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Physical Functioning and Mortality among Individuals with Type 2 Diabetes: Insights from TRIAD

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Abstract

Diabetes is a risk factor for mortality. Subjective health status, including self-reported physical functioning, may also be a marker for mortality. This study examined the association between self-reported physical functioning and mortality in people with diabetes, and determined if this association differed by race/ethnicity. We studied 7,894 type 2 diabetic patients who participated in Translating Research Into Action for Diabetes (TRIAD), a prospective study of diabetes care in managed care. At baseline in 2000, participants completed a questionnaire and had a medical record review. Physical functioning was assessed with the Short Form Health Survey (SF-12). The National Death Index was searched annually for deaths over 10 years of follow-up (2000-2009). At baseline, mean age was 61.7 years, 50% were non-Hispanic white, 22% were black, and 16% of participants reported “good physical functioning” (better than norms for U.S. adults). Over 10 years, 28% of participants died (2,111/7,894); 39% (856/2,111) due to cardiovascular disease. Relative to those reporting good functioning, those reporting poor physical functioning had a 37% higher all-cause death rate, after adjusting for age, sex, race/ethnicity, education, income, body mass index, smoking, and comorbidities (Hazard Ratio (HR)=1.37; 95% Confidence Interval (CI): 1.15, 1.63). Similarly, those reporting poor physical functioning had a 42% higher adjusted cardiovascular death rate compared to those reporting good functioning (HR= 1.42; 95% CI: 1.06, 1.90). Although blacks were less likely than whites to report good functioning ($p<0.01$), the association between functioning and mortality was consistent across race/ethnicity. In this managed care population with diabetes, self-reported physical functioning was a robust predictor of mortality, in addition to traditional biological risk factors, for all race/ethnic groups. Physical functioning assessments are easy to perform and may be useful benchmarks for tailoring the care of persons with chronic disease.

Introduction

Diabetes is a well-established risk factor for all-cause and cardiovascular mortality [Barr 2007]. Subjective health status, including self-reported physical functioning, may be a marker for increased risk of mortality as well [Jylha 2009; McEwen 2009; Landman 2010].

The prospective AusDiab and ZODIAC-18 studies, conducted in Australia and the Netherlands, respectively, reported that the co-occurrence of diabetes and poor self-rated physical functioning was associated with increased risk of mortality [Landman 2010; Williams 2012]. However, it is unclear if this association exists in the United States or differs by race/ethnicity.

Race/ethnicity is an important social determinant of health because of its association with socioeconomic status, health behaviors, and access to health care [Verbrugge 1994]. Although racial/ethnic minorities are more likely to report limitations in functioning, black-white differences in physical functioning and disability may be largely explained by socioeconomic differences [Mendes de Leon 1995] or access to health care.

In this study, we evaluated the association between self-reported physical functioning and mortality among individuals with type 2 diabetes, and determined if this association differed by race/ethnicity. We hypothesized that those with self-reported limitations in physical functioning would have an increased risk of mortality compared to those who reported good physical functioning, and that minorities would demonstrate a stronger association between poor self-reported physical functioning and mortality compared to non-Hispanic whites.

Methods

Study Population

We studied 7,894 patients with type 2 diabetes who participated in Translating Research Into Action for Diabetes (TRIAD), a multicenter prospective observational study of diabetes care in managed care [TRIAD study group 2002]. The analytic study sample included participants who completed the self-reported physical functioning component of the baseline survey in 2000-2001 and had a complete medical record review. We excluded participants with type 1 diabetes defined as age at diagnosis of diabetes <30 years and treatment with insulin only.

The National Death Index (NDI) was searched annually to ascertain deaths over a 10-year follow-up period (2000-2009).

Measures

Physical functioning was defined by participant self-report using the Physical Component Summary (PCS) score from the Short-Form 12 Health Survey (SF-12) [Ware 2000]. The PCS summarizes responses from the physical functioning, role-physical, bodily pain, and general health scales, in which the participant reported he or she was limited in vigorous or moderate activities, was limited in working or other activities, accomplished less than expected due to health, had pain or problems interfere with life, and had a low energy level. The lowest possible score in the PCS reflects limitations in self-care, physical, social, and role activities, severe bodily pain, frequent tiredness, and self-rated health as “poor” [Ware 2000]. The highest possible score in the PCS reflects no physical limitations, disabilities or decrements in well-being, high energy level, and self-rated health as “excellent” [Ware 2000]. In the general population of the United States, the PCS has a mean of 50.0 and a standard deviation of 10.0. Observed PCS values above 50.0 in a sample population

represent “better than average” physical health and functioning and observed PCS scores below 50.0 represent “poorer than average” physical health and functioning [Ware 2000].

ICD-10 codes for the underlying cause of death were used to group causes of death: diabetes (E10-E14), cardiovascular disease (I00-I99), cancer (C00-97), renal failure (N17-19), infection (A00-B99, J10-18), external injury-related causes (V00-Y89), and all other codes. Mortality was classified as cardiovascular, non-cardiovascular, and all-cause from ICD-10 codes. Cardiovascular mortality included ICD-10 codes I00-I99 for underlying cause of death [McEwen 2012].

Race/ethnicity was classified as non-Hispanic white (reference), non-Hispanic black, Hispanic, Asian/Pacific Islander, and Other. We also adjusted for age at baseline, sex, education, baseline annual income, smoking, treatment for diabetes, body mass index, health history, and the Charlson Index, all of which were associated with mortality in the TRIAD cohort [McEwen et al. 2012]. Education was categorized as some high school or less, high school degree (reference), some college, and college degree or higher. Baseline annual income was categorized as <\$15,000 (reference), \$15,000-40,000, \$40,000-75,000, and > \$75,000. Respondents were also dichotomized as either current smokers or non-smokers (reference). Treatment for diabetes was categorized as diet only, oral medication only (reference), insulin only, and insulin and oral medication combined. Body mass index (BMI) was categorized as normal ($\text{BMI} < 25 \text{ kg/m}^2$; reference), overweight ($25 \leq \text{BMI} < 30 \text{ kg/m}^2$), obese ($30 \leq \text{BMI} < 35 \text{ kg/m}^2$), and grossly obese ($\text{BMI} \geq 35 \text{ kg/m}^2$). Health histories were obtained from the medical record reviews and included histories of diabetic retinopathy, diabetic nephropathy, diabetic peripheral neuropathy, hypertension, congestive heart failure, coronary heart disease, and peripheral vascular disease. Finally, the Charlson Index, a score that weights the presence and severity of health comorbidities [Charlson 1987], was calculated and categorized as 0 or 1 (reference), 2 or 3, and 4 or more. Since all participants had diabetes, use of diabetes medications (as opposed to diet only) was used as the indicator for severity of diabetes in the Charlson Index.

Statistical Analyses

We described the sample population using means (standard deviation) for continuous variables and frequencies for categorical variables. We calculated the frequency of good physical functioning (i.e., $\text{PCS} > 50.0$; “better than average”) and poor physical functioning (i.e., $\text{PCS} < 50.0$; “poorer than average”) and described the distribution of baseline sociodemographic variables and health factors by self-reported physical functioning status at baseline. Student's t-tests and chi-square tests were used to compare poor physical functioning and good physical functioning. We constructed Cox proportional hazard models to evaluate how self-reported physical functioning predicted all-cause and cardiovascular mortality, adjusting for all other covariates. We tested for heterogeneity in the association of self-reported physical functioning with mortality by race/ethnicity (i.e., effect modification) by evaluating the statistical significance of multiplicative interaction terms in the Cox proportional hazards model. SAS v9.3 was used for all data management and analysis and statistical significance was considered $p\text{-value} < 0.05$.

Results

At baseline, 16.2% (n=1278) of participants reported good physical functioning and 83.8% (n=6616) reported poor physical functioning. Average age of the population at baseline was 61.7 (12.0) years and did not differ by physical functioning status. Participants with poor physical functioning were more likely to be female and non-Hispanic black, and to have lower levels of education and income. In addition, those with poor physical functioning were more likely to smoke, be overweight or obese, and have a history of health conditions known to be adversely associated with survival (Table 1).

After 10 years of follow-up, 28.0% of participants had died. Those self-reporting poor physical functioning were more likely to die than those reporting good physical functioning (30.0% vs. 17.7%; p-value<0.001) (Figure 1A). Of the 2211 total deaths, 856 (38.7%) were due to cardiovascular disease. Similar to all-cause mortality, those reporting poor physical functioning were more likely to die from cardiovascular disease than those reporting good physical functioning (14.2% vs. 7.6%; p-value<0.001) (Figure 1B).

Hazard ratios and corresponding 95% confidence intervals for the association between self-reported physical functioning and mortality are shown in Table 2. Relative to those reporting good physical functioning, those reporting poor physical functioning had a 37% higher all-cause death rate, after adjusting for age, sex, race/ethnicity, education, income, body mass index, smoking, and comorbidities (Hazard Ratio (HR)=1.37; 95% Confidence Interval (CI): 1.15, 1.63). Similarly, those reporting poor physical functioning had a 42% higher adjusted cardiovascular death rate compared to those reporting good physical functioning (HR= 1.42; 95% CI: 1.06, 1.90). Although non-Hispanic blacks were more likely than whites to report poor physical functioning (p<0.01), the association between self-reported physical functioning and mortality did not differ by race/ethnicity.

Discussion

Poor self-reported physical functioning is a significant predictor of mortality, even after adjusting for other known risk factors for mortality. Compared to the general population, the majority of individuals with type 2 diabetes who participated in TRIAD reported poorer than average physical functioning. Even though non-Hispanic blacks were more likely to report poor physical functioning, the association between functioning and mortality did not differ by race/ethnicity.

Our results are consistent with other studies. The ZODIAC-18 study of type 2 diabetes patients from the Netherlands reported that a 10-point increase on the PCS decreased the risk for mortality by approximately 10% [Landman 2010]. The AusDiab study reported that those with a co-occurrence of diabetes and impaired PCS had an almost three-fold increase in cardiovascular mortality compared to those with diabetes and with average physical functioning [Williams 2012].

To our knowledge, this is the first study to evaluate if the association between physical functioning and mortality differed by race/ethnicity in diabetic patients in the United States. We found that non-Hispanic blacks are more likely to report poor physical functioning than

non-Hispanic whites. In other studies, it has been posited these black-white differences in physical functioning and disability may be explained socioeconomic differences or access to health care. In TRIAD, all participants had access to health care at baseline since they were enrolled in a managed care organization. After adjusting for income and education, the association between subjective physical functioning status and mortality did not differ by race/ethnicity in this population with uniform access to care. Self-reported physical functioning was a robust predictor of mortality, in addition to traditional biological risk factors, for all race/ethnic groups.

Self-reported physical functioning is an important indicator of quality-of-life because the patient's point of view is central to medical outcomes and overall well-being [Ware & Sherbourne, 1992]. Although the positive association between subjective physical functioning and mortality has been previously reported, these patient reports are particularly relevant to the care of persons with chronic conditions like diabetes that require substantial self-management [Richardson 2012]. Physical functioning is a better predictor of self-management than age and has been suggested as the “sixth vital sign” for screening older adults in clinical care because of its prognostic value [Bierman 2001; Richardson 2012; Studenski 2003]. Although patient-reported physical functioning assessments are valid, quick, and easy to perform, physical functioning is an underutilized indicator in the clinical setting [Calkins 1994; Bogardus 2001]. The addition of self-reported physical functioning assessments in clinical practice may give health care providers important information about the patient's well-being and future path to disability and overall health decline. Future studies should also determine if poor self-reported physical functioning is a general marker of disease burden or rather more tightly linked to particular types of comorbidities (e.g., those that cause pain) that could be treated directly.

Several study limitations and strengths are worth noting. The study population was limited to people enrolled in integrated, healthcare delivery systems. Although we consider this a strength of the study in that race/ethnicity would not be confounded by access to health care, our results may not be generalizable to uninsured individuals or those not receiving managed care. There are numerous other measures of self-rated physical health, and we did not explore any of these additional measures. Although there may be stronger predictors of mortality than the PCS, it is practical to collect in usual care settings, and it has been normalized for the general population of the United States. This allowed us to contrast the physical function of TRIAD participants with that of the general U.S. population.

The majority of individuals with type 2 diabetes demonstrated markedly worse physical health compared to the United States general population, which was not surprising considering that diabetes is a condition with many physically debilitating consequences. Despite the utility of self-rated health as a marker of poor health outcomes and increased mortality risk – even among individuals with equal access to health care – it is underutilized in the clinical setting. Self-rated health and physical functioning assessments are easy to perform and may be useful benchmarks for tailoring the care of persons with chronic disease.

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Figure 1A.

Survival curve for all-cause mortality, by good physical functioning (red) and poor physical functioning (blue), TRIAD 2000-2009.

Figure 1B.

Survival curve for cardiovascular mortality, by good physical functioning (red) and poor physical functioning (blue), TRIAD 2000-2009.

Table 1

Distribution (%) of baseline sociodemographic and health factors by self-reported physical functioning status* at baseline, TRIAD Study.

	Total sample	Poor physical functioning	Good physical functioning	P value
<i>n</i>	7894	6616	1278	
Age, years	61.7 (12.0)	61.8 (12.0)	61.3 (12.1)	0.17
Male sex	45.7	43.2	58.5	<0.001
Race/ethnicity				
Non-Hispanic white	49.9	49.4	52.2	
Non-Hispanic black	21.5	22.5	15.9	
Hispanic	19.1	18.7	21.4	
Asian/Pacific Islander	3.7	3.5	4.6	
Other	5.9	5.8	6.0	<0.001
Education				
Some high school or less	25.5	26.9	18.6	
High school degree	28.8	29.5	25.2	
Some college	27.8	27.3	30.6	
College degree or higher	17.9	16.4	25.6	<0.001
Annual income				
<\$15,000	31.6	33.8	20.3	
\$15,000-40,000	31.2	31.8	28.4	
\$40,000-75,000	23.7	22.2	30.9	
>\$75,000	13.5	12.2	20.3	<0.001
Smoking	18.4	19.4	13.2	<0.001
Treatment for diabetes				
Diet only	6.8	6.4	8.7	
Oral medication only	64.9	63.7	70.9	
Insulin only	15.3	16.0	11.6	
Insulin and oral medication	13.0	13.9	8.8	<0.001
Body Mass Index				
Normal	13.1	12.0	18.7	
Overweight	30.8	29.2	39.1	
Obese	43.3	44.5	36.9	
Grossly obese	12.8	14.4	5.3	<0.001
Health history				
Diabetic retinopathy	15.1	15.7	11.9	0.003
Diabetic nephropathy	11.4	12.1	7.8	<0.001
Diabetic peripheral neuropathy	17.9	18.6	14.1	0.001
Hypertension	70.0	72.3	58.4	<0.001
Congestive heart failure	10.5	11.5	4.9	<0.001
Coronary heart disease	20.9	21.8	16.4	<0.001
Peripheral vascular disease	10.1	10.9	5.9	<0.001

	Total sample	Poor physical functioning	Good physical functioning	P value
Charlson comorbidity index				
0 or 1	41.4	39.4	52.0	
2 or 3	42.8	43.7	38.2	
4 or more	15.8	16.9	9.8	<0.001

* Per United States population norms, PCS>50 is good physical functioning; PCS<50 is poor physical functioning.

Table 2

Association between poor self-reported physical functioning and mortality, TRIAD.

	Unadjusted		Adjusted*	
	HR (95% CI)	P value	HR (95% CI)	P value
All-cause mortality	1.85 (1.61, 2.12)	<0.001	1.37 (1.15, 1.63)	<0.001
Cardiovascular mortality	1.94 (1.56, 2.42)	<0.001	1.42 (1.06, 1.90)	0.02

Abbreviations: CI, confidence interval; HR, hazard ratio.

* Adjusted for age, sex, race/ethnicity, education, income, smoking, treatment for diabetes, body mass index, health histories, and Charlson Index.