Change in Physical Activity after a Diabetes Diagnosis: Opportunity for Intervention

KRISTIN L. SCHNEIDER[1], CHRISTOPHER ANDREWS[2], KATHLEEN M. HOVEY[3], REBECCA A. SEGUIN[4], TODD MANINI[5], MICHAEL J. LAMONTE[3], KAREN L. MARGOLIS[6], MOLLY E. WARING[7], YI NING[8], STACY SIMS[9], YUNSHENG MA[10], JUDITH OCKENE[10], MARCIA L. STEFANICK[9], and SHERRY L. PAGOTO[10]

[1]Department of Psychology, Rosalind Franklin University of Medicine and Science, North Chicago, IL; [2]Department of Ophthalmology and Visual Sciences, University of Michigan, Ann Arbor, MI; [3]Department of Social and Preventive Medicine, State University of New York at Buffalo, Buffalo, NY; [4]Division of Nutritional Sciences, Cornell University, Ithaca, NY; [5]Department of Aging and Geriatric Research, University of Florida, Gainesville, FL; [6]HealthPartners Institute for Education and Research, Minneapolis, MN; [7]Department of Quantitative Health Sciences, University of Massachusetts Medical School, Worcester, MA; [8]Department of Epidemiology and Community Health, Virginia Commonwealth University School of Medicine, Richmond, VA; [9]Department of Medicine, Stanford University, Stanford, CA; and [10]Division of Preventive and Behavioral Medicine, Department of Medicine, University of Massachusetts Medical School, Worcester, MA

ABSTRACT

SCHNEIDER, K. L., C. ANDREWS, K. M. HOVEY, R. A. SEGUIN, T. MANINI, M. J. LAMONTE, K. L. MARGOLIS, M. E. WARING, Y. NING, S. SIMS, Y. MA, J. OCKENE, M. L. STEFANICK, and S. L. PAGOTO. Change in Physical Activity after a Diabetes Diagnosis: Opportunity for Intervention. *Med. Sci. Sports Exerc.*, Vol. 46, No. 1, pp. 84–91, 2014. **Introduction**: Moderate-intensity physical activity is recommended for individuals with diabetes to control glucose and prevent diabetes-related complications. The extent to which a diabetes diagnosis motivates patients to increase physical activity is unclear. This study used data from the Women's Health Initiative Observational Study (baseline data collected from 1993 to 1998) to examine change in physical activity and sedentary behavior in women who reported a diabetes diagnosis compared with women who did not report diabetes during 7 yr of follow-up (up to 2005). **Methods**: Participants (n = 84,300) were postmenopausal women who did not report diabetes at baseline (mean ± SD; age = 63.49 ± 7.34 yr; body mass index = 26.98 ± 5.67 kg·m^{-2}). Linear mixed-model analyses were conducted adjusting for study year, age, race/ethnicity, body mass index, education, family history of diabetes, physical functioning, pain, energy/fatigue, social functioning, depression, number of chronic diseases, and vigorous exercise at age 18 yr. Analyses were completed in August 2012. **Results**: Participants who reported a diabetes diagnosis during follow-up were more likely to report increasing their total physical activity (P = 0.002), walking (P < 0.001), and number of physical activity episodes (P < 0.001) compared with participants who did not report a diabetes diagnosis. On average, participants reporting a diabetes diagnosis reported increasing their total physical activity by 0.49 MET·h·wk^{-1}, their walking by 0.033 MET·h·wk^{-1}, and their number of physical activity episodes by 0.19 MET·h·wk^{-1}. No differences in reported sedentary behavior change were observed (P = 0.48). **Conclusions**: A diabetes diagnosis may prompt patients to increase physical activity. Healthcare professionals should consider how best to capitalize on this opportunity to encourage increased physical activity and maintenance. **Key Words:** TYPE 2 DIABETES, EXERCISE, SEDENTARY BEHAVIOR, SEDENTARY ACTIVITY, WOMEN'S HEALTH INITIATIVE

A disease diagnosis may motivate health behavior changes in smoking cessation (28), weight loss (14,28), reducing fat intake (9), completing regular checkups, and improving diet (18). Most studies of health behavior change after disease diagnoses focus on cancer [e.g., (15,18)]. Few studies examine behavior change after a diagnosis of type 2 diabetes, although encouraging lifestyle changes are recommended for diabetes management (2,17).

After a type 2 diabetes diagnosis, recommendations include achieving at least 150 min·wk^{-1} of moderate-intensity aerobic activity and, if indicated, resistance training twice a week (2). Physical activity is recommended to assist with glucose control and weight loss and to prevent diabetes-related complications, but whether patients with recently diagnosed diabetes change their physical activity in response to the diagnosis is unclear. One study of individuals diagnosed with type 2 diabetes reported that a shorter time since diagnosis was associated with greater increases in physical activity for 6 months (42). As participants were diagnosed before inclusion in the study, it is unknown whether their physical activity changed as a result of the diabetes diagnosis or whether their greater level of activity reflected a previous habit. A large prospective study of middle-age and older

Address for correspondence: Kristin L. Schneider, Ph.D., Department of Psychology, Rosalind Franklin University, 3333 Green Bay Road, North Chicago, IL 60064; E-mail: kristin.schneider@rosalindfranklin.edu.
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adults reported that among those with higher education levels, more were engaging in physical activity after a diabetes diagnosis, whereas those with lower education levels were less likely to engage in physical activity after diagnosis (38).

Physical activity recommendations include encouragement to reduce sedentary behavior (17). Evidence has accumulated on the dangers of excessive sedentary behavior, regardless of physical activity level. Sedentary behavior has been associated with type 2 diabetes (24), obesity (20,24,45), and mortality (39), but it is unknown if a diabetes diagnosis prompts changes in sedentary behavior.

The present study aims to expand upon previous research by using the Women's Health Initiative data to examine the relationship between change in physical activity and sedentary behavior for women reporting a new onset of diabetes compared with those not reporting diabetes. This prospective study reduces the bias often observed in studies of postdiagnosis behavior as physical activity data were collected annually for 9 yr and not based on retrospective report. We hypothesize that women who report a diabetes diagnosis during follow-up will report increased physical activity and reduced sedentary behavior compared with women who do not report a diabetes diagnosis. In addition, we hypothesize that higher education and a family history of diabetes will be associated with greater increases in physical activity and greater reductions in sedentary behavior in women recently diagnosed with diabetes. We will further explore whether race/ethnicity modify the relationship between diabetes diagnosis and change in physical activity and sedentary behavior.

METHODS

Procedures

The present study is a secondary data analysis within the Women's Health Initiative (WHI). The WHI was a national, longitudinal study that enrolled 68,132 participants into three clinical trials and enrolled 93,676 participants into an observational study (WHI-OS) at 40 clinical centers across the U.S. from 1993 to 1998. The present study used data from the WHI-OS participants from baseline (1993–1998) and periodic follow-up assessments up to 2005. The design of the WHI has been described elsewhere (32). New diabetes diagnosis, physical activity, and sedentary behavior were collected repeatedly over approximately 7 yr of follow-up and participant retention, and data collection completion rates were >95%. The WHI-OS study protocol was approved by the institutional review boards of WHI institutions, and participants provided written informed consent. The institutional review board of the University of Massachusetts Medical School granted an exemption for the current study.

Participants

WHI-OS eligibility criteria included postmenopausal woman, age 50 to 79 yr, reliable/mentally competent, and expected survival and local residency for at least 3 yr. Exclusion criteria included current alcoholism, drug dependency and dementia, or other conditions that would limit full participation in the study. Because the present study aimed to examine change in physical activity and sedentary behavior after a diabetes diagnosis, participants with a history of diabetes diagnosis at baseline (n = 3902) were excluded from the analysis. In addition, we excluded 5474 participants who were missing baseline information on diabetes history (n = 121), self-reported diabetes diagnosis during follow-up (n = 602), physical activity at baseline (n = 979), or all physical activity data during follow-up (n = 3772). The analytic sample included 84,300 participants, 90% of the WHI-OS sample.

Measures

Diabetes diagnosis. Diabetes at baseline was defined as a self-report of "ever having received a physician diagnosis of diabetes when not pregnant." At each annual follow-up visit (years 1–9), participants reported whether a doctor prescribed pills or insulin shots for diabetes. Although self-reported diabetes cases were not adjudicated, self-reported diabetes was found to be a valid indicator of diagnosed diabetes in the WHI, as assessed using medication and laboratory data, although undiagnosed diabetes was likely missed (35). This method was used in other WHI studies (34,50).

Physical activity. Physical activity during the past week was measured via a self-report questionnaire that demonstrated concurrent validity and test–retest reliability (13,36). For baseline and years 3–8, participants indicated the number of times per week and usual duration for walking and for activities of mild intensity (e.g., slow dancing, bowling), moderate intensity (e.g., biking outdoors, using a treadmill), and vigorous intensity (e.g., aerobics, swimming laps). Frequency and duration data were converted to weekly energy expenditure (MET·h·wk^{-1}) during walking, mild-intensity exercise, moderate-intensity exercise, and vigorous-intensity exercise. Total MET-hours per week was calculated by summing the MET-hours per week for walking, mild-, moderate-, and vigorous-intensity activity. The number of physical activity episodes that were 20 min or longer was also collected. All of these variables were examined as outcomes to examine whether physical activity change could be attributed to a particular type or intensity of activity. Annual change in each type of physical activity was calculated using difference scores (current year minus previous year).

Sedentary behavior. Sedentary behavior was assessed using the item for hours of sitting time, which asked participants, "During a usual day and night, about how many hours do you spend sitting? Be sure to include the time you spend sitting at work, sitting at the table eating, driving or riding in a car or bus, and sitting up watching TV or talking." This item demonstrated adequate test–retest reliability (36). Responses were categorical and ranged from "less than 4 hours" to "16 or more hours." The midpoint of each category was used to compute hours of sedentary behavior and used in statistical analyses. Participants answered this item at baseline, year 3, and year 6. Thus, change data were computed using difference scores at year 3 (year 3 minus baseline hours) and at year 6 (year 6 minus year 3).

Covariates. Several baseline variables were included as covariates for their association with physical activity (6,16,22,25,26,30,31,48,49) or behavior change after a disease diagnosis (5,18,33). Age, race/ethnicity, education, family history of diabetes, and vigorous exercise at age 18 yr were self-reported. WHI-certified clinic staff measured height using a stadiometer and weight using a balance-beam scale to calculate body mass index (BMI; kg·m^{-2}). Four subscales from the RAND Health Survey (SF-36 [52]) pertaining to physical functioning, pain, energy/fatigue, and social functioning were included as covariates. Depression symptoms were measured using the Center for Epidemiological Studies Depression Scale (CES-D) six-item short form (53). The number of chronic diseases, defined by Seguin et al. (44), was defined as number, up to 5, of the following: cardiovascular disease ever (myocardial infarction, angina, coronary artery bypass graft, or percutaneous transluminal coronary angioplasty), hypertension (treated or high blood pressure defined as systolic ≥140 or diastolic ≥90 mm Hg), congestive heart failure ever, stroke ever, cancer ever, treated diabetes, arthritis ever, falls (two or more falls in the last 12 months was coded as a chronic disease), emphysema, and hip fracture 55 yr or older. Participants with previous diabetes diagnoses were excluded from this study; thus, diabetes was not a part of the number of chronic diseases calculation for the current study's participants. Lastly, study year was included in the model to examine change in physical activity after a diabetes diagnosis from years 3 through 8.

EPIDEMIOLOGY

Analytic Plan

This study compared participants with and without a diabetes diagnosis on change in physical activity and in sedentary behavior during 6 yr of follow-up assessments. Change in physical activity was computed as current reported value minus previous reported value for each individual at each scheduled follow-up clinic visit (years 3, 4, 5, 6, 7, and 8). Thus, among participants who self-reported a diabetes diagnosis, change in physical activity was calculated from before to in close proximity (i.e., within 1 yr) of reporting a diabetes diagnosis. For participants with missing physical activity data at the previous time point, the year before that was selected to capture change, but only up to 1 yr earlier. For instance, if a participant was missing year 4, then change at year 5 was calculated as year 5 minus year 3; however, change at year 4 was still regarded as missing. Analyses were conducted with and without using the previous time point for missing cases to ensure consistent results. Change in sedentary behavior was computed as current reported value minus previous for each individual at each scheduled follow-up (years 3 and 6). Participants with missing sedentary activity data were omitted from these analyses (n = 7352).

Linear mixed models were conducted using PROC MIXED in SAS version 9.2. (SAS Institute Inc., Cary, NC) with a repeated statement for subject and specified a first-order Toeplitz covariance structure. As the response variables were difference scores between two time points, correlations among the variables within an individual were small. More complicated covariance structures gave similar results. Three separate models were run for each outcome. The first model was the unadjusted model, the second model was adjusted for baseline BMI only (to minimize missing data from other covariates), and the third model controlled for the remaining covariates. Physical activity was not included as a covariate when sedentary behavior was the outcome, and sedentary behavior was not a covariate when physical activity was the outcome. Analyses were completed in August 2012.

For the effect modification analyses, interaction terms were created with the diabetes diagnosis variable and each of the moderator variables: education, family history of diabetes, and race/ethnicity. These terms were then entered into the model that controlled for all covariates.

Preliminary Analyses

Continuous variables were assessed for normality by examining skew and kurtosis. Physical activity and sedentary behavior change values were fairly symmetric, but "no change" was reported more often than expected for a normal distribution. The CES-D and the social functioning variables demonstrated significant skew and were coded as categorical variables using standard cut points (0.06 for the CES-D [53] and 50 for the social functioning subscale [19]). Because the timing of assessments is critical to this analysis, study year was compared with a variable specifying the number of days since enrollment to completion of the yearly assessments to ensure that assessments occurred in a logical sequence.

RESULTS

The sample consisted of 84,300 postmenopausal women whose age = 63.5 ± 7.3 yr and BMI = 27.0 ± 5.7 kg·m^{-2} (mean ± SD), and 15% were from ethnically/racially diverse groups. Participant characteristics, split by whether they reported diabetes during follow-up, are described in Table 1. Of the participants, 5% reported being diagnosed with diabetes during follow-up up. The number of participants who reported being diagnosed with diabetes in a given year ranged from 407 in year 8 to 1521 in year 3 (year 3 includes diagnoses that occurred in years 1–3). Incidence ranged from 5.7 (per 1000) in year 8 to 7.8 in year 5, which is lower than population estimates (in 2010, women age 45–64 yr had a crude incidence = 11.5 per 1000 and women age 65–79 yr had a crude incidence = 11.9 per 1000) (7). Participants who were diagnosed with diabetes during follow-up

TABLE 1. Baseline participant characteristics in the WHI observational study by diabetes diagnosis status (N = 84,300)

	Participants Who Develop Diabetes in Follow-up		
	Yes (n = 4385)	No (n = 79,915)	
	Mean ± SD or n (%)	Mean ± SD or n (%)	P
Age at screening (yr)	63.6 ± 7.2	63.5 ± 7.4	0.264
Education (yr)	14.1 ± 2.9	14.9 ± 2.6	<0.001
<High school	375 (8.6)	3269 (4.1)	<0.001
High school diploma	2595 (59.8)	41,156 (51.9)	
College graduate	1373 (31.6)	34,866 (44.0)	
Race/ethnicity			
American Indian or Alaskan Native	41 (0.94)	268 (0.34)	<0.001
Asian or Pacific Islander	158 (3.6)	2211 (2.8)	
Black or African American	631 (14.4)	5247 (6.6)	
Hispanic/Latino	268 (6.1)	2575 (3.2)	
White (not of Hispanic origin)	3213 (73.5)	68,540 (86.0)	
Other	59 (1.4)	867 (1.1)	
BMI (kg·m^{-2})	31.5 ± 6.8	26.7 ± 5.5	<0.001
Physical functioning score	73.2 ± 23.1	82.8 ± 19.1	<0.001
Pain score	68.5 ± 26.0	75.4 ± 22.9	<0.001
Energy/fatigue score	58.1 ± 20.7	64.7 ± 19.0	<0.001
Social functioning score	85.7 ± 20.8	90.2 ± 17.6	<0.001
<50	252 (5.8)	2650 (3.3)	<0.001
≥50	4089 (94.2)	76,639 (96.7)	
CES-D	0.06 ± 0.16	0.04 ± 0.13	<0.001
<0.06	3639 (85.8)	69,900 (89.4)	<0.001
≥0.06	604 (14.2)	8305 (10.6)	
Vigorous exercise at 18 yr			
No	2083 (49.7)	43,189 (56.0)	<0.001
Yes	2112 (50.4)	33,913 (44.0)	
Chronic disease history (number)	1.6 ± 1.1	1.2 ± 1.0	<0.001
Relative had adult diabetes			
No	1926 (44.2)	53,147 (66.7)	<0.001
Yes	2200 (50.4)	23,141 (29.1)	
Do not know	236 (5.4)	3371 (4.2)	
Walking MET-hours per week	3.9 ± 5.5	5.3 ± 6.3	<0.001
Mild MET-hours per week	1.1 ± 2.6	1.4 ± 3.2	<0.001
Moderate MET-hours per week	2.7 ± 4.8	3.4 ± 5.5	<0.001
Vigorous MET-hours per week	2.5 ± 6.5	4.1 ± 8.7	<0.001
Total MET-hours per week	10.1 ± 11.9	14.2 ± 14.5	<0.001
Frequency of recreational physical activity per week ≥20 min	3.3 ± 3.6	4.4 ± 4.0	<0.001
No. hours spent sitting (hours)	7.6 ± 3.4	7.3 ± 3.3	<0.001

CES-D, Center for Epidemiological Studies Depression Scale.

had, on average, a higher BMI at baseline (P < 0.001) and lower educational level (P < 0.001) and were less likely to be non-Hispanic white (P < 0.001) compared with participants who did not report diabetes during follow-up. Participants who reported diabetes during follow-up also reported less total physical activity at baseline (e.g., difference in total physical activity was −4.1 MET·h·wk^{-1}, 10.1 vs 14.2 MET·h·wk^{-1}) and greater sedentary behavior (P < 0.001).

Results from mixed models revealed significant associations between reported diabetes diagnosis and physical activity change (Table 2). Participants who reported a diabetes diagnosis were more likely to report increased total weekly physical activity (β = 0.61, SE = 0.18, P < 0.001 for crude model), walking (β = 0.26, SE = 0.07, P < 0.001 for crude model), and physical activity episodes (β = 0.23, SE = 0.05, P < 0.001 for crude model). Results remained significant after adjusting for BMI (all P values <0.05) and other covariates (all P values <0.05). Results also held when limited to those with complete data for computing changes (all P values <0.01). On average, participants reporting a diabetes diagnosis increased their total physical activity by 0.49 MET·h·wk^{-1} (SD = 10.9), their walking by 0.033 MET·h·wk^{-1} (SD = 4.6), and their number of physical activity episodes by 0.19 MET·h·wk^{-1} (SD = 3.5). For participants who did not report diabetes, mean change was minimal and decreased for total physical activity (M = −0.13 MET·h·wk^{-1}, SD = 11.1), walking (M = −0.23 MET·h·wk^{-1}; SD = 4.7), and number of physical activity episodes (M = −0.041 MET·h·wk^{-1}, SD = 3.4). Table 3 displays yearly change in total physical activity, walking, and number of physical activity episodes.

Diabetes diagnosis had no association with mild (P = 0.66) or moderate-intensity activity change (P = 0.31). Results did not change with adjustment for BMI (all P values >0.43) or other covariates (all P values >0.30). Diabetes diagnosis was significantly associated with vigorous-intensity physical activity for the crude model (P = 0.04), but the relationship abated after controlling for BMI (P = 0.11) and other covariates (P = 0.11). Diabetes diagnosis also had no impact on change in sedentary behavior for the crude (P = 0.86), BMI-adjusted (P = 0.63), or full model (P = 0.48; Table 4).

Education, family history of disease, or race/ethnicity did not modify the relationship between diabetes diagnosis and change in any of the physical activity outcomes (all P values >0.14).

DISCUSSION

Postmenopausal women who reported a diabetes diagnosis reported significant increases in their physical activity compared with women who did not report a diabetes diagnosis. The increase in physical activity appeared to be driven by a small increase in reported walking and physical activity episodes. Women who reported a diabetes diagnosis reported an increase of 0.5 MET·h·wk^{-1} in total physical activity.

TABLE 2. Change in physical activity[a] for participants with reported diabetes compared with those without diabetes

	Crude, N = 84,300			BMI Adjusted, N = 83,324			Full Model,[b] N = 76,020		
	Beta	SE	P	Beta	SE	P	Beta	SE	P
Walking MET-hours per week	0.259	0.074	**<0.001**	0.230	0.075	**0.002**	0.263	0.078	**<0.001**
Mild MET-hours per week	0.025	0.056	0.660	0.027	0.057	0.632	0.027	0.060	0.649
Moderate MET-hours per week	0.091	0.090	0.312	0.071	0.091	0.433	0.095	0.096	0.321
Vigorous MET-hours per week	0.239	0.118	**0.043**	0.189	0.119	0.113	0.200	0.125	0.110
Total MET-hours per week	0.613	0.176	**<0.001**	0.517	0.178	**0.004**	0.585	0.186	**0.002**
Episodes ≥20 min per week	0.234	0.054	**<0.001**	0.217	0.054	**<0.001**	0.260	0.057	**<0.001**

[a]Computing change from earlier time point for those missing data (up to 1 yr earlier; for instance, if missing year 4, then change at year 5 is year 5 minus year 3).
[b]Full model included year, age, ethnicity, BMI, education (yr), family history of diabetes, physical functioning (SF-36), pain (SF-36), energy/fatigue (SF-36), social functioning (cut at 50), depression (CES-D, cut at 0.06), number of chronic diseases, and strenuous/hard exercise at age 18 yr.

TABLE 3. Physical activity change and sedentary behavior change for those reporting a diabetes diagnosis and those not, by year

Physical Activity	No Diabetes Reported during the Year, Mean Change (SD)	Diabetes Reported during the Year, Mean Change (SD)
Walking MET-hours per week		
Year 3	−0.48 ± 5.55	−0.24 ± 5.17
Year 4	−0.25 ± 4.55	0.41 ± 4.18
Year 5	−0.15 ± 4.41	0.05 ± 4.16
Year 6	−0.09 ± 4.38	0.26 ± 4.02
Year 7	−0.19 ± 4.29	0.18 ± 3.87
Year 8	−0.14 ± 4.32	0.19 ± 4.13
Mild MET-hours per week		
Year 3	0.10 ± 3.51	0.14 ± 2.96
Year 4	0.10 ± 3.55	0.14 ± 2.73
Year 5	−0.03 ± 3.53	0.13 ± 3.29
Year 6	−0.17 ± 3.51	−0.22 ± 3.13
Year 7	0.24 ± 3.59	0.22 ± 3.35
Year 8	−0.05 ± 3.64	−0.35 ± 3.11
Moderate MET-hours per week		
Year 3	0.12 ± 6.11	0.09 ± 5.34
Year 4	−0.15 ± 5.65	0.07 ± 5.39
Year 5	0.01 ± 5.48	0.13 ± 4.62
Year 6	−0.14 ± 5.54	−0.08 ± 5.49
Year 7	0.27 ± 5.58	0.37 ± 4.88
Year 8	0.02 ± 5.72	0.16 ± 4.93
Vigorous MET-hours per week		
Year 3	−0.09 ± 8.12	0.17 ± 6.71
Year 4	−0.02 ± 7.15	0.43 ± 6.53
Year 5	−0.05 ± 7.07	0.09 ± 6.31
Year 6	0.26 ± 7.28	0.52 ± 6.5
Year 7	0.19 ± 7.4	0.14 ± 7.46
Year 8	0.05 ± 7.46	0.41 ± 6.81
Total MET-hours per week		
Year 3	−0.35 ± 12.5	0.17 ± 11.5
Year 4	−0.31 ± 10.8	1.06 ± 10.9
Year 5	−0.22 ± 10.3	0.41 ± 9.7
Year 6	−0.14 ± 10.7	0.48 ± 9.3
Year 7	0.50 ± 10.9	0.92 ± 10.5
Year 8	−0.13 ± 11.0	0.40 ± 10.9
Episodes ≥20 min per week		
Year 3	−0.07 ± 3.72	0.10 ± 3.52
Year 4	−0.09 ± 3.35	0.39 ± 3.49
Year 5	−0.05 ± 3.25	0.09 ± 3.42
Year 6	−0.09 ± 3.28	0.18 ± 3.42
Year 7	0.12 ± 3.30	0.40 ± 3.18
Year 8	−0.04 ± 3.34	0.16 ± 3.48
Sedentary hours per week		
Year 3	−0.41 ± 3.03	−0.48 ± 3.34
Year 6	−0.07 ± 2.92	−0.03 ± 3.16

Although an increase of this magnitude represents only 6% of the recommended amount of physical activity (i.e., 7.5 MET·h·wk^{-1}) (2), any increase in recreational physical activity, particularly in those at greater risk for comorbid disease, may confer benefits. A pooled analysis of six prospective cohort studies demonstrated that adults who reported 0.1–3.74 MET·h·wk^{-1} had a 32% lower mortality risk and an average of 1.8 yr longer life expectancy compared with adults who reported no recreational physical activity (37). The slight increase observed, coupled with research demonstrating that physical activity tends to decline with age (51), justifies a need for future research to investigate how a diabetes diagnosis may encourage physical activity and how public health practitioners and clinicians might capitalize on this opportunity to promote activity.

Results suggest that a diabetes diagnosis may provide some motivation for increasing physical activity in a population that is often quite sedentary (4). The diabetes diagnosis may have highlighted participants' worsening health, prompting them to increase their physical activity, without further intervention or guidance, in an attempt to assuage health concerns. They also may have received counseling from a health professional on increasing physical activity (47).

Before diagnosis, people with type 2 diabetes often have warning signs or receive a prediabetes diagnosis that could heighten their awareness for the necessity of behavior change. Because physical activity may help prevent diabetes, research should examine whether classifying a patient as prediabetic or using an impaired glucose tolerance diagnosis can similarly motivate increased physical activity. A qualitative study of individuals with impaired glucose tolerance who participated in a diabetes prevention lifestyle intervention trial and maintained improvements in lifestyle behaviors mentioned that their impaired glucose tolerance diagnosis was a strong motivating factor for behavior change (41). The best strategies for facilitating behavior change during these instances require further study.

Although the participants who developed diabetes reported increased physical activity, the average amount was still lower than the physical activity of participants who never developed diabetes and the amount recommended for health benefits. The fact that those who developed diabetes continued to lag behind individuals who did not develop diabetes, coupled with the evidence that individuals with diabetes are more likely to relapse to a sedentary lifestyle after beginning an exercise program (29), raises the question as to how to further increase and maintain physical activity in individuals with diabetes. Access to exercise facilities, social support, and preventing pain and obesity are key factors for facilitating physical activity maintenance in individuals with diabetes (43,54). The extent to which technology, such as continuous blood glucose monitors and virtual reality, encourages physical activity maintenance appears promising but requires further study (1,10).

No differences were observed in reported sedentary behavior. Increased physical activity may not necessarily prompt reductions in sedentary behavior (23). Some individuals compensate for increased physical activity by increasing their sedentary behavior (27). Participants may also have had little awareness of the importance of reducing sedentary behavior. Although recommendations to reduce sedentary behavior are included in the physical activity recommendations, the extent

TABLE 4. Change in sedentary hours for participants with reported diabetes compared with those with no diabetes

Sedentary Hours per Week	Beta	SE	*P*
Crude (*N* = 76,948)	−0.010	0.056	0.862
BMI adjusted (*N* = 76,069)	−0.027	0.057	0.633
Full model[a] (*N* = 69,763)	−0.043	0.06	0.478

[a]Full model containing year, age, ethnicity, BMI, education (yr), family history of diabetes, physical functioning (SF-36), pain (SF-36), energy/fatigue (SF-36), social functioning (cut at 50), depression (CES-D, cut at 0.06), number of chronic diseases, and strenuous/hard exercise at age 18 yr.

to which advice to reduce sedentary behavior is provided is unknown. A study of counseling by primary care physicians found that only 10% of patients received counseling to reduce sitting, compared with 53% of patients who received physical activity counseling (46). Research is just beginning to emerge on the factors that facilitate decreases in sedentary behavior (e.g., point-of-choice prompting software [11]), which could assist individuals with decreasing sedentary activity after a diabetes diagnosis.

The lack of a moderating effect of education on physical activity change conflicts with the study of Newsom et al. (38) in which individuals with a higher education level reported increased physical activity after a diabetes diagnosis. That study used data from the Health and Retirement Study, which includes a probability sampling of U.S. adults 50 yr and older with oversampling of blacks, Hispanics, and Florida residents (21). The WHI-OS sample is a more highly educated sample than the U.S. population. This difference and the inclusion of males in the Health and Retirement study sample may have accounted for the discrepant results.

The main limitation of this study is that diabetes was self-reported treated diabetes and was only captured as having occurred in the past year as the WHI does not contain the date of diabetes diagnosis. Thus, participants may have been diagnosed as long as 12 months ago or as little as 1 d before they completed the follow-up assessment. The use of self-reported physical activity and sedentary behavior is not ideal given the possibility of inaccurate reporting. The lack of objective physical activity data limits our ability to validate participants' self-report. In addition, sedentary behavior was only measured at baseline, year 3, and year 6, which creates a larger time span between diabetes diagnosis and the postdiagnosis sedentary behavior measurement. The WHI sample also reported little vigorous-intensity physical activity (12), which may have limited the possibility of finding change over time in vigorous-intensity physical activity. Participants were less likely to report diabetes than postmenopausal women in the United States, which suggests that participants may not be representative of postmenopausal women. In addition, results may not generalize to men or premenopausal women. Strengths of the study include the large, longitudinal, national, and well-characterized racially and ethnically diverse group of postmenopausal women, the use of multiple measures of physical activity and an examination of sedentary behavior.

A disease diagnosis may motivate health behavior change and prompt increases in physical activity. Health professionals should be cognizant of this opportunity to discuss healthy behavior change upon diagnosis, as not all patients with diabetes report receiving encouragement from their physicians on increasing physical activity (3,40) and opportunities to motivate behavior change can be overlooked in primary care settings (8). Providing physical activity recommendations, relevant resources and evidence-based strategies such as tracking physical activity, scheduling physical activity, and eliciting social support for activity as well as increasing contact and support for patients who have been newly diagnosed with diabetes may facilitate greater increases in physical activity and support physical activity maintenance.

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EPIDEMIOLOGY

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