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Lower Body Function as a Predictor of Mortality over 13 Years of Follow-Up: Findings from the Hispanic EPESE* , **

Sanggon Nam, PhD, MS¹, Soham Al Snih, MD, PhD^{2,3,4}, and Kyriakos Markides, PhD^{4,5}

¹ Department of Health Administration, Pfeiffer University, NC, USA

² Division of Rehabilitation Sciences, School of Health Professions, University of Texas Medical Branch, TX, USA

³ Division Geriatrics, Department of Internal Medicine, University of Texas Medical Branch, TX, USA

⁴ Sealy Center on Aging, University of Texas Medical Branch, TX, USA

⁵ Department of Preventive Medicine and Community Health, University of Texas Medical Branch, TX, USA

Abstract

Aim—The objective of this research is to investigate the effect of lower body function on mortality over 13 years of follow-up study.

Methods—Data from the Hispanic Established Population for the Epidemiological Study of the Elderly (Hispanic EPESE) were used, and the Cox proportional hazard model of mortality on age, gender, education, BMI, CES-D, MMSE, any ADL, walk score, and SPPB was applied.

Results—Results showed lower body function to be a strong predictor of mortality over 13 years, as indicated by walk and SPPB scores as well as any ADL, depression, and cognitive function. Moreover, overweight or obese participants tended to live significantly longer over the long term.

Conclusions—Lower body function significantly impacts mortality at 2, 7, and 13 years of follow-up study, but this association decreases in magnitude over time.

Keywords

ADL disability; Lower body function; Mortality; Older Mexican Americans; SPPB score; Walk score

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Corresponding Author: Sanggon Nam, Ph.D., M.S., Address: 2880 Slater Rd, Ste. 100, Morrisville, NC 27560. USA., Phone: 919-238-2401, Fax: 919-941-2920, sanggon.nam@pfeiffer.edu.

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Introduction

In seeking to explain why some older people retain higher levels of independence and well-being, lower body function is frequently mentioned in gerontology and geriatric studies as a primary predictor (1–3). Lower body function is highly associated with self-reported Activities of Daily Living (ADL) disability (4–7). Further, a relationship has been established between depression and institutionalization and diminished lower body function (8). Lower body function could also be a mortality predictor for older adults (8–12).

One lower body function measurement, walking speed, may be a better mortality predictor than ADLs (13). Moreover, some studies relying on the Established Populations for Epidemiologic Studies of the Elderly (EPSE) have found that a combination of lower body function and ADL disability better predicts mortality risk among community-dwelling older adults than either method alone (14). Thus, other researchers have concluded that self-reported measurements of lower body function focusing on walking speed are significant predictors not only of functional mobility, but also of overall functional mobility performance (15).

Although older Mexican Americans are a rapidly growing segment of the U.S population, with high rates of disability and longer life expectancy (11–13), few studies have considered lower body function as a predictor of mortality among older Mexican American adults. Although some research has examined the relationship between lower body function and mortality, few studies have focused on the older Hispanic population. Table 1 represents previous mortality research that considers lower body function (performance-based and self-rated assessments) with an emphasis on walking disability.

In their examination of self-reported ADL assessments, Markides and colleagues found that lower body function was associated with short-term mortality risk (2 years) among older Mexican Americans (11). Subsequently, an inverse relationship between walking speed and 7-year mortality was found among the older Hispanic population (12). Most of the research concerning lower body function and mortality risk covered a relatively short period (less than 10 years) due to a lack of well-established longitudinal survey data.

Although previous research has suggested that decreased lower body function is significantly associated with mortality in the older population (8–10), unknown indicators of mortality remain, from a long-term perspective, in the general older adult population. It is unclear whether lower body function will remain a predictor of mortality for periods of more than 10 years, and what other variables may predict long-term mortality.

The objective of this research is to investigate the effect of lower body function on mortality in older Mexican Americans across a 13-year follow-up. The primary research question is “Is lower body function a predictor of mortality among older Mexican Americans over 13 years of follow-up?” We hypothesize that lower body function (a short physical performance battery (SPPB), walk score and activities of daily living (ADL) limitations are mortality risk factors among older Mexican Americans over a study period encompassing 13 years. Further, by considering other variables, including depression, cognitive function, ADL, and BMI, we investigate which of these other factors may predict mortality over the longer term.

Methods

Study Population

Data from the baseline (1993–1994) to Wave 6 (2007) of the Hispanic Established Population for the Epidemiological Study of the Elderly (Hispanic EPESE) were used in the analysis. The Hispanic EPESE is a longitudinal study of 3,050 Mexican Americans aged 65 and over residing in southwestern states (Texas, New Mexico, Colorado, Arizona and California). Participants were sampled from these five southwestern states beginning in 1993 using area probability sampling procedures so as to be generalizeable to approximately 500,000 older Mexican Americans residing in the southwest (16). The baseline of the Hispanic EPESE data was collected from 1993–1994, and Wave 6 data were collected in 2007.

Measures

Measures included Body Mass Index (BMI), Activities of Daily Living (ADL) disability, Body Mass Index (BMI), the Center for Epidemiological Studies Depression Scale (CES-D), the Mini-Mental State Examination (MMSE), and socio-demographic information from the baseline. In addition, lower body function measurements included a performance-based assessment (SPPB), a walk score and self-reported measurements (any ADL).

Covariates—Socio-demographic variables included age (≤ 80 , 81–85, 86–90, and ≥ 91), gender, years of formal education (0–6, 7–11, and ≥ 12), and marital status (married = 1, not married/widowed/separated = 0). BMI was measured by dividing weight in kilograms by height in meters squared. BMI was categorized as underweight (< 18.5), normal weight (18.5–24.9), overweight (25–30), and obese (> 30) (17). The MMSE was used to measure cognitive function. Lower MMSE scores represent lower cognitive functioning or impairment (18). The cutoff of the MMSE is allocated based on national rates into the categories of probable dementia (MMSE < 24), possible cognitive impairment (24–26), and normal (28–30) (18). Cognitive impairment may be related to mobility impairment (13) and a high CES-D score could be associated with decreased functioning, given the strong relationship between mobility disability and depression (19). The standard cutoff score of 16 or greater indicates clinical depression risk (19).

Any ADL—There are 7 items comprising Activities of Daily Living (ADL) disability. “Any ADL” refers to four tasks related to lower body function (walking across a room, bathing, transferring from bed to chair, and using the toilet). Respondents who answered “unable to” or “needing help to perform” any of the four ADL items were categorized as having diminished lower body function.

Short Physical Performance Battery (SPPB)—The short physical performance battery (SPPB), a lower body function measure, is a hierarchical test that considers standing balance, short walk speed, and five repetitive chair stands. Each of these three tests is scored on a scale ranging from 0 (unable) to 4 (best performance). The SPPB score, the sum of scores on the three categories, ranged from 0 to 12 for each respondent, with higher scores indicating better lower body function. Respondents were divided into 4 categories based on

their SPPB score: 1 (scores 0 to 3), 2 (scores 4 to 6), 3 (scores 7 to 9), and 4 (scores 10 to 12).

Walking Speed—Participants were asked to walk 8 feet at a normal pace, with walking speed measured to the tenth of a second. Walking speed was divided into 5 categories: 0 (unable), 1 (< 9.0 seconds); 2 (6.0–8.9 seconds); 3 (4.0–5.9 seconds); and 4 (< 3.9 seconds).

Dependant Variable — Mortality—Vital information included the death data for the 3,050 older Mexican Americans in the study, as confirmed by the Social Security Administration's Death Master File. All sample participants (3,050) were alive at the baseline (1993–1994), and their mortality status was assessed after follow-up. A total of 2,129 research participants had died over 13 years of follow-up.

Statistical Analysis

The Statistical Analysis System (SAS: SAS Institute Inc., Cary, NC) version 9.2 was used in this analysis. The selected alpha level for statistical significance was 0.05. Descriptive statistics represented the major variables among the surviving sample distribution. Cox proportional hazard models were used to examine the hazard ratio of mortality risk by lower body function (SPPB and Any ADL) adjusting for age, sex, CES-D, and MMSE.

Hypotheses

We hypothesized that lower body function (a short physical performance battery (SPPB) and walking speed) would be a risk factor for mortality in older Mexican Americans over 13 years of follow-up. In addition, we hypothesized that over the long term, depression, cognitive function, any ADL, and BMI would also be significant predictors of mortality in this older population.

Results

Table 2 shows the characteristics of the survival sample of the Hispanic EPESE wave 6 (2007). Of the initial 3,050 participants in the baseline Hispanic EPESE (1993–1994), 921 (26.31%) were still alive after 13 years of follow-up.

Around half of the population was in the 81–85 age group. Approximately 27.9% were less than 80 years old and 8.14% were older than 91. Approximately 65% of the sample was women; 35% were men. Among participants, 62.8% were unmarried and 37.24% were married. Years of education and household income were quite low in the sample: Study participants who had less than 6 years education comprised around 73.20% of the total population. Regarding BMI, the normal (BMI: 18.5–25) and overweight (25–30) populations were similar in size at 36.42% and 36.80% of the total respectively. In addition, 23.65% of the population was obese (BMI more than 30) and 3.13% was underweight (BMI less than 18.5).

A total of 224 participants had CES-D scores ranging from 0–2 (27.59%), 195 had scores ranging from 3–7 (24.01%), 209 had scores ranging from 8–15 (25.74%), and 184 had scores ranging from 16–54 (22.66%), indicating some degree of depression. In terms of the

MMSE, more than 60% of participants had scores in the normal range, ranging from 0 to 23. Research participants with MMSE scores in the 24–27 range comprised 14.59 % of the sample, and those with MMSE scores in the 28–29 range comprised almost 25%. Of the total population, 51.96% had at least one problem in activities of daily living, while 48.04% participants had no limitations in activities of daily living.

On the walk score, 286 participants (32.91%) had a score of 0; 139 (16.00%) had a score of 1; 205 (23.59%) had a score of 2; 174 (20.92%) had a score of 3; and 65 (7.48%) had a score of 4. On the SPPB, 352 (39.60%) of participants scored in the 0–3 range, 195 (21.93%) in the 4–6 range, 220 (24.75%) in the 7–9 range, and 122 (13.72%) in the 10–12 range. In addition, 32 participants were missing SPPB score measurements.

Table 3 presents the Cox proportional hazard model of mortality considering the Hispanic EPESE data on age, gender, education, BMI, CES-D, MMSE, any ADL, walk score, and SPPB. Model 1 considered the SPPB score rather than walk score, while Model 2 focused on the walk score rather than the SPPB score to compare the potential of each as an explanation for mortality.

The values of hazard ratios for walk score and SPPB were significant indicators of 13-year mortality. Generally participants who were younger, female, more overweight or obese, or who had lower depressive symptoms, lower cognitive function, a lower walk score, or a higher SPPB score tended to have lower mortality.

Any ADL proved to be another primary explanation for mortality over the long term. Values of hazard ratios for any ADL were 1.52 for Model 1 and 1.85 for Model 2. Thus, participants with at least one ADL limitation tended to have higher mortality compared to those with no limitations. Severe depression (1.28 in Model 1 and 1.40 in Model 2) and low cognitive function (1.27 in Model 1 and 1.34 in Model 2) also showed much higher mortality. Overweight and obese participants showed much lower mortality than normal BMI people. As Table 2 shows, overweight participants lived longest, obese participants lived longer, and participants with normal BMI lived less long.

Figure 1 represents unadjusted survival curves for older Mexicans in the Hispanic EPESE by SPPB category score from 1993–1994 to 2007. This curve revealed a relationship of the categorical SPPB and the 13-year survival rate. A total of 52% of participants who scored in the 10–12 SPPB category (SPPB=1: yellow) were alive at the end of 13 years compared with 27% of those who scored in the 0–3 SPPB category (SPPB=4: black). This survival curve clearly indicates that better lower body function increases survival rate.

Discussion

This research examined the effect of lower body function on mortality among older Mexican Americans over a 13-year period. Previous research has suggested a significant association between lower body function and mortality in the general older population (8–10) as well as among older Mexican Americans (11–12), but has not contemplated mechanisms and indicators of mortality over the longer term. Short-term studies of the relationship between

lower body function and mortality have likewise shown self-reported assessments of any ADL (11) and walking speed (12) to be possible indicators of mortality.

Like previous 2-year and 7-year studies of mortality in older Mexican Americans (11–12), the present study clearly showed that lower body function remains a significant predictor of mortality over a 13-year period, based on participants' walk and SPPB scores. In addition, any ADL, depression, and cognitive function also emerged as indicators of long-term mortality risk. Moreover, compared to normal BMI people, overweight or obese participants tended to live significantly longer over a longer term of data collection. Importantly, this research has been the first long-term study of the association between lower body function and mortality. Lower body function significantly impacts mortality at 2, 7, and 13 years of follow-up, but the association decreases in magnitude over time.

Life expectancy has been steadily increasing among older adults over the past century. In 2010, the life expectancy in the United States was nearly 79 years, meaning 65-year-olds could expect to live around 14 more years (20). Thus, health care professionals and consumers would do well to discern long-term mortality predictors so as to make better decisions concerning their time, money, and successful aging. Moreover, in contemplating preventive medicine, determining long-term mortality risk factors could help adults live longer and healthier lives even from late middle age. As compared to the general population, Mexican Americans are living longer (a life expectancy of 81.6 years) than white (79.1 years) and black (75.5 years old) Americans (20), but older Mexican Americans are experiencing high rates of severe obesity, diabetes, and disability (21). Thus, these findings on significant predictors of mortality can assist medical researchers, clinicians, and policymakers in long-term planning to help older Mexican Americans remain healthy and free of disability, age successfully, and enjoy better quality of life (21).

This study was subject to several limitations. First, it did not examine survival effects. For a more precise analysis, participants who died within 2–3 years of the EPESE baseline should be removed from this mortality research, given that they may have died due to other, unknown reasons. Thus, their history could be less effective in identifying mortality risk.

Second, this study did not use time-varying covariates. As we expected, BMI, MMSE, CES-D, and other measurements changed from wave to wave of the Hispanic EPESE. This analysis did not consider sensitivity changes in measurements for each wave across more than 13 years. Such an approach could yield better and more precise outcomes.

In summary, this study found that better lower body function is related to increased survival over a 13-year follow-up period, but that this association decreases in magnitude over time. In addition, any ADL, MMSE, CES-D, and BMI remain predictors of mortality risk over the longer term among the older Hispanic population.

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Figure 1. Survival Curve for Older Mexicans by SPPB category score, Hispanic EPESE 1993-2007

Figure 1 represents unadjusted survival curves for older Mexicans in the Hispanic EPESE by SPPB category score from 1993–1994 to 2007. This curve revealed a relationship of the categorical SPPB and the 13-year survival rate. A total of 52% of participants who scored in the 10–12 SPPB category (SPPB=1: yellow) were alive at the end of 13 years compared with 27% of those who scored in the 0–3 SPPB category (SPPB=4: black). This survival curve clearly indicates that better lower body function increases survival rate.

Table 1

Mortality Research—Lower Body Function and ADL assessments

	Self reported	Performance-based	Results	Sample	Design	Analysis
Angel, Ostir, Frisco, & Markides, 2000	ADLs (Activities of Daily Living)	Walking speed	Those who were negatively concordant (OR=1.72), those who were optimistic (OR=1.14), and those with missing information (OR=1.14) experienced higher mortality using the concordance (reference= positively concordant).	H-EPESE	Longitudinal	Logistic Regression
Markides et al., 2001	ADLS	Walk score	The short walk alone was predictive of mortality, but the ADL measure was not a significant predictor of mortality in older Mexican Americans at 2 years.	H-EPESE	Longitudinal	Logistic Regression
Reuben, Keeler, Hayes et al., 2002	ADLs (Activities of Daily Living) A=independent in mobility and all ADLs; B=dependent in mobility and independent in all ADLs	Performance-based functional status was measured using the PPS (Palliative Performance Scale).	For participants with baseline self-reported levels of A or B, a higher PPS was significantly associated (all p<.005) with a lower risk for 1- and 4-year mortality (adjusted relative risks, .86 to .91 per PPS unit).	EPESE	Longitudinal	Logistic Regression
Ostir et al., 2007		Short physical performance battery (SPPB) & walking speed	This research indicated a linear association between continuous walking speed and mortality in older Mexican Americans at 7 years.	H-EPESE	Longitudinal	Survival Analysis
Cesari et al., 2009	Self-assessed health status (SAHS)	Walking speed	Participants reporting a 'poor' health status at the baseline were more likely to die compared to subjects reporting an 'excellent' health status, even after adjustment for potential confounders (HR=1.55). Participants with low walking speed (< 0.29 m/s; HR= 1.71) compared to participants with walking speed >0.81 m/s (reference group).	H-EPESE	Longitudinal	Survival Analysis

Table 2
Wave 6 Survival Descriptive Statistics of the Hispanic EPESE (N=921, 26.31% of baseline)

	N	% of 2007
AGE		
<=80	257	27.90
81-85	408	44.30
86-90	181	19.65
>=91	75	8.14
SEX		
Men	325	35.29
Women	596	64.71
MARITAL STATUS		
Married	343	37.24
Unmarried	578	62.76
EDUCATION		
0-6	672	73.20
7-11	150	16.34
>=12	96	10.46
BMI Missing = 122		
<18.5	25	3.13
18.5-25	291	36.42
25-30	294	36.80
>30	189	23.65
CES-D Missing = 109		
0-2	224	27.59
3-7	195	24.01
8-15	209	25.74
16-54	184	22.66
MMSE Missing = 64		
28-30	208	24.27
24-27	125	14.59
0-23	524	61.14
ANYADL		
Yes	478	51.96
No	442	48.04
WALK SCORE Missing = 52		
0	286	32.91
1	139	16.00
2	205	23.59

	N	% of 2007
3	174	20.02
4	65	7.48
SPPB	Missing = 32	
0-3	352	39.60
4-6	195	21.93
7-9	220	24.75
10-12	122	13.72

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Table 3
Cox Proportional Hazard Model of Mortality of the Hispanic EPESE (1993-2007, N=921)

	Model 1	Model2
	HAZARD RATIO (95% CI)	HAZARD RATIO (95% CI)
AGE		
<=80	1.00	1.00
81-85	2.021 *** (1.742 - 2.344)	2.111 *** (1.822 - 2.445)
86-90	2.394 *** (1.908 - 3.004)	2.629 *** (2.100 - 3.291)
>=91	3.256 *** (2.174 - 4.876)	3.409 *** (2.285 - 5.086)
SEX		
Men	1.00	1.00
Women	0.622 *** (0.559 - 0.692)	0.629 *** (0.565 - 0.700)
EDUCATION		
0-6	1.00	1.00
7-11	1.174 * (1.020 - 1.352)	1.199 * (1.041 - 1.381)
>=12	1.130 (0.934 - 1.368)	1.134 (0.939 - 1.370)
BMI		
<18.5	1.285 (0.925 - 1.784)	1.271 (0.918 - 1.758)
18.5-25	1.00	1.00
25-30	0.772 *** (0.681 - 0.875)	0.771 *** (0.681 - 0.874)
>30	0.735 *** (0.641 - 0.844)	0.749 *** (0.654 - 0.859)
CES-D		
0-2	1.00	1.00
3-7	1.029 (0.885 - 1.196)	1.056 (0.909 - 1.227)
8-15	1.208 * (1.039 - 1.405)	1.287 *** (1.109 - 1.494)
16-54	1.283 ** (1.096 - 1.502)	1.403 *** (1.201 - 1.637)
MMSE		
28-30	1.00	1.00
24-27	1.100 (0.956 - 1.264)	1.157 * (1.007 - 1.329)
0-23	1.271 *** (1.109 - 1.456)	1.338 *** (1.169 - 1.531)
ANYADL		
Yes	1.523 *** (1.267 - 1.832)	1.836 *** (1.553 - 2.172)
No	1.00	1.00
WALK SCORE		
0		2.165 *** (1.653 - 2.837)
1		1.852 *** (1.474 - 2.326)
2		1.548 *** (1.227 - 1.953)

	Model 1	Model2
	HAZARD RATIO (95% CI)	HAZARD RATIO (95% CI)
3		1.421 ** (1.130 - 1.787)
4		1.00
SPPB		
0-3	1.601 *** (1.319 - 1.945)	
4-6	1.599 *** (1.354 - 1.888)	
7-9	1.109 (0.953 - 1.291)	
10-12	1.00	

* P<.05

** P<.01

*** P<.001