider when designing programs to reduce this outcome, especially in light of prior work highlighting socioeconomic barriers to avoiding readmission.[53]

The results of this study should be interpreted in the context of several limitations. First, the data are cross-sectional, and we were unable to evaluate time ordering of exposures and outcomes. Although it is certainly plausible that food insecurity, by incenting increased consumption of cheap, calorie-dense, highly processed foods,[54] and cost-related medication underuse, through reduced adherence,[55] can worsen diabetes mellitus outcomes and increase use of health care resources, the possibility of reverse causation remains. Despite this possibility, significant improvements in diabetes control while these factors remain unaddressed are difficult to imagine. Moreover, if material need insecurities have an effect on the care of diabetes mellitus, the temporal relationship between material need insecurities and health care outcomes would be important to study; it may differ among the various needs.

A second limitation is that this study was conducted in a single health care system among a population sample with less racial/ethnic diversity and greater educational attainment and that was older than the national mean values for patients with diabetes mellitus.[56] Material need insecurities may be even more prevalent in more diverse populations. However, the results of this study indicate that material need insecurities are common even among persons who are relatively well off.

Third, with regard to data on the use of health care resources, we were unable to capture resource use that occurred outside our system. Although we used a validated linkage algorithm to capture patients who usually receive care, and especially primary care, in our system,[23] we do not know what proportion of patents had visits to health care providers in other institutions. However, these data would change our qualitative interpretation only if well-off patients were seen differentially more often in outside clinics, which we have no reason to suspect.

Fourth, although this study was adequately powered for its primary end point, some exploratory subanalyses likely lacked power. This limitation is particularly evident when examining the different components of diabetes control, in which CIs were quite wide but did not always exclude a clinically relevant increase in risk. In addition, relatively low numbers of ED/inpatient visits were observed in this group, and we may have observed different associations between material need insecurities and ED/inpatient visits in a cohort with more of such visits.

Finally, with regard to housing instability, several types may not have been captured by our items but may still be of clinical consequence. Specifically, frequent moves that did not meet our threshold, living in a single-room occupancy hotel, living in residential treatment or supervised housing that may be temporary, living with the threat of eviction, or paying more than 50% of monthly income in rent may all be relevant forms of housing instability not captured. Thus, our data likely underestimate the true prevalence of housing instability. Furthermore, whether the addition of these other forms of housing instability would change the associations we observed remains unknown.

These limitations were balanced by several strengths. The study included English- and Spanish-speaking patients, we used objective data for the use of health care resources, and we had access to detailed information on medications, clinical characteristics of patients with diabetes mellitus, and social circumstances beyond economic factors. In addition, this study was conducted in Massachusetts, which has near-universal health insurance coverage. Increasing access to care for patients with material need insecurities may not be sufficient to eliminate disparities in health outcomes.

Conclusions

Health care systems are increasingly accountable for health outcomes that have roots outside of clinical care. Because of this development, strategies that increase access to health care resources might reasonably be coupled with those that address social determinants of health, including material need insecurities. In particular, food insecurity and cost-related medication underuse may be promising targets for real-world management of diabetes mellitus.

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Author Affiliations: Division of General Internal Medicine, Massachusetts General Hospital, Boston (Berkowitz, Meigs, Atlas); Diabetes Unit, Massachusetts General Hospital, Boston (Berkowitz, Wexler); Harvard Medical School, Boston, Massachusetts (Berkowitz, Meigs, Atlas, Wexler); Division of General Medicine and Clinical Epidemiology, University of North Carolina School of Medicine, Chapel Hill (DeWalt); Division of General Internal Medicine, University of California, San Francisco (Seligman); Center for Vulnerable Populations, San Francisco General Hospital and Trauma Center, San Francisco, California (Seligman); currently an undergraduate in the Community Health Program, Tufts University, Medford, Massachusetts (Barnard, Bright, Schow); currently an undergraduate in the Biology Program, Tufts University, Medford, Massachusetts (Barnard).

Author Contributions: Dr Berkowitz had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Berkowitz, Meigs, Seligman, Wexler.
Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: Berkowitz, Barnard, Bright, Wexler.
Critical revision of the manuscript for important intellectual content: Meigs, DeWalt, Seligman, Bright, Schow, Atlas, Wexler.
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