

Fear of Injury With Physical Activity Is Greater in Adults With Diabetes Than in Adults Without Diabetes

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OBJECTIVE—Physical activity is a cornerstone of treatment for diabetes, yet people with diabetes perform less moderate and vigorous physical activity (MVPA) than people without diabetes. In contrast, whether differences in walking activity exist has been understudied. Diabetes-specific barriers to physical activity are one possible explanation for lower MVPA in diabetes. We hypothesized that people with diabetes would perform less walking and combined MVPA and would be less likely to anticipate increasing physical activity if barriers were theoretically absent, compared with people without diabetes.

RESEARCH DESIGN AND METHODS—We surveyed 1,848 randomly selected rural Colorado adult residents by telephone from 2002 to 2004. Respondents reported weekly walking and MVPA duration and their likelihood of increasing physical activity if each of seven barriers was theoretically absent.

RESULTS—People with diabetes ($n = 129$) had lower odds of walking and MVPA than people without diabetes (walking: adjusted odds ratio 0.62 [95% CI 0.40–0.95]; MVPA: adjusted odds ratio 0.60 [0.36–0.99]; ≥ 10 vs. < 10 min/week, adjusted for age, sex, BMI, and ethnicity). Respondents with diabetes reported fear of injury as a barrier to physical activity more often than respondents without diabetes (56 vs. 39%; $P = 0.0002$), although this relationship was attenuated after adjusting for age and BMI (adjusted odds ratio 1.36 [0.93–1.99]).

CONCLUSIONS—Although walking is a preferred form of activity in diabetes, people with diabetes walk less than people without diabetes. Reducing fear of injury may potentially increase physical activity for people with diabetes, particularly in older and more overweight individuals.

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Physical activity is considered a cornerstone of diabetes treatment (1), yet people with diabetes are less physically active than people without diabetes, especially with regard to moderate and vigorous physical activity (MVPA) (2–4). Although MVPA optimally promotes cardiovascular health for people with diabetes, regular walking activity is associated with reduced cardiovascular mortality (5,6) and is the preferred activity of people with diabetes (3,7). To our

knowledge, only two studies have compared walking activity by diabetes status using population-based samples (3,8). In summary, a handful of studies have demonstrated that diabetes is related to lower MVPA levels, but we need additional data to assess whether diabetes status is also related to lower walking activity levels.

Identifying and removing barriers to physical activity is important because of the strong relationship between physical inactivity and cardiovascular disease

in people with type 2 diabetes and the likely cardiovascular benefits for people with type 1 diabetes (5,6). Some barriers have been identified that may be considered diabetes specific, including “fear of hypoglycemia” (9,10), the presence of “bad feet due to diabetes” (11), and an “unwillingness to exercise in the presence of people who do not have type 2 diabetes” (12). In the laboratory setting, diabetes is associated with impaired submaximal exercise performance and greater perceived effort during low-intensity exercise (13). While these potential diabetes-specific barriers to physical activity have been identified, this area has been understudied.

Other barriers to physical activity exist in people with type 2 diabetes, including lack of social support, lack of knowledge of the types of exercise to perform, health problems, pain/difficulty taking part in exercise, lack of local exercise facilities, and aversion to exercising in poor weather (12). Although several studies have identified barriers to physical activity in people with type 2 diabetes, only one study used population-based sampling (14), only one assessed whether usual activity levels influence barriers (12), and differences in barriers by diabetes status (diabetes vs. no diabetes) were not compared.

The current study compares barriers to physical activity by diabetes status in a rural, biethnic population-based sample within two strata of physical activity: “less active” (< 150 min weekly MVPA) and “more active” (≥ 150 min weekly MVPA). Because walking activity differences by diabetes status have been understudied, we also compared walking and MVPA differences in participants with and without diabetes. We hypothesized that people with diabetes would perform less walking and MVPA and would be less likely to anticipate increasing physical activity if barriers were theoretically absent, compared with people without diabetes.

RESEARCH DESIGN AND METHODS

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2004 (estimated eligible population aged ≥ 18 years = 10,976) (15). Alamosa County is a rural, biethnic (50% Hispanic), low-income county in south central Colorado (15). The survey was designed, in part, to assess the physical activity habits of Alamosa County residents. Trained staff subcontracted from the Colorado Department of Public Health and Environment (CDPHE) followed the standard random-digit dial telephone survey techniques used by the CDPHE to conduct the annual Behavioral Risk Factor Surveillance System (BRFSS) surveys (16). To maintain population-based sampling, a random selection algorithm accounting for household members' age and sex selected one adult to survey. Up to 20 calls were made to reach the selected adult.

Assessment of covariates

Respondents self-reported demographic, physical activity, and barriers data. Demographic variables were age, sex, race, ethnicity, education, annual income, and marital status. BMI was calculated from self-reported weight and height. To assess for diabetes, we used the BRFSS question, "Have you ever been told by a doctor that you have diabetes?" Responses were structured into three categories: diabetes (both type 1 and type 2 diabetes), gestational diabetes mellitus (excluded from analysis), or no prior diagnosis of diabetes. In keeping with standard BRFSS methodology, this survey did not differentiate between adults with type 1 and type 2 diabetes. Because the CDC estimates $>90\%$ of adults with diabetes have type 2 diabetes, the vast majority of our sample with diabetes should have type 2 diabetes (17).

We used BRFSS techniques to measure physical activity in three subcategories: "walking," "moderate activity," and "vigorous activity" (16). Respondents reported walking activity as "walking for recreation, exercise, to get to and from places, or for any other reason." Moderate activity and vigorous activity were assessed via standard BRFSS questions (16). Moderate activity included "brisk walking, bicycling, vacuuming, gardening, or anything else that causes small increases in breathing or heart rate." Vigorous activity included "running, aerobics, heavy yard work, or anything else that causes large increases in breathing or heart rate."

For each of these categories of physical activity, we used the standard BRFSS

method to calculate weekly physical activity (16). Briefly, respondents who reported 0 days per "usual week" of physical activity ≥ 10 min in a certain category (e.g., walking) were assigned a value of 0 min of weekly physical activity in that category. Among respondents reporting ≥ 10 min of consecutive physical activity on ≥ 1 day in a "usual week," we calculated weekly physical activity (min/week) as the usual minutes of consecutive physical activity multiplied by the usual number of days per week spent in that category of physical activity. We calculated each participant's combined MVPA as the sum of weekly moderate activity and weekly vigorous activity.

Seven survey questions pertaining to barriers to physical activity came from ethnographic methods used with families living in Alamosa County (18), qualitative studies of older Hispanic adults (19), and common barriers reported in the general population (20) (see full survey in Supplementary Data). Barrier themes ranged from emotional ("afraid of hurting or injuring myself" and "less conscious about my looks when I exercise"), to social support (lack "people to be physically active with, such as friends and family members" and "someone to encourage me"), and material support (lack "better or less expensive facilities available," "more organized fitness classes," and "more organized sports"). Respondents reported their anticipated likelihood of increasing physical activity if each barrier was theoretically absent. Questions were posed with a common stem of, "I would increase my amount of physical activity if... (e.g., less conscious about my looks when I exercise)." Respondents rated their anticipated likelihood to increase physical activity on a five-point Likert scale (1 = "strongly disagree," 2 = "somewhat disagree," 3 = "neither agree nor disagree," 4 = "somewhat agree," and 5 = "strongly agree"). For χ^2 and logistic regression analyses, we dichotomized barrier responses into two categories: those who somewhat or strongly agreed they would increase their physical activity versus those who were neutral or disagreed. Because barriers may differ by physical activity levels, we analyzed barriers by diabetes status in two separate physical activity strata: among respondents who were "less active" (<150 min of weekly MVPA) and "more active" (≥ 150 min per week of MVPA). We based the "more active" categorization on the 1995 joint Centers for Disease Control

and Prevention and American College of Sports Medicine physical activity guideline target of ≥ 150 min of weekly moderate physical activity (21).

Statistical analyses

All statistical analyses were performed with SAS software (version 9.2) (22). We compared demographic data between groups using *t* tests, χ^2 tests (Cochrane-Mantel-Haenszel), and ANOVA tests. We compared physical activity between groups using nonparametric analyses (Wilcoxon and logistic regression) due to the skewed nature of these data. Comparisons of barriers to physical activity were performed with *t* tests, χ^2 tests, and logistic regression analyses. We considered a *P* value < 0.05 to denote statistical significance for the physical activity and regression analyses. However, because the physical activity barriers analyses required multiple χ^2 tests, we reported the statistical significance of our physical activity barriers analyses with regard to a standard $\alpha = 0.05$ and with regard to the Dunn-Bonferroni correction (i.e., $\alpha = 0.05/15$ statistical tests = 0.0033). The reader can interpret the exploratory physical activity barriers findings with regard to the least and most stringent measures for statistical significance. For regression analyses, we provided 95% CIs rather than *P* values to provide the potential range of statistical estimates.

RESULTS

Response rate

Interviewers surveyed 2,050 randomly selected Alamosa County residents from 2002 to 2004. Response rates among eligible households were 50.6% in 2002, 56.5% in 2003, and 50.9% in 2004, which are comparable with the recent median BRFSS response rate of 48.9% (23). Typical of BRFSS studies, our sample underrepresented males, 18–24-year-olds, and those reporting $< \$25,000$ in yearly income in comparison with U.S. Census data (16,24). After excluding 16 respondents with gestational diabetes mellitus or missing diabetes status data and 186 respondents with missing physical activity data, we had a study sample of 1,848 adults, 129 of whom reported they had diabetes.

Study sample characteristics

Table 1 presents study sample characteristics by diabetes status and level of

Table 1—Demographics stratified by physical activity levels and study group

	Less active (<150 min of weekly combined MVPA)			More active (≥150 min of weekly combined MVPA)		
	No diabetes	Diabetes	P	No diabetes	Diabetes	P
n	634	68		1,085	61	
Duration of diabetes (years)	N/A	8.9 ± 10.1	N/A	N/A	7.9 ± 7.9	N/A
Age (years)	47.3 ± 17.4	59.1 ± 13.3	<0.0001	44.1 ± 16.4	53.2 ± 13.6	<0.0001
Sex (female)	69	60	0.15	59	44	0.02
BMI (kg/m ²)	26.5 ± 5.8	30.0 ± 6.3	<0.0001	25.4 ± 4.4	29.2 ± 6.4	<0.0001
Ethnicity (non-Hispanic white)	61	49	0.07	65	47	0.006
Education (≥12 years)	86	75	0.02	92	90	0.61
Annual income			0.005			0.06
<\$25,000	43	65		35	47	
\$25,000–49,000	33	24		38	40	
>\$49,000	23	11		27	14	
Marital status (married or “in a couple”)	57	35	0.0005	59	51	0.23

Data are means ± SD or percent; ≤7% data are missing in each category. Missing data were not included in denominator.

physical activity. In both strata of physical activity (<150 min vs. ≥150 min of weekly MVPA), respondents with diabetes were older and had greater adiposity than respondents without diabetes. Among more active respondents, participants with diabetes were more likely to be male and of Hispanic ethnicity compared with participants without diabetes. Among less active respondents, there were lower educational attainment and lower income in participants with diabetes than in those without diabetes.

Physical activity

People with diabetes were less active than respondents without diabetes both in terms of walking (diabetes 90 ± 225 vs. no diabetes 135 ± 275 min/week, $P = 0.01$; data are mean ± interquartile range) and combined MVPA (diabetes 135 ± 390 vs. no diabetes 210 ± 360 min/week, $P = 0.0006$) (Fig. 1A and B). After adjustment for age, sex, BMI, and ethnicity, participants with diabetes had lower odds of walking ≥10 vs. <10 min/week (adjusted odds ratio [OR] 0.62 [95% CI 0.40–0.95]) (Fig. 1C) and lower odds of performing combined MVPA ≥10 vs. <10 min/week (adjusted OR 0.60 [0.36–0.99]) (Fig. 1D). When data were compared across tertiles of activity, similar trends were observed for walking (10–149 vs. <10 min/week [adjusted OR 0.63 [95% CI 0.37–1.04]]; ≥150 vs. <10 min/week [adjusted OR 0.62 [0.39–1.0]]). When data were compared across tertiles of combined MVPA, diabetes status was less significant when the middle and lowest tertiles were compared than when the highest and lowest tertiles were compared (adjusted OR

0.70 [95% CI 0.39–1.25]) for 10–149 vs. <10 min/week; 0.54 [0.32–0.93] for ≥150 vs. <10 min/week).

Barriers to physical activity

Table 2 describes barriers to physical activity for respondents by diabetes status, stratified by weekly MVPA level (<150 vs. ≥150 min). Fear of injury was the only barrier that significantly differed by diabetes status; a summary of Likert scores across all seven barriers did not differ by diabetes status (data not shown). Participants with diabetes were more likely to report a fear of injury barrier than people without diabetes in both physical activity strata (Table 2). Because MVPA strata did not substantially modify the relationship between diabetes status and fear of injury, we also compared group differences regardless of MVPA strata: 56% of respondents with diabetes and 39% of respondents without diabetes agreed they would increase physical activity if they were not afraid of injury (unadjusted OR 1.95 for diabetes vs. no diabetes; $P = 0.0002$ [less than the standard α -significance level of 0.05 and the Dunn-Bonferroni-corrected α -significance level of 0.0033]).

Relative rankings of physical activity barriers revealed an important qualitative theme. Regardless of diabetes status or physical activity strata, the most highly ranked physical activity barrier was lacking an exercise partner. This qualitative theme must be interpreted with caution because there was considerable heterogeneity of barriers among respondents.

Fear of injury was a notable barrier to physical activity for respondents with

diabetes regardless of usual physical activity levels. To better understand this, we examined the extent to which demographic factors and adiposity influenced the relationship between diabetes status and fear of injury using bivariate and multivariate logistic regression analyses. Based on prior studies (12), we considered age and adiposity to be likely independent determinants of fear of injury. After adjustment for age and BMI, diabetes status was no longer significantly related to “fear of injury” (adjusted OR 1.36 [95% CI 0.93–1.99]), but older age and greater BMI were significantly related to “fear of injury” (adjusted OR 1.07 [1.01–1.14] for each additional 10 years of age; adjusted OR 1.36 [1.24–1.50] for each additional 5 kg/m² of BMI).

CONCLUSIONS—In a rural, low-income, biethnic (~50% Hispanic) Colorado population, people with diabetes walked less than people without diabetes. To our knowledge, this is the first study in a population-based sample to demonstrate that people with diabetes walk less than people without diabetes. People with diabetes also performed less overall physical activity (combined MVPA) than people without diabetes, as has been previously observed. One potential reason for our observed lower activity levels is our finding that “fear of injury” was a greater barrier to physical activity in people with diabetes than in those without.

Fear of injury is a previously identified important barrier to physical activity in populations without diabetes (12,19), but our study is the first to identify it as an important barrier for people with diabetes.

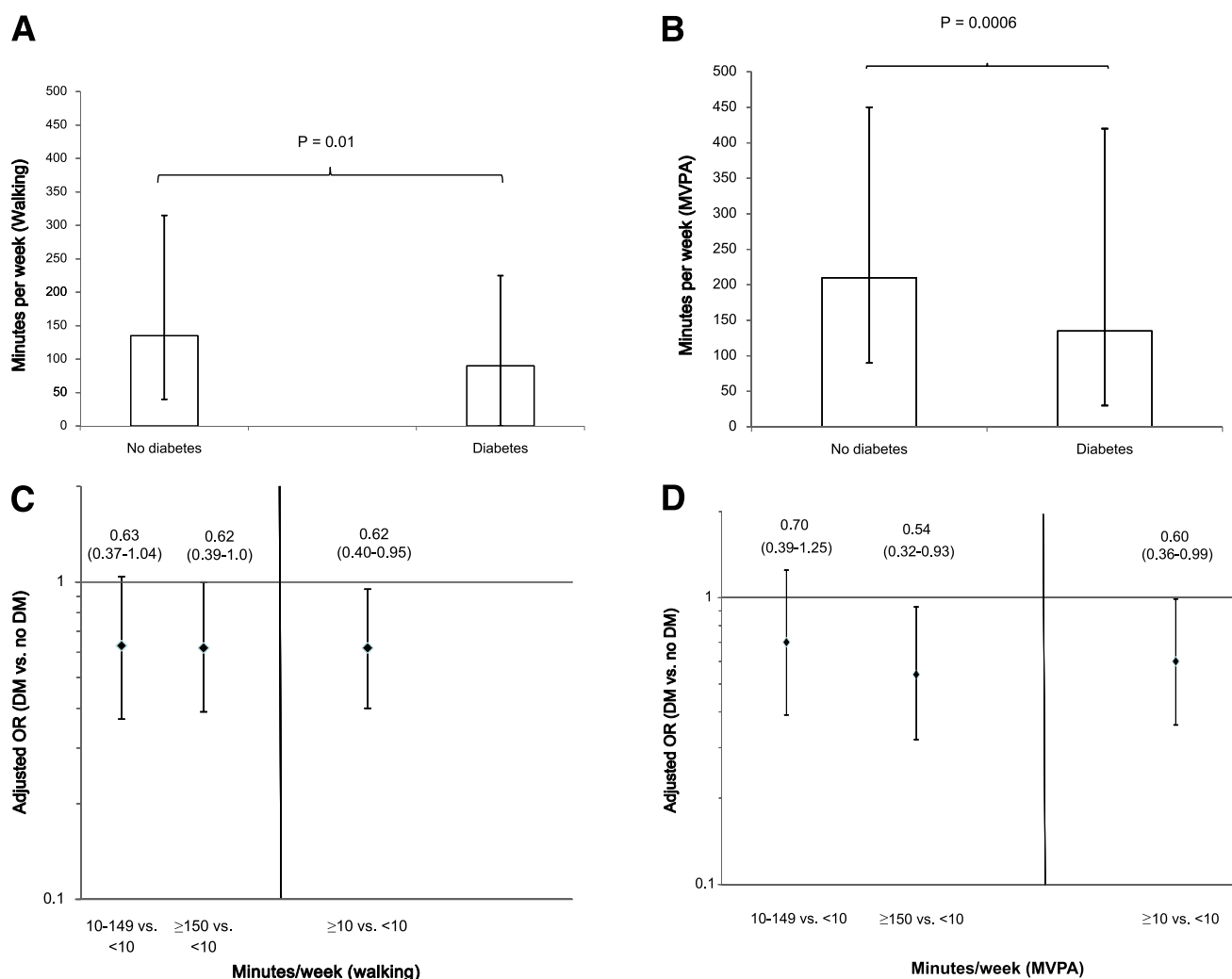


Figure 1—Physical activity levels. A and B: Unadjusted activity values displayed as median \pm interquartile range. C and D: Values displayed as adjusted OR \pm 95% CI. Adjusted OR represents odds of physical activity displayed in subjects with diabetes (DM) vs. odds displayed in those without diabetes with adjustment for age, sex, BMI, and ethnicity.

Perhaps related to fear of injury, fear of hypoglycemia has been described as a significant barrier to physical activity in people with type 1 and type 2 diabetes (9,10).

However, in our study the group differences in “fear of injury” by diabetes status appear mostly related to the older age and greater BMI in the study group with diabetes

rather than to the presence of a diabetes-specific fear of injury. It is also possible that our sample size was too small to detect a true association (adjusted OR

Table 2—Differences in barriers to physical activity by diabetes status and physical activity strata

	Less active (<150 min of weekly combined MVPA)			More active (\geq 150 min of weekly combined MVPA)		
	No diabetes	Diabetes	P	No diabetes	Diabetes	P
n	634	68		1,081	61	
Lack “someone to be active with”	72	73	0.90	66	72	0.36
Lack “better or less expensive exercise facility”	63	54	0.12	59	59	0.98
Lack “someone to encourage me”	62	67	0.59	53	53	0.99
“Fear of injury”	44	61	0.01	35	48	0.04
Lack “more organized fitness classes”	49	49	1.0	46	48	0.67
Lack “more organized sports”	37	26	0.07	40	41	0.87
“Less conscious about my looks when I exercise”	37	41	0.60	27	29	0.72

Data are expressed as “% agree,” which includes responses of “somewhat agree” and “strongly agree” that respondent anticipated increasing physical activity if barrier was absent; <7% of missing data in each group for each response. P values are for diabetes vs. no diabetes within each physical strata.

1.36 [0.93–1.99]) for diabetes status and fear of injury after adjustment for age and BMI. Further study should clarify the nature of “fear of injury” in diabetes to inform strategies to overcome this fear.

Other studies have assessed physical activity barriers for people with diabetes but not typically in population-based samples. A recent review identified numerous barriers to exercise for people with type 2 diabetes, including unmet needs for social support, lack of knowledge of the types of exercise to perform, pain/difficulty taking part in exercise, and lack of local exercise facilities (12). However, the majority of these studies were performed in convenience samples of patients in medical settings. This study represents one of few population-based samples where barriers to physical activity were compared by diabetes status. One other population-based survey of barriers to physical activity in diabetes identified lack of social support and health problems as barriers to exercise but did not ask about fear of injury (14). To our knowledge, ours is the first study to evaluate and identify fear of injury as a potential barrier to physical activity in diabetes.

Unmet needs for social support were important barriers to physical activity for all respondents. Regardless of diabetes status, the lack of “someone to exercise with” was the most highly ranked barrier, suggesting that helping individuals identify and use supportive exercise settings and supportive personal contacts is an important avenue to increase physical activity.

We found people with diabetes performed less combined MVPA than people without diabetes, similar to the findings of others (2–4). The majority of respondents with diabetes (53%) reported <150 min of weekly MVPA, showing that most respondents with diabetes were not optimally active. Physical activity levels for our participants with and without diabetes were somewhat greater than those observed in other studies (2–4), and this may be due in part to greater levels of physical activity in rural Western regions and/or social desirability bias (25). However, the data available to us do not allow us to determine the exact reason why our physical activity reports are greater than those observed in other studies.

Although diabetes is consistently associated with performing less MVPA, to our knowledge ours is the first population-based study to demonstrate lower walking activity levels in people with diabetes than in people without diabetes. Our walking

data are in contrast with the two other population-based studies, which found that walking activity was comparable or greater in people with diabetes than in those without diabetes (3,8). More epidemiologic data regarding walking activity by diabetes status are needed because walking is a favored and important form of physical activity for people with diabetes (3,7).

A major strength of this study is the population-based sampling method. Other strengths include the evaluation of barriers by physical activity strata and the assessment of a biethnic population. The assessment of barriers in a rural population is also novel. One important limitation of the study is the inability to reliably exclude respondents with type 1 diabetes; however, people with type 1 diabetes make up <10% of the adult population with diabetes (17). Thus, these data likely primarily represent the barriers of adults with type 2 diabetes. Another limitation is the relatively small sample size of respondents with diabetes ($n = 129$). However, our sample prevalence of diabetes was consistent with U.S. diabetes prevalence estimates (~8%) from 2003 (17), and our sample size was comparable to other studies of barriers to physical activity in people with type 2 diabetes (12). Another limitation is the inability to adjust for disease comorbidities as a result of the limitations of the dataset. The random-digit dial survey methods used in this study and other BRFSS studies limit the generalizability to certain subsets of the population because of the common underresponse from participants 18–24 years old, male subjects, and those of lower socioeconomic status. Our statistical analyses addressed this underresponse by adjusting for these variables rather than applying sample weights, as this was the more appropriate technique to compare results between study groups. Thus, our results provide valid comparisons of physical activity and physical activity barriers by diabetes status, but they should not be misconstrued as population-based prevalence rates. Finally, the associations measured do not imply causality.

In this population-based biethnic sample of rural adults, “fear of injury” was a greater barrier to physical activity in people with diabetes than in those without diabetes. Older age and greater BMI were more strongly related to having a “fear of injury” barrier than was the presence of diabetes itself. For clinicians, these data support asking patients with diabetes, particularly older and heavier

patients, whether they are worried about “injury” or “hurting themselves” during physical activity in order to identify safe ways to exercise when fear of injury is a barrier. Barriers other than fear of injury are also important to consider because participants with diabetes commonly reported social support barriers to physical activity. These data, in combination with data from other studies, suggest that helping patients develop social support for exercise is an important strategy to facilitate increased physical activity.

Further research is needed to identify and overcome physical activity barriers for people with diabetes. One possible approach is to develop and validate efficient questionnaires that could be used in clinical care settings to identify and address the most important modifiable barriers to physical activity for individuals with diabetes. Responses to such questionnaires could be used to provide tailored recommendations to overcome barriers. From a public health perspective, we need to identify key modifiable physical activity barriers that are related to physical activity levels in larger studies that are representative of the overall population with diabetes. The identification of key modifiable barriers should guide health policy decisions and the design of future behavioral intervention trials to increase physical activity for people with diabetes.

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A.G.H. reviewed and analyzed data and wrote the manuscript. L.A.C. contributed to discussion and reviewed and edited the manuscript. E.S.B. collected data, contributed to discussion, and reviewed and edited the manuscript. S.S. supervised data analysis and reviewed and edited the manuscript. J.A.M. reviewed data, contributed to discussion, and reviewed and edited the manuscript. J.G.R. contributed to discussion, reviewed data, and reviewed and edited the manuscript.

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