Perception of Neighborhood Problems, Health Behaviors, and Diabetes Outcomes Among Adults With Diabetes in Managed Care

The Translating Research Into Action for Diabetes (TRIAD) Study

TIFFANY L. GARY, PHD[1]
MONIKA M. SAFFORD, MD[2]
ROBERT B. GERZOFF, MS[3]
SUSAN L. ETTNER, PHD[4]
ANDREW J. KARTER, PHD[5]
GLORIA L. BECKLES, MD, MSC[3]
ARLEEN F. BROWN, MD, PHD[4]

OBJECTIVE — Recent data suggest that residential environment may influence health behaviors and outcomes. We assessed whether perception of neighborhood problems was associated with diabetes behaviors and outcomes.

RESEARCH DESIGN AND METHODS — This cross-sectional analysis included 7,830 diabetic adults enrolled in Translating Research Into Action for Diabetes, a study of diabetes care and outcomes in managed care settings. Perception of neighborhood problems was measured using a summary score of participants' ratings of crime, trash, litter, lighting at night, and access to exercise facilities, transportation, and supermarkets. Outcomes included health behaviors and clinical outcomes. Hierarchical regression models were used to account for clustering of patients within neighborhoods and to adjust for objective neighborhood socioeconomic status (percentage living in poverty) and potential individual-level confounders (age, sex, race/ethnicity, education, income, comorbidity index, and duration of diabetes).

RESULTS — After adjustment, residents of neighborhoods in the lowest tertile (most perceived problems) reported higher rates of current smoking (15 vs. 11%) than those in the highest tertile and had slightly lower participation in any weekly physical activity (95 vs. 96%). In addition, their blood pressure control was worse (25 vs. 31% <130/80 mmHg), and their Short Form 12 scores were slightly lower (44 vs. 46 units for emotional well-being and 43 vs. 44 units for physical well-being); all $P < 0.01$.

CONCLUSIONS — Neighborhood problems were most strongly associated with more smoking and higher blood pressure, both of which have significant implications for cardiovascular risk. Potential mechanisms that explain these associations should be further explored in longitudinal studies.

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From the [1]Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland; the [2]Deep South Center on Effectiveness at Birmingham VA Medical Center and Department of Preventive Medicine, University of Alabama at Birmingham, Birmingham, Alabama; the [3]Centers for Disease Control and Prevention, Division of Diabetes Translation, Atlanta, Georgia; the [4]Division of General Internal Medicine and Health Services Research, Department of Medicine, David Geffen School of Medicine at University of California, Los Angeles, Los Angeles, California; and the [5]Division of Research, Kaiser Permanente, Oakland, California.

Address correspondence and reprint requests to Tiffany L. Gary, PhD, 615 N. Wolfe St., Rm E6531, Baltimore, MD 21205. E-mail: tgary@jhsph.edu.

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Abbreviations: DBP, diastolic blood pressure; SBP, systolic blood pressure; SES, socioeconomic status; SF-12, Short Form 12; SMBG, self-monitoring of blood glucose; TRIAD, Translating Research into Action for Diabetes.

Recent data suggest that neighborhood environment may substantially influence both risk of chronic disease and rates of participation in health behaviors that are necessary for managing chronic disease (1–6). To date, much of the focus in this literature has been on objective community-level neighborhood problems, using aggregate education and income data available for census tracts and census block groups. These studies found community-level effects on cardiovascular risk and health behaviors such as physical activity that were independent of individual-level factors.

Neighborhood problems might pose severe constraints on individuals with diabetes (7), among whom clinical management is required to attain good glycemic control, blood pressure, and lipid control, which require substantial self-management such as a healthy diet, regular physical activity, self-monitoring of blood glucose (SMBG), regular foot care, and adherence to medications (8). Poor neighborhoods may present barriers such as crime and lack of access to certain resources that can impede an individual from actively engaging in healthy behaviors (9–11). Moreover, lack of access to public transportation could affect participation in appropriate diabetes care by making it difficult to reach clinics and pharmacies. In several studies, perceived neighborhood problems were associated with more physical inactivity and symptoms and risk of functional loss among older adults (12–14). Data from the landmark Whitehall II study suggest two reasons why subjective (or perceived) socioeconomic status (SES) may have an impact on health. First, subjective SES represents an "average" of markers of SES, including those social and economic. In addition, it has been hypothesized that a link between income inequality and population health is mediated through perceptions of place (15). Both objective neighborhood characteristics and percep-

tions of neighborhood features may be important factors in chronic disease management (16,17).

We conducted a cross-sectional analysis to determine whether perceived neighborhood problems were independently associated with health behaviors and outcomes among adults with diabetes in managed care after adjusting for an objective measure of neighborhood SES and potential individual-level confounders. We hypothesized that more perceived neighborhood problems (e.g., crime, trash) would be associated with worse health behaviors and diabetes outcomes.

RESEARCH DESIGN AND METHODS

— Translating Research into Action for Diabetes (TRIAD) is a longitudinal study of diabetes care in managed care settings; the design and other details of the study have been published previously (18,19). Briefly, the 10 TRIAD health plans contract with 68 provider groups and serve ~180,000 individuals with diabetes. The plans are geographically and ethnically diverse, with patients in California, Hawaii, Indiana, Michigan, New Jersey, Pennsylvania, and Texas. The proportion of patients with diabetes in these plans ranges from 5 to 10%. Between July 2000 and August 2001, we surveyed a random sample of adults with diabetes from these plans using a combination of computer-assisted telephone interviews, mailed surveys, and a review of medical records. Those eligible to be included in the study had diabetes, were ≥18 years old, were continuously enrolled in a participating health plan for ≥18 months with at least one claim for health care in that time, reported receiving the majority of their diabetes care through the health plan, and spoke English or Spanish. The TRIAD study excluded nursing home residents, pregnant women, and those who could not provide informed consent.

Multiple reviewers abstracted the medical records from the participants' primary care providers for the 18 months before the interview date. Five percent of the records were reviewed in a double-blind fashion, i.e., reviewers were not aware of which participants were selected for double abstraction. Interrater reliability for the main quality measures derived from medical record data ranged from 0.86 to 0.94. The TRIAD study protocol was reviewed and approved by the U.S. Centers for Disease Control and Prevention Institutional Review Board and the institutional review boards at all six translational research centers. Of the 8,792 individuals who completed the survey, 7,830 with data for the perceived neighborhood problems score were included in this analysis.

Individual sociodemographic variables

Sociodemographic variables included in the analysis were age, sex, race/ethnicity, education, and income. Race/ethnicity was self-reported using questions from the 2000 U.S. Census and categorized as non-Hispanic white, African American or non-Hispanic black, Hispanic or Latino, Asian/Pacific Islander, or other. To account for disease severity, the duration of diabetes and the Charlson Comorbidity Index (20,21), which summarizes the number of comorbid conditions for each participant, were also included.

Main independent variables. The main independent variable in this analysis was the perception of neighborhood problems. Six items were included: "Thinking about where you live, how much of a problem is each of the following: crime, access to exercise facilities, trash and litter, lighting at night, access to public transportation, and access to nearby supermarket." Each item had four possible responses (very serious, somewhat serious, minor, and not a problem), and responses for each item were summed to create a summary score (range 1–24, mean 20). The summary score was then divided into tertiles (mean 16, 21, and 24 for the lowest to the highest tertiles, respectively). Higher scores indicate perception of fewer problems. Among the six translational research centers, missing values for the score ranged from 6.7 to 17.5%.

After considering several U.S. Census–based measures of objective neighborhood SES that were similar to those used in previous studies (2,22,23), we ultimately decided on the single item "percentage of individuals in the census tract living below the federal poverty line" because this measure is highly correlated with other census-based indexes and has been shown to be similarly predictive of health outcomes (23).

Dependent variables

Health behaviors. Health behaviors related to diabetes self-management were assessed by questionnaire. Smoking was categorized as being a current smoker versus never a smoker or a former smoker. Any physical activity during the week was defined as light or vigorous activity compared with no activity at all. SMBG was dichotomized into monitoring at least once or less than once per day. Foot care was measured similarly (did vs. did not check his or her feet for sores daily).

Intermediate outcomes. Intermediate outcomes (A1C, LDL cholesterol, systolic blood pressure [SBP], and diastolic blood pressure [DBP]) were determined by the most recent value recorded at the time of the medical record review. Intermediate outcomes were analyzed as both continuous and dichotomous variables. A1C was dichotomized as <7 vs. ≥7%, LDL cholesterol as <100 vs. ≥100 mg/dl, blood pressure as SBP <130 mmHg or DBP <80 mmHg vs. SBP ≥130 mmHg or DBP ≥80 mmHg. General physical and mental health were assessed using scores on the Short Form 12 (SF-12) (physical and mental health component scores) (24); higher scores indicate better well-being.

Statistical analysis

We used descriptive statistics to summarize each variable and conducted univariate analyses to assess the relationship between the variables of interest and tertile of neighborhood problems score. We fit hierarchical linear mixed models to examine the relationships between neighborhood problems and behaviors and outcomes while accounting for the clustering of patients within tracts and for fixed health plan effects. All models were adjusted for potential confounders: patient age, sex, race/ethnicity, education, income, Charlson Comorbidity Index (20,21), duration of diabetes, and objective neighborhood SES (proxied by the percentage of individuals in the census tract who were living in poverty). For continuous outcomes, we present estimates of least squares means by tertile of neighborhood problems score, adjusted for potential confounders. We calculated least squares means using the observed margins for all categorical variables and at the mean for all continuous variables.

For dichotomous outcomes, because odds ratios are poor estimates of relative risk when outcomes are common, we report the predicted probabilities of the outcome for each tertile of neighborhood problems score while adjusting for potential confounders. Models were fit in stages to determine whether the point estimates differed when sociodemographic characteristics, objective neighborhood poverty measure (percentage living in poverty),

and disease severity were entered separately into the models. We also tested for interactions between the perceived neighborhood problems score and the objective neighborhood poverty measure. Because the point estimates did not differ substantially between models, we report only the fully adjusted models in this manuscript. All analyses were performed using SAS, version 9.1, and the models were fit using either the SAS MIXED or GLIMMIX procedures (25).

RESULTS

Unadjusted associations between neighborhood problems and characteristics of the study population

Several sociodemographic characteristics, health behaviors, and intermediate outcomes were significantly ($P < 0.05$) associated in unadjusted analyses with the perceived neighborhood problems score (Table 1). Women and those with lower educational levels, lower incomes, or more comorbid conditions reported more neighborhood problems. Individuals who lived in neighborhoods with higher poverty rates (according to the 2000 U.S. Census) also reported more neighborhood problems.

The percentage of current smokers was higher and the percentage of individuals engaged in weekly physical activity was lower in neighborhoods perceived as having more problems. There was no association between the neighborhood problems score and SMBG. A subanalysis of the perceived neighborhood problems score and SMBG, conducted only among insulin users, also yielded nonsignificant results (data not shown). There was also no significant association between the neighborhood problems score and foot self-care behavior.

Among intermediate outcomes, SBP was lower for those who reported fewer neighborhood problems. Physical and mental health component scores were higher, indicating better physical and emotional well-being, among individuals who reported fewer neighborhood problems.

Regression models for neighborhood problems score, health behaviors, and intermediate outcomes

In the adjusted regression models predicting health behaviors and intermediate outcomes, individuals who reported fewer neighborhood problems (i.e., the highest tertile) were significantly less likely to smoke, slightly more likely to engage in physical activity, and had better blood pressure control (Table 2). Furthermore, those who reported fewer problems also had slightly higher mental and physical heath scores on the SF-12. No other behaviors or intermediate outcomes were significantly associated with the perceived neighborhood problems score.

Several subanalyses were conducted to explore the relationships between key study variables. The results did not appreciably change when we entered interaction terms between race and the perceived neighborhood problems score or between health plan and the perceived neighborhood problems score. Furthermore, the interaction between the perceived neighborhood problems score and the objective neighborhood SES measure (percentage living in poverty) was nonsignificant for every outcome except for blood pressure ($P = 0.02$). When evaluating blood pressure outcomes for the extremes of the subjective neighborhood measure, we see that for the lowest level of subjective neighborhood perception (most problems), a smaller proportion of individuals was well controlled (17%) even at the lowest level of objective neighborhood poverty. In contrast, for the highest tertile of subjective neighborhood, more individuals were well controlled (51%) even at the highest level of objective neighborhood poverty. We interpret all of the interactions with caution because statistical power to detect them was limited.

CONCLUSIONS — Among this diverse group of individuals with diabetes in managed care, having more perceived neighborhood problems was associated most strongly with current smoking and poorer control of blood pressure. These relationships persisted, even after adjusting for an objective measure of neighborhood SES, for individual-level SES and for other potential confounders. Small associations with any reported physical activity and SF-12 physical and mental health scores were also noted but not considered clinically significant.

While much of the literature on neighborhoods and their influence on physical activity and obesity has evaluated residents' perceptions of their environment, only a few studies have included both perceived and objective measures of the neighborhood (26–28). These studies conclude that both types of measurements correlate with physical activity and stress the importance of continuing to include both in future studies. (It should be noted that the measures of physical activity in these studies were specific and included intensity, duration, and frequency of activity.) Further, in the one study that attempted to identify the most robust indicator of neighborhood problems, both perceived and observed neighborhood characteristics (land use patterns, reduced access to sidewalks, and aesthetic quality) were strong, robust correlates (28). Our report adds to this expanding literature by including both perceptions of neighborhood problems and objective measures of neighborhood SES as they relate to several measured outcomes among individuals with an established chronic disease such as diabetes.

Studies of neighborhood problems in the context of diabetes are few. One recent study examined neighborhood problems with the clustering of cardiovascular risk factors and found a positive correlation between poor neighborhood problems and the presence of diabetes (29). In addition, an analysis from the Multi-Ethnic Study of Atherosclerosis showed that greater distance from a wealthy area was associated with insulin resistance independent of area-level poverty and individual-level covariates (30). In contrast, another study failed to find an association between neighborhood deprivation and the presence of diabetes in a Swedish population (31). Longitudinal studies are needed to confirm these associations. Furthermore, studies that have evaluated the utilization of diabetes preventive care services have generally focused on individual-level SES predictors such as education and income (7,32). Comparable studies in diabetes are not available, but our findings appear to be consistent with other studies of neighborhood problems and health behaviors in general populations.

Some limitations should be noted. First, because the study was cross-sectional, no causal inferences were made. Second, assessment of health behaviors was based on self-report; thus, social desirability may have influenced participants' responses. Third, the measure of physical activity used in our study was nonspecific and unrelated to current recommendations. Finally, our findings may not generalize to the uninsured or to other clinical settings. Nonetheless, our

Table 1—*Sociodemographic characteristics, health behaviors, and intermediate outcomes stratified by tertile of perceived neighborhood problems score*

	Total sample*	Tertile of perceived neighborhood problems score			
		1 (most problems)	2	3 (fewest problems)	*P*
Sociodemographics					
Mean age (years)	61.8	61.6	61.6	62.1	0.26
Sex					
Female	4,200 (53.6)	1,380 (59.5)	1,432 (52.5)	1,388 (49.9)	<0.01
Education					
<High school	1,516 (19.8)	539 (23.8)	456 (17.1)	521 (19.2)	<0.01
High school graduate	2,266 (29.7)	743 (32.9)	761 (28.5)	762 (28.1)	
>High school	3,858 (50.50)	980 (43.3)	1453 (54.4)	1425 (52.6)	
Annual income (thousands)					
<$15	1,496 (22.6)	647 (33.4)	470 (20.0)	379 (16.3)	<0.01
$15–$40	2,161 (32.7)	659 (34.0)	770 (32.8)	732 (31.5)	
$40–$75	1,713 (25.9)	408 (21.1)	625 (26.6)	680 (29.3)	
>$75	1,242 (18.8)	224 (11.6)	485 (20.60)	533 (22.9)	
Race/ethnicity					
Hispanic	1,169 (16.0)	315 (14.6)	361 (13.9)	493 (18.9)	<0.01
Non-Hispanic black	1,063 (14.4)	418 (19.4)	356 (13.7)	289 (11.1)	
Non-Hispanic white	3,355 (45.5)	926 (42.9)	1,266 (48.6)	1,163 (44.6)	
Asian/Pacific Islander	1,146 (15.6)	292 (13.5)	393 (15.1)	461 (17.7)	
Other	636 (8.6)	206 (9.6)	227 (8.7)	203 (7.8)	
Charlson Comorbidity Index (from baseline)	2.20 ± 1.5	2.30 ± 1.6	2.16 ± 1.5	2.15 ± 1.5	<0.01
Percent poverty (objective neighborhood index)	12	15	12	11	<0.01
Health behaviors					
Smoking					
Nonsmoker	6,584 (84.7)	1,885 (82.0)	2,285 (84.3)	2,414 (87.5)	<0.01
Current smoker	1,187 (15.3)	415 (18.0)	426 (15.7)	346 (12.5)	
Physical activity (weekly)					
None	657 (8.6)	241 (10.8)	202 (7.5)	214 (7.8)	<0.01
Light	3,584 (46.80)	1,113 (49.80)	1,247 (46.3)	1,224 (44.9)	
Vigorous	3,417 (44.6)	881 (39.4)	1,245 (46.2)	1,291 (47.3)	
SMBG					
Less than once/day	3,857 (50.2)	1,142 (50.5)	1,339 (49.9)	1,376 (50.2)	0.93
Once/day or more	3,829 (49.8)	1,120 (49.5)	1,342 (50.1)	1,367 (49.8)	
Foot care					
No	2,805 (37.5)	840 (38.6)	958 (36.4)	1,007 (37.9)	0.23
Yes	4,673 (62.5)	1,339 (61.5)	1,684 (63.7)	1,650 (62.1)	
Intermediate outcomes					
Mean A1C level (%)	7.8 ± 1.7	7.8 ± 1.7	7.7 ± 1.6	7.8 ± 1.7	0.17
A1C <7%	1,766 (34.3)	497 (32.8)	659 (35.5)	610 (34.2)	0.26
Mean LDL level (mg/dl)	108.8 ± 32.9	109.8 ± 33.7	108.1 ± 32.6	108.7 ± 32.4	0.33
LDL <100 (mg/dl)	1,973 (42.3)	560 (41.8)	707 (42.3)	706 (42.7)	0.89
SBP (mmHg)	135.0 ± 18.7	136.3 ± 19.0	134.8 ± 18.4	134.0 ± 18.5	<0.01
DBP (mmHg)	75.5 ± 11.1	75.7 ± 11.1	75.5 ± 11.1	75.3 ± 11.0	0.64
BP control (mmHg)					
BP <130/80 mmHg	1,422 (27.7)	389 (25.2)	493 (26.9)	540 (30.5)	<0.01
SF-12 physical health score	43.7 ± 7.0	42.1 ± 7.4	43.8 ± 6.9	44.9 ± 6.6	<0.01
SF-12 mental health score	45.1 ± 6.5	44.1 ± 6.7	45.1 ± 6.5	45.9 ± 6.1	<0.01

Data are *n* (%) or means ± SD unless otherwise indicated. *n = 7,830. BP, blood pressure.

Table 2—*Adjusted model of predicted values for health behaviors and intermediate outcomes by tertile of perceived neighborhood problems score*

	Tertile of perceived neighborhood problems score			
	1 (most problems)	2	3 (fewest problems)	*P*
Health behaviors				
Current smoker	0.15	0.13	0.11	<0.01
Any weekly physical activity	0.95	0.96	0.96	0.01
SMBG once/day or more	0.51	0.51	0.53	0.21
Foot care	0.61	0.64	0.63	0.17
Intermediate outcomes				
Mean A1C (%)	7.9	7.8	7.8	0.47
A1C <7%	0.31	0.35	0.34	0.17
LDL level (mg/dl)	109.1	108.3	109.2	0.75
LDL <100 mg/dl	0.43	0.42	0.42	0.93
Mean SBP (mmHg)	135.6	134.5	134.2	0.16
Mean DBP (mmHg)	76.0	75.6	75.6	0.54
BP control (<130/80 mmHg)				
Percent poverty (lowest tertile)	0.16	0.31	0.24	0.02
Percent poverty (middle tertile)	0.33	0.26	0.34	(interaction)
Percent poverty (highest tertile)	0.33	0.25	0.50	
SF-12 physical health score (mean)	42.8	43.6	44.4	<0.01
SF-12 mental health (mean)	44.3	45.0	45.8	<0.01

Data are adjusted means for continuous variables and estimated conditional probabilities for dichotomous variables. All models adjusted for age, sex, race/ethnicity, education, income, Charlson Comorbidity Index, duration of diabetes, and percent poverty. BP, blood pressure.

cohort was large and diverse, with a wealth of data on neighborhoods, sociodemographic characteristics, and diabetes-related behaviors and outcomes. Accordingly, the study should make a unique and significant contribution to the diabetes literature.

Our results suggest that perceptions of neighborhood problems are associated with smoking and high blood pressure among adults with diabetes. As these are potent risk factors for cardiovascular disease, the leading cause of morbidity and mortality among adults with diabetes, it is important to identify the mechanism that may explain these findings, which could include previously hypothesized influences of poverty and chronic stressors that might be present in suboptimal environments (33). In addition to such mechanisms, additional determinants of relevant behaviors and risk factors that expand the traditional paradigm are needed.

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