Environmental Correlates of Physical Activity Among Individuals With Diabetes in the Rural Midwest

ANJALI D. DESHPANDE, PHD, MPH
ELIZABETH A. BAKER, PHD, MPH
SARAH L. LOVEGREEN, MPH
ROSS C. BROWNSON, PHD

OBJECTIVE — To determine the relationship between physical and social environment attributes and levels of physical activity in a population-based sample of diabetic individuals living in rural areas.

RESEARCH DESIGN AND METHODS — Cross-sectional telephone survey data from rural communities of southeastern Missouri, Tennessee, and Arkansas were used. Logistic regression was used to calculate crude and adjusted prevalence odds ratios (PORs) and 95% CIs.

RESULTS — A total of 278 (11%) individuals with diabetes were identified. Almost 37% of this group reported no leisure-time physical activity. Individuals with diabetes who reported regular physical activity were more likely to report better general health status, normal BMI, and no physical impairment. After adjustment, regular activity was positively associated with use of three or more facilities (POR 14.3, 95% CI 3.0–67.3) in the past 30 days, the availability of many nearby places to walk (2.3, 1.1–4.8), the availability of shoulders on streets (2.4, 1.3–4.5), often walking to nearby places (4.1, 2.0–8.3), and rating the community for physical activity as generally pleasant (2.3, 1.1–4.8). Additionally, the regular activity group was more likely to report their physician had helped make a plan to increase physical activity (2.8, 1.3–5.8) and followed up on their plan (2.2, 1.1–4.4). Social environment variables were not associated with physical activity after adjustment.

CONCLUSIONS — Physical inactivity is a significant problem in rural diabetic populations. We have identified aspects of the social and physical environment that are positively associated with physical activity. Understanding the role of the environment may result in increased physical activity for individuals with diabetes.

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The global burden of diabetes is expected to explode by the year 2025, with the number of individuals diagnosed with diabetes increasing 41% from 51 to 72 million in the developed world (1). In the U.S. in 2003, the nationwide self-reported prevalence of physician-diagnosed diabetes was 7.1% (2). Although diabetes is a significant health burden in the U.S. overall, there are numerous population subgroups that are disproportionately affected, including certain ethnic groups (e.g., African Americans, Hispanic Americans, and Native Americans), women, older adults, and individuals living in rural areas (1).

The benefits of regular physical activity on overall health have been well documented (3). Even moderate levels of activity have been shown to provide health benefits (3). According to the most recent year of available Behavioral Risk Factor Surveillance System data (2003), only 23.1% of U.S. adults reported getting any physical activity in the past month (2).

Regular physical activity is often recommended for individuals with type 2 diabetes for its beneficial effects on the metabolic risk factors often associated with diabetes complications (4). Several recent large studies have investigated the effects of exercise regimens on relatively short-term outcomes such as glycemic control, blood glucose levels, glucose tolerance, insulin sensitivity, body mass/weight, and lipid profiles as well as long-term outcomes such as cardiovascular events (5,6) and mortality (7). A meta-analysis by Boule et al. (5) concluded that exercise significantly reduces HbA_{1c} levels and that these effects were not caused by differences in body mass, exercise intensity, or exercise amount. There is a reduced risk of long-term cardiovascular outcomes or mortality in individuals with diabetes who engaged in physical activity (6,7). The effects of physical activity appeared in these studies to be dose dependent, with higher levels/amounts of activity being associated with a lower risk of cardiovascular outcomes or mortality. Despite clear evidence that physical activity is important in controlling and managing type 2 diabetes, individuals with diabetes are among the least likely to engage in regular physical activity.

Numerous studies have identified individual-level correlates of physical activity (e.g., low socioeconomic status, low education level, older age, race, and presence of underlying chronic disease) in the general population (8). Additionally, personal barriers such as lack of time, lack of facilities, and fear of pain or injury are consistently identified as reasons for avoiding regular physical activity. A growing body of literature has explored other non–individual-level correlates of

From the Department of Community Health and Prevention Research Center, School of Public Health, Saint Louis University, St. Louis, Missouri.

Address correspondence and reprint requests to Dr. Deshpande, Department of Community Health, Division of Epidemiology, School of Public Health, Saint Louis University, 3545 Lafayette Avenue, Suite 300, St. Louis, MO 63104. E-mail: deshpaad@slu.edu.

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Abbreviations: POR, prevalence odds ratio.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

physical activity. Several recent studies have examined the influence of individual characteristics and the physical environment on physical activity behavior (9–14). These studies found numerous physical environment characteristics were associated with physical activity, including access to facilities, esthetic qualities of facilities and neighborhoods, land use mix, and issues of safety from traffic and crime. Fewer studies have focused on the role of the social environment on physical activity behavior (15–18), but these studies found that social environment factors such as social support for physical activity, membership in organizations, social participation (as a measure of social capital), and protective social and community factors were positively associated with physical activity.

Relatively few studies have investigated correlates of physical activity in a diabetic population (19–21). These studies have mainly described the prevalence of physical activity behavior in diabetic populations (21) and have identified individual-level correlates of activity such as younger age, higher education level, fewer personal motivation barriers, and more positive performance expectations (19,20). Even fewer studies have examined the relative influences of the physical environment (use of facilities, community characteristics) and the social environment (social cohesion, social engagement, social support for physical activity) in a diabetic population.

The purpose of this study was to describe physical activity behavior among rural individuals with diabetes and to determine the relationship between specific physical environmental attributes (use of facilities, overall rating of community for physical activity, community esthetics) and social environment attributes (dimensions of neighborhood social cohesion and social engagement, safety from crime and traffic) with different levels of physical activity.

RESEARCH DESIGN AND METHODS

Study design and data collection

The data for this study were from a cross-sectional baseline survey for an ongoing intervention program in Missouri, Tennessee, and Arkansas. Data were collected through a random digit dial telephone survey using a modified version of the Behavioral Risk Factor Surveillance System interview protocol from July through September 2003 (22). Eligible households were identified by a 2-mile radius around one walking trail in each of 12 towns in rural Missouri, Tennessee, and Arkansas. Of the 12 communities identified for this survey, seven had populations of <2,500 individuals, two were between 2,500 and 10,000 individuals, and three had populations between 10,000 and 20,000 individuals. These 12 communities were chosen for study because of their previous participation in the Ozark Heart Health Project (funded by the Centers for Disease Control and Prevention), the presence of an established walking trail in the community, the relatively high rate of poverty in this region compared with the rest of Missouri, and the higher rates for hospitalization and death due to diabetes compared with the state overall. Because of the rather rural nature of our sample, the two-mile radius encompassed the entire town in most cases, whereas in others it was only a portion of the community. All blocks within the 2-mile radius were enumerated and used to create a random digit list of listed and unlisted residential numbers. Only adult individuals residing within a 2-mile radius of the community walking trail completed the survey. The screening completion rate was 79.4%, the interview completion rate was 65.2%, and the overall response rate for the interview was 51.7%, as calculated using the method of the Council of American Survey Research Organizations (23).

Study population

The study population for this analysis was all individuals who answered "yes" to the question, "Have you ever been told by a physician that you have diabetes?"

Measures

The measures and survey items used in this study were identified from previous work done by members of this research group as well as those published in the literature (17,24–26).

Physical activity. Current physical activity level was categorized into three levels: regular physical activity, irregular physical activity, and no physical activity. Regular physical activity was defined as an answer of "yes" to the question, "I currently engage in regular physical activity (defined as ≥30 min for at least 5 days per week)." Irregular physical activity was defined as an answer of "yes" to the question, "During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?" and "no" to the regular physical activity question. And no physical activity was defined as an answer of "no" to the question, "During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?"

Demographic characteristics. The following characteristics were examined: current smoking, physical impairment that prevented walking within past 7 days, ever been told by physician that he or she has heart disease, ever been told by physician that he or she has arthritis, ever been told by physician that he or she has cancer, BMI (kg/m^2), self-reported general health status, income below $25,000, age, education level, race, marital status, and sex.

Physician advice. To determine whether physician advice influences physical activity, respondents were queried on whether a physician advised them to exercise more within the last year, whether a physician helped make a plan to increase exercise, and whether a physician followed up on the plan.

Community facility use. To assess facility use, respondents were asked, "During the last 30 days, on how many days did you use the nearest . . . ?" (park, public recreation center, gym, or fitness facility; trail for walking or biking; school that allows the public to use their facility for physical activity; public swimming pool not associated with the above facilities; fitness center, health club, YMCA, or any other facility that requires a membership). These variables were then dichotomized into any use versus no use. These were further grouped to determine whether number of facilities used (facility use) was associated with physical activity level. Respondents were also asked, "How many minutes would it take you to walk from your home to the nearest. . . ?" Places included the facilities described above.

Community characteristics/esthetics. The following variables were evaluated: many places for physical activity (not including walking), community has equipment for physical activity, signs to

Table 1—*Characteristics of the study population by level of physical activity*

	No current activity	Some current activity	Regular current activity	χ^2 *P* value
n	102	36	136	
Sex				0.266
Male	26.5	19.4	32.4	
Female	73.5	80.6	67.6	
Age (years)				0.149
20–39	6.9	8.3	9.6	
40–64	59.8	36.1	52.2	
≥65	33.3	55.6	38.2	
Marital status				0.340
Married/couple	44.1	50.0	50.0	
Divorced/separated	29.4	13.9	18.4	
Widowed	22.5	30.6	24.3	
Never married	3.9	5.6	7.4	
Income <$25,000	63.3	52.9	51.5	0.191
Education Level				0.186
Less than high school	35.3	33.3	23.5	
High school/GED	28.4	33.3	33.8	
Technical school/some college	25.5	16.7	20.6	
College graduate	4.9	8.3	15.4	
Postgraduate	5.9	8.3	6.6	
Race				0.929
White	94.1	97.2	95.6	
Black	2.9	0.0	1.5	
Hispanic	1.0	0.0	0.7	
Other	2.0	2.8	2.2	
General health status				<0.001
Excellent	0.0	0.0	2.9	
Very Good	5.9	16.7	8.8	
Good	13.7	22.2	37.5	
Fair	38.2	36.1	33.1	
Poor	42.2	25.0	17.6	
BMI category				0.024
Normal weight	7.2	9.1	19.4	
Overweight	26.8	39.4	32.1	
Obese	66.0	51.5	48.5	
Physical impairment prevents walking				<0.001
Yes	72.5	41.7	33.8	
No	27.5	58.3	66.2	

Date are percent unless otherwise indicated.

encourage physical activity, news articles to encourage physical activity, other encouragement for physical activity, community has health fairs, community organizes physical activity events, community organizes recreational events, community has clubs for physical activity, community has sports leagues, many places to walk, often walk to nearby places, sidewalks, shoulders on streets, interesting things to look at, tree-lined streets, community well maintained, and community free of garbage. Respondents were also asked to rate their community as a place to be physically active.

Neighborhood social cohesion. Neighborhood social cohesion was evaluated using the following variables: safe from crime and safe from traffic, trust in community, good community in which to live, people in community have same values, help by community members if destruction to trails, and others would take advantage. A composite social cohesion variable was created by combining the following variables: trust, good community in which to live, people in community have same values, others would take advantage (reverse coded). For each individual, the scores for the four variables were averaged and then a dichotomous variable was created (high vs. low).

Social engagement. The following variables were evaluated: belong to religious organization, belong to community organizations, gotten together with social groups, and exercise alone or with someone else.

Statistical analysis

Categorical variables were compared by physical activity level using χ^2 analysis with a *P* value of <0.05, indicating statistical significance. Multinomial logistic regression was used to estimate the crude and adjusted associations of physical activity level with potential correlates of physical activity identified in MEASURES above. The prevalence odds ratios (PORs) and 95% CIs are presented. The "no activity" group served as the referent category for all analyses. Crude PORs were adjusted for variables for which there were significant between-group differences, such as BMI, health status, and physical impairment, unless otherwise indicated.

This study received human subjects approval from the Saint Louis University Institutional Review Board.

RESULTS — A total of 278 (11.1%) individuals with diabetes were identified in the sample. Of this sample, 274 individuals had complete physical activity data and served as the total study population for this study. A total of 102 individuals (37.2%) had no physical activity, 36 individuals (13.1%) had irregular physical activity, and 136 individuals (49.6%) had regular physical activity.

There were no differences between physical activity level groups by sex, age, marital status, income, education level, or race (Table 1). Individuals with regular physical activity were more likely to have no physical impairment, be of normal weight, and report better health status. Crude and adjusted PORs for the association of regular physical activity with potential correlates of physical activity are presented in Table 2. After adjustment, individuals with regular physical activity were more likely to report no physical im-

Table 2—*Crude and adjusted associations between individual characteristics, community characteristics, and regular physical activity in a rural diabetic population*

Characteristic	%*	Crude POR	Adjusted POR
Individual health			
No current smoking	79.4	1.68 (0.93–3.05)	1.19 (0.60–2.35)
No physical impairment†	66.2	5.17 (2.95–9.07)	3.67 (2.00–6.73)
Not been told heart disease	67.4	1.80 (1.06–3.06)	1.06 (0.58–1.95)
BMI category (compared with obese)‡	48.5		
Normal	19.4	3.66 (1.48–9.02)	2.57 (0.98–6.74)
Overweight	32.1	1.63 (0.90–2.96)	1.27 (0.66–2.46)
Health status (good/very good/excellent)§	49.3	3.98 (2.20–7.21)	2.52 (1.29–4.95)
Income <$25000	51.5	0.62 (0.36–1.05)	1.08 (0.58–2.04)
Male	32.4	1.33 (0.75–2.34)	1.21 (0.64–2.30)
MD advice			
MD advised exercise more	68.4	1.22 (0.71–2.10)	1.34 (0.71–2.51)
MD helped make plan	51.6	2.13 (1.11–4.10)	2.79 (1.34–5.80)
MD followed up plan	63.4	2.36 (1.24–4.49)	2.20 (1.09–4.43)
Community facility use			
Park use	38.2	4.24 (2.15–8.34)	4.21 (1.94–9.14)
Recreation center use	25.0	11.00 (3.27–36.98)	12.20 (2.74–54.27)
Trail use	31.6	5.43 (2.42–12.18)	3.81 (1.55–9.38)
School use	15.7	4.55 (1.51–13.72)	3.37 (1.03–11.01)
Health club use	23.5	10.05 (2.98–33.88)	7.48 (2.12–26.37)
Facility use (compared with 0)	33.8		
1 or 2	47.1	4.41 (2.43–7.99)	4.64 (2.37–9.08)
3 or more (up to 6)	19.1	21.48 (4.87–94.74)	14.30 (3.04–67.26)
Community characteristics/ aesthetics			
Rate community as very pleasant/pleasant for physical activity	89.0	3.05 (1.53–6.09)	2.27 (1.07–4.81)
Places for physical activity	75.0	1.50 (0.85–2.65)	1.18 (0.62–2.24)
Community-organized recreation events	69.0	1.84 (1.11–3.05)	1.50 (0.88–2.55)
Many places to walk	74.3	2.94 (1.70–5.09)	2.30 (1.25–4.23)
Often walk to nearby places	41.9	4.19 (2.20–7.98)	4.11 (2.03–8.33)
Sidewalks	47.1	1.22 (0.73–2.05)	1.28 (0.71–2.29)
Shoulder on streets	47.8	2.64 (1.51–4.62)	2.41 (1.29–4.49)
Interesting things to look at	72.1	2.12 (1.23–3.64)	1.76 (0.96–3.21)
Tree-lined streets	89.7	0.95 (0.40–2.23)	0.66 (0.26–1.70)
Community well maintained	85.3	2.30 (1.21–4.37)	1.58 (0.78–3.22)
Community garbage free	86.0	2.22 (1.15–4.27)	1.87 (0.90–3.91)
Social engagement			
Belong to religious organization	75.7	1.49 (0.84–2.64)	1.23 (0.65–2.34)
Belong to community organization	35.3	2.08 (1.15–3.77)	1.27 (0.64–2.51)
Gotten together with social clubs	36.8	2.00 (1.12–3.57)	1.47 (0.76–2.84)
Social cohesion			
Safe from crime	81.3	2.08 (1.14–3.81)	1.39 (0.70–2.75)
Safe from traffic	67.9	1.99 (1.17–3.40)	1.45 (0.80–2.63)
Trust	85.7	2.03 (1.04–3.94)	1.31 (0.62–2.79)
Help with destruction	87.9	2.05 (1.01–4.14)	1.48 (0.68–3.20)
Good community	95.6	2.89 (1.05–7.98)	1.60 (0.52–4.97)
Same values	87.3	2.56 (1.30–5.04)	2.00 (0.93–4.28)
Others take advantage (reverse coded)	77.6	1.27 (0.69–2.33)	0.78 (0.39–1.54)
Composite social cohesion (trust, good community, same values, others take advantage–reverse coded)	74.2	1.49 (0.83–2.67)	0.96 (0.51–1.90)

Data are PORs (95% CI), unless otherwise indicated, and are adjusted for BMI, health status, and physical impairment, unless noted otherwise. *% of regular activity group with characteristic. †Adjusted for BMI and health status only. ‡Adjusted for physical impairment and health status only. §Adjusted for BMI and physical impairment only.

pairment (adjusted for BMI, health status only), excellent/very good/good health status (adjusted for BMI, physical impairment only), physician helped make a physical activity plan, and physician followed up on plan.

Several physical environment characteristics were associated with regular activity (Table 2). Facility use was significantly associated with regular physical activity. Individuals reporting regular physical activity were more likely to report use of parks, recreation centers, walking trails, schools, and health clubs. Among this group, the associations of recreation center use (POR 12.2, 95% CI 2.74–54.27) and health club use (7.48, 2.12–26.37) with regular physical activity were strongest. Additionally, individuals with regular physical activity were 14.3 times more likely (3.04–67.26) to report using three or more facilities within the past 30 days compared with individuals with no physical activity, after controlling for physical impairment, BMI, and health status. There was no effect modification of the association between facility use and regular physical activity by income (<$25,000). Because facility use is strongly associated with regular physical activity, we investigated the nature of this relationship further. The percentage of the regular physical activity group that used three or more facilities within the 30 days before interview was 19% compared with 2% in the no activity group. A greater percentage of people with regular physical activity used one or two facilities compared with those with no physical activity (47 vs. 24%). Additionally, people were asked how many minutes it would take to walk to each of the facilities assessed. Mean values were calculated for each facility and group and then compared. Individuals reporting regular physical activity reported significantly shorter walking times to each of the following facilities: park, recreation center, walking trail, school, and fitness club compared with individuals reporting no physical activity. Additionally, community characteristics such as "rate your community for physical activity," "many places to walk to nearby," "often walk to nearby places," and "shoulders on streets" were all positively associated with regular physical activity. Physician advice alone was not associated with regular physical activity; however, when a physician helped to make a plan for physical activity or followed up on the plan, positive associations were noted. In contrast, after adjustment for BMI, physical impairment, and general health status, there was no association between social environment variables (neighborhood social cohesion and the four social engagement variables defined in RESEARCH DESIGN AND METHODS) and regular physical activity in this diabetic population.

Though the primary objective of this study was to identify correlates of regular physical activity in this diabetic group, regular physical activity may not be an achievable or even desirable behavior for many with diabetes because of the presence of comorbid conditions and functional and/or cognitive limitations. Individuals reporting irregular physical activity were more likely to report no current smoking, no physical impairment, and better health status. Community characteristics such as shoulders on streets, places in community for physical activity, many nearby places to walk, the presence of tree-lined streets, a well-maintained community, and a garbage-free community were all associated with irregular physical activity. Social cohesion variables were strongly associated with irregular physical activity (POR 2.89, 95% CI 1.02–8.23). Social engagement variables were not, however, associated with irregular physical activity. After adjustment for BMI, physical impairment, and health status, only smoking status and the community characteristics identified in crude analysis remained associated with irregular physical activity. Additionally, no physical impairment was still associated with irregular physical activity after controlling for BMI and health status.

CONCLUSIONS — Findings from this study indicate that among individuals with diabetes, numerous aspects of the physical environment, particularly facility use, distance to various facilities, and community characteristics/esthetics, are associated with regular physical activity. Our finding indicating that physician advice alone was not associated with physical activity is consistent with earlier research (27). However, our study found that physician planning and follow-up for physical activity behavior are strongly associated with regular physical activity among individuals with diabetes, and this may deserve particular emphasis for clinicians and other health providers in their interactions with individuals with diabetes. In this sample, the social environment did not appear to influence regular physical activity behavior.

While the results from this study indicate a strong association between regular physical activity and the use of multiple facilities, only 19% of the regular activity group reported using three or more facilities, whereas 47% used one or two facilities. Also, the lower mean walking times in the regular activity group versus no activity group may be attributed to several things: it may be an issue of perception, people who are physically active may choose to live closer to such facilities, or proximity to a facility may be a motivator to be active. Other studies of the urban environment, however, have suggested that selection bias due to choosing to live close to facilities is unlikely to explain differences in behavior. Prospective studies looking at change in physical activity behavior after community intervention might enhance our ability to address these questions. The significant differences in physical impairment in the physical activity groups are important (12.7% of the regular activity group vs. 20.9% of the irregular activity group vs. 47.6% of the no activity group). This indicates that physical impairment may be a significant barrier to physical activity. Therefore, it may be necessary to reevaluate what we recommend to diabetic patients regarding level and/or intensity of physical activity. There is a continuous gradient between physical activity and health (28), and it is likely that even small improvements in activity are beneficial. Therefore, we may need to readjust the focus of future messages and interventions for this population. Crude PORs indicated that in the regular activity group, physical environment characteristics showed greater influence on physical activity behavior, whereas the irregular activity group showed greater influence of neighborhood social environment factors. This was not seen after adjustment for several individual factors. It would be important to investigate these associations further with larger sample sizes and more extensive assessment of the social environment.

While the findings from this study are consistent with similar studies in the general population (9–11,13,16) regarding the relative influence of physical environment characteristics on physical activity

behavior, the magnitude of the associations between physical environment characteristics and physical activity were much greater. There are several differences also with regard to social environment factors. Giles-Corti and Donovan (16), Brennan et al. (17), Stahl et al. (15), and Lindstrom et al. (18) all showed the significant association of social environment characteristics with physical activity behavior. Our study found these associations only in the crude analyses and only in the irregular activity group. This may be in part due to differences in the types of social environment factors that were investigated and the small sample size within each of the physical activity groups. Additionally, there may be important differences in studies/findings done in urban versus rural settings and U.S. versus European/Australian communities. Perhaps social environment variables are more homogeneous in rural settings or may be of greater significance in urban settings that are more diverse ethnically or economically. These will be important issues to consider in future studies.

To our knowledge, this is the first population-based study of a diabetic rural population that assessed the relative influence of individual characteristics, physical environment, social environment, and disease condition status on physical activity behavior. A few study limitations deserve mention. The survey question regarding diabetes does not allow us to distinguish between type 1 and type 2 diabetes. However, because >90% of case subjects would have type 2 diabetes, this would not dramatically affect the results. We did ask respondents if they were currently taking either insulin or diabetic pills. There was no difference in the distribution of either treatment approach by physical activity level in this population. It may be warranted in future studies to distinguish between different types of diabetes. We did not collect objective measures of physical activity, nor information on possible confounding variables such as mental health status or glycemic control. The physical activity questions are drawn from the Behavioral Risk Factor Surveillance System and have been shown to be reliable and valid measures of physical activity (29). We only asked respondents about leisure-time activity and did not measure specific activity in other domains such as occupation, transport, or household. We did find in our sample that only 8% of respondents reported being both employed and engaging in physically demanding activity on the job. Given the low prevalence of occupational activity in this population, we do not believe that occupation-related activity would have a significant impact on our findings. The findings presented are based on respondents' perceptions of their environment and have not been correlated with objective measures of the physical environment. Additionally, the questions regarding the physical environment were specifically developed for use in urban settings. How well they capture the same information in rural settings is not fully known. Finally, the cross-sectional nature of this study prevents us from determining causality of the identified correlates with physical activity behavior. Despite these limitations, we believe this work provides preliminary evidence for the importance of studying environmental correlates of physical activity in a diabetic population.

The present study of correlates of physical activity identified factors associated with different levels of activity. Such studies are important as a foundation for future prospective and/or intervention studies that can better determine causal associations between various identified factors and physical activity in high-risk population groups (30). To date, most work in diabetes intervention has focused on individual factors, psychosocial factors, self-management issues, and health care outcomes (31). These interventions were generally focused on the diabetic individual and/or among patients in health care settings. Identifying physical and social environment factors for diabetes intervention would be a significant paradigm shift and may enhance our long-term prevention and control efforts. Greater emphasis on assessing the effects of the community factors and the "built" environment should be a major focus of future studies in this area.

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