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Diabetes diagnosis and exercise initiation among older Americans

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Abstract

Objective—To determine whether exercise participation increased following a new diagnosis of diabetes using a sample of U.S. individuals age 50 and over who did not report exercise prior to diagnosis.

Methods—We used data from the 2004–2010 Health and Retirement Study in a pre-post study design. Individuals newly-diagnosed with diabetes (N=635) were propensity score matched to a comparison group with no diabetes.

Results—In the year following a reported diagnosis, 35.7 percent (95% CI 32.0 to 39.5) of those newly diagnosed with diabetes initiated exercise as compared with 31.4 percent (95% CI 27.9 to 35.1) for the matched cohort with no diabetes, with a between-group difference of 4.3 percentage points (95% CI –0.9 to 9.4). Among individuals with fewer health risk factors at baseline, the between-group difference was 15.6 percentage points (95% CI 1.58 to 29.5).

Conclusion—Over 35% of persons with a new diagnosis of diabetes initiated moderate or vigorous exercise in the year following their diagnosis. Among individuals with fewer health risk factors at baseline, those newly-diagnosed with diabetes were more likely to begin exercise than those without diabetes.

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INTRODUCTION

Exercise and diet modification are foundations in the management of type 2 diabetes, with oral medications reserved for patients with severely elevated blood glucose or for those who do not achieve glucose control through lifestyle modification (Nathan, 2002; Ripsin et al., 2009; Short, 2012). Medication in conjunction with exercise improves glycemic control beyond that achieved by medication alone (Boulé et al., 2001; Castaneda et al., 2002; Dunstan et al., 2002). Moreover, an intensive lifestyle intervention consisting of exercise and diet has been shown to induce a partial remission of type 2 diabetes among overweight adults (Gregg EW et al., 2012). Even without weight loss, exercise has been shown to effectively lower blood glucose, cholesterol, and blood pressure (Marwick et al., 2009; Sigal et al., 2006, 2004).

Prior cross-sectional studies have found that persons with type 2 diabetes are less likely to engage in exercise than those without type 2 diabetes (Hays and Clark, 1999; Morrato et al., 2007; Nelson et al., 2002; Nothwehr and Stump, 2000). However, despite the central importance of exercise in diabetes management, it is unknown whether a new diagnosis of diabetes prompts patients to initiate exercise. This knowledge is critical to understanding the value of screening for diabetes and guide clinicians about whether a diagnosis of diabetes is associated with successful behavior change. For example, the United States Preventive Services Task Force (USPSTF) has stated that screening for type 2 diabetes other than for asymptomatic adults with high blood pressure will not improve outcomes. Others have argued that expanding the screening to a greater number of asymptomatic adults can prevent disease onset and improve outcomes (Gillies et al., 2008; Kahn et al., 2010; Knowler et al., 2002; Villarivera et al., 2012). Whether screening improves outcomes is contingent on whether patients respond to a diagnosis of diabetes and associated physician lifestyle counseling by changing health behaviors such as exercise.

The purpose of this study was to estimate the effect of a new diagnosis of diabetes on the initiation of exercise. This work is informed by Grossman's model of health production, in which an individual's health is a stock variable that depreciates over time but can be augmented by investments in time, income and medical care (Grossman, 1972). Each person's optimal level of health occurs when the marginal cost of maintaining a certain level of health equals the marginal benefit. Using this model, we hypothesized that when patients receive a new diagnosis of diabetes by a physician, they gain information that increases their demand to invest in their health. If individuals understand that diabetes leads to disease or death if not properly managed and exercise is recommended as a way to improve outcomes, then individuals will choose to exercise more. As a secondary hypothesis, we posit that the effect of a diabetes diagnosis to be larger for moderate exercise because it is more attainable than vigorous exercise while the health benefits are comparable (Powell et al., 2005).

METHODS

We employed a quasi-experimental study design that assessed longitudinal trends in the adoption of exercise among individuals who were newly diagnosed with diabetes compared

to concurrent trends among a propensity-matched comparison sample who were not diagnosed with diabetes.

We used the University of Michigan Health and Retirement Study (HRS), a nationally representative sample of more than 30,000 individuals born between 1931 and 1941 and their spouses who could be of any age. Information on demographics, physical health, health behaviors, insurance coverage, financial status, and labor market status is collected in survey waves every two years since 1992. The study cohort, recruitment, and data collection procedures are described elsewhere (Heeringa and Connor, 1995). Brown University's Human Research Protection Office deemed the study to be exempt from Institutional Review Board (IRB) review.

Variables

The primary outcome variable was the initiation of exercise, defined as engaging in either moderate or vigorous physical activities at least twice per week after a prior wave in which the same respondent reported not participating in any moderate or vigorous physical activities. Vigorous physical activities include running or jogging, swimming, cycling, aerobics or gym workout, tennis, or digging with a spade or shovel. Moderate physical activities include gardening, cleaning the car, walking at a moderate pace, dancing, or floor or stretching exercises. Figure 1 shows the time trend in exercise prevalence for the HRS cohort by survey year for individuals with and without diabetes.

The initiation of vigorous exercise, defined as participating in vigorous physical activities at least twice per week after a prior wave in which the same respondent reported not participating in any moderate or vigorous physical activities, was used as a secondary outcome variable.

The primary independent variable was a new diagnosis of diabetes, which we defined as a respondent indicating that a physician diagnosed him/her with diabetes after a prior wave in which the same respondent did not indicate he/she had been diagnosed with diabetes.

Other important covariates were age (in years), sex, race/ethnicity (white, black, Hispanic, other), education (number of years of schooling), income (continuous), current employment, presence of health insurance coverage, marital status, self-rated health (excellent, very good, good, fair or poor), body-mass index (continuous), smoking status, presence of high blood pressure, presence of heart disease, and hospitalization since prior wave. These variables were measured at baseline defined as the wave prior to a new diabetes diagnosis except for hospitalizations, which were measured in the same wave since it was asked retrospectively.

Study Sample

Using data for waves 2004, 2006, 2008, and 2010, when questions on exercise were asked, we identified 1,532 individuals who reported that a physician had diagnosed him/her with diabetes in waves 2006, 2008, and 2010 after a previous survey wave in which they indicated that they had never been diagnosed with diabetes. Those who reported "ever" diagnosed, e.g. not newly diagnosed, with diabetes were not included in the study sample. Of these newly diagnosed individuals, we excluded 106 who had cancer or lived in a nursing

home prior to the diagnosis and 45 who were missing data on covariates. We further excluded 746 newly diagnosed individuals who had reported that they exercised at least 2 times per week in the prior survey wave. We matched each newly diagnosed individual in the final sample (N=635) to a control respondent from the same pool of HRS individuals who did not report a new diagnosis of diabetes. Controls could not have reported exercise in the prior survey wave.

As shown in the Table 1 for exercise participation outcome, the matched control group had 597 unique persons. This means that 38 observations used a person more than once. However, no person-wave was used more than once. So if a person was used more than once as a matched control, he/she was observed in a different wave for each match.

Statistical Analysis

The propensity-score was estimated using a logit model specification such that the likelihood of a diabetes diagnosis is a function of the baseline and current characteristics of the individual. Individuals in the study sample were matched to individuals in the comparison sample based on the propensity-score using one-to-one nearest neighbor matching with a greedy algorithm, no replacement, and common support for the baseline characteristics. All individuals in the study sample were matched.

To analyze how the effect of a diabetes diagnosis varies with the presence of other health risk factors, we sorted and assigned individuals into 6 stratas according to their estimated propensity score where each strata is balanced on baseline characteristics. Within each strata, individuals in the study sample were then matched to individuals in the comparison sample using one-to-one nearest neighbor matching with a greedy algorithm, no replacement, and common support for the baseline characteristics.

All reported P values are two-sided, and P values of less than 0.05 were considered to indicate statistical significance. STATA software, version 12 was used for statistical analyses. In the Sensitivity Analysis section, we report results using other matching and non-matching estimation methods.

RESULTS

Table 1 shows the mean and standard error of each baseline characteristic in the propensity score estimation model for the study and matched comparison samples. None of the characteristics were statistically significantly different at the 5 percent significance level.

Figure 2 (left panel) shows the estimated adjusted difference in exercise initiation in the wave of a reported diabetes diagnosis and the wave before and after the diagnosis. As designed, prior to the diagnosis, exercise participation rate is zero for both the study and matched cohorts. In the year following a reported diagnosis, the proportion reporting moderate or vigorous exercise was 35.7 percent (95% CI 32.0 to 39.5) for those newly diagnosed with diabetes and 31.4 percent (95% CI 27.9 to 35.1) for the matched cohort who were not diagnosed with diabetes. Therefore, the adjusted between-group difference in exercise initiation was 4.3 percentage points (95% CI -0.9 to 9.4).

Figure 2 (right panel) shows that of the patients newly diagnosed with diabetes, 10.0 percent (95% CI 7.6 to 12.3) initiated vigorous exercise in the year following their diagnosis. The concurrent rate of vigorous exercise initiation was 8.9 percent (95% CI 6.6 to 11.1) for the matched cohort with no diabetes. The adjusted between-group difference in vigorous exercise participation was 1.1 percentage points (95% CI -2.1 to 4.3).

Figure 3 shows the adjusted between-group difference in exercise initiation by propensity score strata, where 1 is the strata with the lowest propensity scores and 6 the highest. There is a clear negative relationship between propensity score and difference in exercise initiation. The between-group difference in exercise initiation is highest for strata 2 at 15.6 percentage points (95% CI 1.6 to 29.5) and lowest for strata 5 at -4.4 percentage points (95% CI -16.9 to 8.2). Since propensity scores are positively associated with presence of health risk factors such as obesity, age, hypertension, and smoking, the negative relationship in Figure 3 can be interpreted to mean that those with fewer health risk factors are more likely to initiate exercise after a diagnosis.

Sensitivity Analysis

The main finding, that there was a non-significant increase in exercise participation following a new diabetes diagnosis, was consistent across these sensitivity analyses (data not shown). The estimates with vigorous or moderate exercise participation as the outcome ranged from 1.9 percentage points (95% CI -3.5 to 7.2) using Mahanalobis metric matching to 4.6 percentage points (95% CI -0.6 to 9.9) using logit regression after propensity-score matching with no replacement.

DISCUSSION

We extend prior literature by using a quasi-experimental longitudinal design to examine exercise adoption among persons following a new diagnosis of diabetes and to compare the initiation of exercise with a propensity matched comparison group that did not receive a new diagnosis of diabetes. We found that approximately 35 percent of persons with a new diagnosis of diabetes initiated moderate or vigorous exercise in the year following their diagnosis. Among a matched control group of individuals who did not receive a diagnosis of diabetes, 31 percent initiated moderate or vigorous exercise. Thus, we found a trend toward higher rates of exercise initiation among persons newly diagnosed with diabetes, but the difference did not reach statistical significance. We also found almost no difference in the initiation of vigorous exercise (10.0 percent among persons with newly diagnosed diabetes vs. 8.9 percent in the control group). This supports our hypothesis that the effect of a diabetes diagnosis is larger for moderate exercise than for vigorous exercise, though the difference between these rates also did not reach statistical significance.

Our main findings are consistent with Manschot et al. (2014) who concluded that a diabetes diagnosis was not statistically significantly associated with an increase in exercise. However, we showed that a diabetes diagnosis was statistically significantly associated with an increase in exercise among those with fewer health risk factors at baseline. Taken together, these findings suggest that provider messages about the importance of lifestyle modification or the health information conveyed by a diabetes diagnosis triggers patients to

initiate important changes in their health behaviors. It also suggests that health information delivered when individuals have fewer health risk factors have greater impact.

Previous studies have separately examined the effects of a negative health shock and physician advice on health behaviors. Falba (2005) using data from the Health and Retirement study (HRS), found that smokers were much more likely to quit smoking following a serious health event. Similarly, Clark and Etile (2002) and Clark and Etile (2006), using data from the British Household Panel Survey (BHPS), showed that smokers whose health worsened smoked less in the future and were more likely to quit. Kreuter et al. (2000) demonstrated in a randomized control trial set in four community-based group family medicine clinics in southeastern Missouri that patients who received physician advice to quit smoking, eat less fat, or get more exercise prior to receiving intervention materials on the same topic were more likely to recall the materials and show them to others. Bao et al. (2006), using an instrumental variables framework, concluded that receiving physician advice on smoking cessation doubles the probability of quitting by the end of the 12-month reference period. Likewise, Loureiro and Nayga (2006) showed that receiving physician's advice to lose weight is associated with both a higher probability of eating a diet with fewer calories and fat. The results from these studies are also consistent with a model in which individuals modify health behaviors in response to receiving information about their level of health.

As with any study that matches subjects from observational data, there are some limitations that should be noted. A new diabetes diagnosis may involve a concurrent decline in health and functional status, which may reduce or limit the ability to exercise. For example, individuals with diabetes also commonly have fatigue or may have other symptoms that limit their ability to exercise (Fritschi and Quinn, 2010). If so, a new diabetes diagnosis may be associated with a lower propensity to exercise. On the other hand, individuals newly diagnosed with diabetes may face social pressure to report engaging physical activities. In this case, a new diabetes diagnosis may be associated with a spurious higher propensity to exercise due to the reliance on self-reported data. With regards to the matched comparison sample, not reporting a diabetes diagnosis may be associated with a greater propensity to exercise and, since exercise has been shown to prevent the onset of diabetes (Tuomilehto et al., 2001), a lower propensity for diabetes. For example, individuals who have fewer health risk factors for diabetes are also less likely to have comorbid conditions, such as arthritis or pulmonary disease, which preclude exercise. This suggests that the matched comparison sample may be biased towards greater exercise participation. In summary, there may be unobserved factors that simultaneously affect the likelihood of a diabetes diagnosis and of exercise which are not accounted for in the model and bias the results toward zero.

Another limitation is that this study relies on categorical self-reported responses to survey questions measuring the frequency of engagement in moderate and vigorous exercise. Although the recommended amount of exercise is three times per week, there was not an option for respondents to select this frequency. Furthermore, the HRS changed the survey questions and responses across waves, which precludes measuring long-term adherence to exercise participation following initiation.

In conclusion, in this nationally representative study of respondents from four waves of the Health and Retirement Study (HRS) from 2004 to 2010, we found that 35 percent of persons with a new diagnosis of diabetes initiated moderate or vigorous exercise in the year following their diagnosis, a rate that was 4.3 percentage points (95% CI -0.9 to 9.4) higher than that of a propensity-score matched comparison group. These results suggest that a substantial fraction of patients with diabetes initiate exercise following their diagnosis, particularly among those with fewer health risk factors at baseline, and highlight the importance of documenting patient response and adherence to diabetes counseling. Future research should examine factors that can promote greater uptake of exercise and other lifestyle modifications among individuals with diabetes.

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Highlights

Over one third of individuals newly diagnosed with diabetes initiated exercise.

Exercise initiation was highest for those with fewer health risk factors at baseline.

Diagnosis delivered when patients have fewer health risk factors have greater impact.

Figure 1.

Exercise prevalence rates from the Health and Retirement Study (HRS) for individuals with and without diabetes by survey year.

I-beams indicate 95% confidence intervals

Figure 2.

Exercise initiation rates for study and propensity-score matched comparison groups by years since self-reported diabetes diagnosis.

I-beams indicate 95% confidence intervals

Figure 3.

Difference in exercise initiation rates between study and propensity-score matched comparison groups by propensity score.

Table 1

Baseline characteristics of study and propensity-score matched comparison samples for exercise and vigorous exercise outcomes.

	Moderate or Vigorous? Exercise			Vigorous Exercise		
	Newly-diagnosed with diabetes (N=635)	Matched control (N=635)	P Value	Newly-diagnosed with diabetes (N=632)	Matched control (N=632)	P Value
Unique persons* (no.)	635	597		632	605	
Age (yr)	65.9 (0.4)	66.2 (0.4)	0.502	65.8 (0.4)	66.3 (0.4)	0.343
Age squared (yr)	44.3 (0.5)	44.7 (0.5)	0.568	44.2 (0.5)	44.8 (0.5)	0.408
Female (%)	60.3 (1.9)	58.6 (2.0)	0.53	60.3 (1.9)	62.2 (1.9)	0.489
Black (%)	16.2 (1.5)	19.4 (1.6)	0.143	16.3 (1.5)	17.7 (1.5)	0.501
Hispanic (%)	13.1 (1.3)	12.8 (1.3)	0.867	13.1 (1.3)	11.9 (1.3)	0.497
Married (%)	65.8 (1.9)	66.9 (1.9)	0.678	65.8 (1.9)	66.6 (1.9)	0.766
No degree (%)	26.6 (1.8)	27.4 (1.8)	0.752	26.4 (1.8)	26.4 (1.8)	1.000
Education (yr)	11.9 (0.1)	12.0 (0.1)	0.588	11.9 (0.1)	12.0 (0.1)	0.606
Income (\$1000)	51.6 (2.4)	51.2 (2.5)	0.907	51.7 (2.4)	55.0 (3.1)	0.413
Labor force (%)	38.6 (1.9)	35.9 (1.9)	0.324	38.8 (1.9)	39.1 (1.9)	0.908
Unemployed (%)	1.9 (0.5)	0.9 (0.4)	0.155	1.9 (0.5)	2.4 (0.6)	0.560
Insured (%)	85.5 (1.4)	85.5 (1.4)	1.000	85.4 (1.4)	86.9 (1.3)	0.464
Fair/poor health (%)	38.3 (1.9)	40.6 (2.0)	0.390	38.4 (1.9)	39.2 (1.9)	0.773
Smoker (%)	15.6 (1.4)	15.9 (1.5)	0.878	15.7 (1.4)	13.8 (1.4)	0.341
Heart disease (%)	27.1 (1.8)	26.8 (1.8)	0.899	27.1 (1.8)	28.6 (1.8)	0.531
High blood pressure (%)	70.1 (1.8)	72.4 (1.8)	0.353	70.1 (1.8)	72.0 (1.8)	0.457
Hospitalized (%)	34.2 (1.9)	35.0 (1.9)	0.768	34.0 (1.9)	34.2 (1.9)	0.953
Obese (%)	51.3 (2.0)	50.9 (2.0)	0.866	51.4 (2.0)	51.4 (2.0)	1.000
Body-mass index (no.)	31.2 (0.3)	31.0 (0.3)	0.553	31.2 (0.3)	31.0 (0.3)	0.530

Standard errors in parentheses.

* The same subject in the comparison group was matched to multiple subjects in the study sample group but in different waves.

† P values were determined by a two-tailed t-test for the difference between the groups.