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Physical Performance Trajectories and Mortality Among Older Mexican Americans

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Abstract

Background: We sought to identify distinct trajectory classes of physical performance in Mexican Americans aged 75 years and older and to examine whether these trajectories predict mortality.

Methods: We used four waves of Hispanic Established Populations for Epidemiologic Studies of the Elderly (H-EPESE) data for adults 75 years and older from 2004–2005 to 2013. Latent growth curve analysis was used to identify distinct trajectory classes. Multinomial logistic regression analysis was used to examine the association between baseline characteristics and the

newly constructed trajectories. Cox proportional hazards regression models examined the hazard of mortality as a function of Short Physical Performance Battery (SPPB) trajectories.

Results: The study follow-up period was approximately 9.5 years. One thousand four hundred and eleven adults were successfully classified into three (low-declining, high-declining, and high-stable) physical performance trajectory classes. Depressive symptoms (relative risk ratio = 1.94, 95% confidence interval [CI] = 1.17–3.22), diabetes (relative risk ratio = 2.44, 95% CI = 1.63–3.65), number of other comorbid health conditions (relative risk ratio = 1.40, 95% CI = 1.16–1.68), and obesity (relative risk ratio = 2.83, 95% CI = 1.67–4.80), increased the relative risk of classification into the low, relative to high-stable trajectory class. Male gender and foreign-born status significantly reduced risk of classification in the low-declining and high-declining trajectory classes. We observed a statistically significant association between low-declining (hazard ratio = 3.01, 95% CI = 2.34–3. 87) and high-declining (hazard ratio = 1.64, 95% CI = 1.32–2.03) trajectories and increased risk of mortality.

Conclusions: Differences in mortality across physical performance trajectory classes suggest that these physical performance classes represent differences in underlying disease progression, and thus differences in mortality risk among older Mexican Americans, which warrants additional research to better understand differential physical performance trajectories and their effects on morbidity and mortality in heterogeneous aging populations.

Keywords: Physical performance, Mortality, Older adults, Mexican American

According to the literature, high performance in objective measures of lower extremity capacity is associated with decreased risk of all-cause mortality in older adults (1–3). Several studies using physical performance measured at baseline only (3,4) have reported a significant association between physical performance scores and mortality. The use of baseline-only physical performance measures, however, presents a limitation as physical changes are reported to develop non-monotonically (5). Considerable heterogeneity in physical function over time has been observed (6–8), as physical performance scores may change through the years due to intraperson changes (9). Furthermore, baseline-only physical performance measures may result in misclassification of individuals who may exhibit low physical performance at the time of measurement due to short-term illness and injury, as having poor physical performance (10).

Repeated measures examining longitudinal physical performance, taking into account change over time (5), would allow for a better understanding of inter- and intra-individual lower body function trajectories and their effect on subsequent health outcomes and mortality. Few studies using repeated measures have examined the association between change over time in physical performance and mortality (9–12). This association was found to be significant in diverse populations of older adults (10–13).

Perera and colleagues using data pooled from multiple large cohorts reported that Hispanics had the weakest association between gait speed (measured at four time points in 1 year) and mortality, relative to non-Hispanic blacks and whites (14). Several longitudinal studies have

examined the relationship between lower body function and mortality in older Mexican Americans (4, 15, 16, 17). Two-, 7-, and 13-year studies using baseline physical performance as the predictor variable of interest found it to significantly predict both short- and long-term mortality (4, 15, 16, 17). To date however, there has not been any published research examining how physical performance measures might differentially change over time, and the predictive validity of such physical performance trajectories on mortality among older Mexican Americans. Some researchers have suggested that physical performance measures may be less predictive of mortality among the very old (75 years and older), who may exhibit less variation in physical functioning than their younger counterparts (16). Further, greater numbers of age-related clinical and subclinical conditions in the very old are postulated to modify the predictive value of physical performance measures (18). Research is therefore needed to better understand the patterns of decline and their ability to predict mortality in this particular subpopulation.

Consequently, we seek to address these gaps in knowledge through the examination of variations in patterns of physical performance over time and predictors of reduced physical performance, and assess how these might contribute to mortality risk in the very old. Identifying variations in patterns and predictors of reduced physical performance can facilitate clinical and public health interventions aimed at mitigating risk and consequences of decreased lower extremity functioning. The specific objectives of this study were to (a) identify distinct trajectory classes of physical performance as measured by the Short Physical Performance Battery (SPPB) in Mexican American adults aged 75 years and older and (b) to examine whether these trajectories were associated with an increased risk of mortality over a 9-year period. In addition, we were interested in identifying demographic and health-related factors associated with the likelihood of having a particular physical performance trajectory.

Methods and Data

We used data from the Hispanic Established Populations for Epidemiologic Studies of the Elderly (H-EPESE) cohort study. The H-EPESE is an ongoing longitudinal community-based study of older Mexican Americans residing in five southwestern states (Texas, California, Arizona, Colorado, and New Mexico), which was initiated in 1993/1994. An initial sample of 3,050 participants 65 years and older was enrolled in the study, with an additional sample of 902 (75 years or older at the time) added in Wave 5 (2004–2005). Participants were followed-up approximately every 2 or 3 years to Wave 8 (2012–2013). Exhaustive sampling procedures of the H-EPESE were previously described and are available elsewhere (19). Data collected during four observation periods from Wave 5 (2004–2005) to Wave 8 (2012–2013) were used for the current study. Using Wave 5 as the baseline enabled us to have a larger sample size of adults 75 years and older, with approximately 9 years of follow-up data.

Inclusion Criteria

At baseline, there were a total of 2,069 eligible participants aged 75 and older. The inclusion criteria for the current study required participants to have completed the baseline interview and have two or more waves with completed measures on SPPB, including an SPPB measure at

baseline. The final analytical sample included 1,411 participants. Proxy respondents were omitted as were those with missing data on covariates. Participants ranged in age from 75 to 109 years. The average participant contributed 3.1 waves of data.

Variables of Interest

The SPPB was used to identify trajectory classes of physical performance over time. The SPPB is based on three lower extremity tasks. Participants were tested on their standing balance (semi-tandem and side-by-side), gait (a timed 8-ft walk), and repeated timed chair stands. Gait and repeated chair stands were divided into quartiles each and scored 1 (slowest) to 4 (fastest). The standing balance test included three tasks: maintaining side-by-side, semi-tandem, and tandem positions for 10 seconds. Participants were scored (1) if they completed a side-by-side stand but were unable to complete a semi-tandem stand, (2) if they completed a semi-tandem stand but were unable to complete a full tandem stand for >2 seconds, (3) if they completed the full tandem stand for 3–9 seconds, and (4) if they completed a full tandem stand for 10 seconds. Participants unable to complete a task were assigned a value of 0. A performance score was created by summation of the scores for the tests with aggregate scores ranging from 0 to 12 for all three tests, and higher scores indicating better physical performance. This index has been shown to have predictive validity for incident disability and risk for mortality in the general population and among older Mexican Americans (2,4,20).

All-cause mortality was the secondary outcome of interest, which was determined by mortality linkages through the National Death Index, as well as from reports from next of kin. Follow-up time was calculated as the difference between the interview date in Wave 5 and most recent wave participation or date of death until December 31, 2013.

Additional baseline participant characteristics chosen based on their association with physical performance and mortality included age, sex, education, marital status (married, not married), nativity (foreign born, U.S. born), depressive symptoms as measured by the Center for Epidemiologic Studies Depression Scale (CES-D $\geq$ 16), cognitive functioning as measured by continuous Mini-Mental State Examination (MMSE) scores, body mass index (BMI) based on measured height and weight, and other comorbid health conditions (computed as a summed disease burden score of self-reported physician diagnosed hypertension, heart attack, heart failure, stroke, Parkinson's disease, Alzheimer's disease, hip fracture, other bone fracture). BMI was treated as an ordinal variable with four discrete categories according to the classification of the World Health Organization (21): underweight (<18.5 kg/m^2), normal weight (<25.0 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese ($\geq$30.0 kg/m^2). Missing BMI was treated as an unknown group.

Statistical Analysis

Descriptive analyses of the sample were summarized using means and *SD* for continuous variables and frequencies and percentages for categorical variables. Latent growth curve analysis that adjusted for the above-mentioned baseline characteristics was used to identify distinct trajectory classes and to describe the pattern of each latent trajectory by the estimated mean SPPB scores over the study waves. The growth curve models generate individual classes

(trajectories) that are based on estimates of person-specific intercepts (initial value) and slopes (rate of change) that describe intraindividual patterns of change in SPPB scores (22,23). Through latent growth curves analysis, we are able to (a) estimate the number and size of the trajectories, (b) assign latent trajectory membership to individuals in the population, and (c) estimate varying trajectory membership probabilities as a function of a set of covariates (ie, for each trajectory class the values of latent growth parameters can be influenced by covariates) (22,23). The appropriate and distinguishable number of trajectories was determined on the basis of three well-established criteria: Bayesian information criterion, the Bayesian information criterion log Bayes factor approximation, and entropy. For example, the Bayesian information criterion for two to four trajectory classes were as follows: 2 (−12,028.16); 3 (−11,766.09); and 4 (−11,783.07). Our analysis indicated that a three-class solution representing (a) low-declining, (b) high-declining, and (c) high-stable physical performance trajectory classes was the best fit for our data (Figure 1). It is undisputed that traditional methods that use only baseline data are a powerful tool in many research applications; however, literature examining different methodologies has demonstrated that when applied to the same data, growth models are characterized by higher levels of statistical power relative to comparable traditional approaches (24,25).

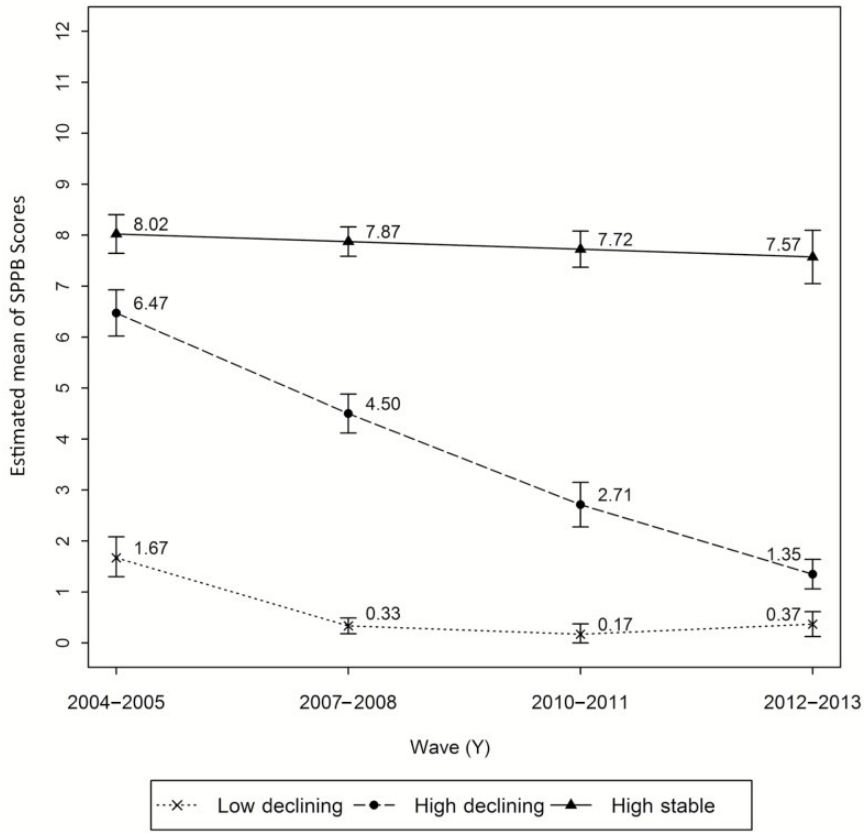

Figure 1. Estimated mean SPPB scores for each trajectory class, 2004–2013.

Multinomial logistic regression analysis for which we report relative risk ratios (RRR) and 95% confidence intervals (CI) was simultaneously employed to examine the association between participant baseline characteristics and the newly constructed trajectories. Diabetes and arthritis

were treated as independent covariates and thus were not included in the other comorbid health conditions variable, as both are strongly associated with physical performance (26).

To examine the hazard of mortality as a function of SPPB trajectories, we estimated Cox proportional hazards regression models that were adjusted for the above-mentioned baseline characteristics. Unadjusted Kaplan–Meier survival curves were used to assess and display the association between SPPB trajectories and mortality. To examine potential effect modification in the fully adjusted analyses, interactions between physical performance trajectory class and all covariates of interest were tested. The interaction between physical performance and foreign-born status was the only significant finding and is therefore the only one we present in the results and in Table 3.

Results

SPPB Trajectories

Three trajectory classes (low declining, high declining, and high stable) were identified using SPPB scores over four study waves. Figure 1 displays estimated mean SPPB scores for each trajectory class. The estimated mean SPPB score for the high-stable trajectory was approximately 8.0 over the study period. The estimated mean SPPB scores for the high-declining trajectory declined over the study period, from a mean score of 6.5 in 2004–2005 to 1.4 by 2013. The low-declining trajectory at baseline had a low estimated mean SPPB score of less than 1.0, which decreased to approximately 0.4 by the end of the study period.

Descriptive Baseline Participant Characteristics

Table 1 presents the baseline characteristics by the newly constructed physical performance trajectories. One thousand four hundred and eleven adults aged 75 and older were successfully classified into one of the three physical performance trajectory classes. The average age at baseline was 81.1 years. Women accounted for 63.6% of the sample; 44.4% of participants were married; and 29.6% had ≥7 years of education. Approximately 26% of participants were in the low-declining trajectory class, 35.9% were in the high-declining trajectory class, and 38.4% were in the high-stable trajectory class. Rates of participants in the high-stable trajectory were highest among those who were younger, male, married, and more educated (Table 1).

Table 1. Baseline Characteristics by SPPB Trajectory Classes

			SPPB Trajectory Classes						
	Total		Low Declining		High Declining		High Stable		
	n	%	n	%	n	%	n	%	
Baseline Characteristics	**1,411**		**363**	**25.73**	**506**	**35.86**	**542**	**38.41**	**p Value**
Age	81.10 ± 4.59		83.03 ± 5.62		81.45 ± 4.26		79.49 ± 3.39		<.01
Gender									
Female	897	63.57	267	73.55	335	66.21	295	54.43	<.01
Male	514	36.43	96	26.45	171	33.79	247	45.57	
Marital status									
Married	626	44.37	116	31.96	219	43.28	291	53.69	<.01
Not married	785	55.63	247	68.04	287	56.72	251	46.31	
Education									
<7 years	993	70.38	291	80.17	375	74.11	327	60.33	<.01
≥7 years	418	29.62	72	19.83	131	25.89	215	39.67	
BMI category									
Less weight	18	1.28	6	1.65	8	1.58	4	0.74	<.01
Normal weight	378	26.79	60	16.53	143	28.26	175	32.29	
Over weight	500	35.44	81	22.31	199	39.33	220	40.59	
Obesity	374	26.51	101	27.82	145	28.66	128	23.62	
Unknown	141	9.99	115	31.68	11	2.17	15	2.77	
Depressive symptoms									
No	1,157	82.00	253	69.70	416	82.21	488	90.04	<.01
Yes	254	18.00	110	30.30	90	17.79	54	9.96	
MMSE scores	22.23 ± 5.82		18.81 ± 6.97		22.42 ± 4.88		24.35 ± 4.61		<.01
Diabetes									
No	960	68.04	210	57.85	350	69.17	400	73.80	<.01
Yes	451	31.96	153	42.15	156	30.83	142	26.20	
Arthritis									
No	562	39.83	100	27.55	178	35.18	284	52.40	<.01
Yes	849	60.17	263	72.45	328	64.82	258	47.60	
Nativity									
U.S. born	794	56.27	195	53.72	294	58.10	305	56.27	.62
Foreign born	617	43.73	168	46.28	212	41.90	237	43.73	
Other comorbid health conditions	1.23 ± 1.03		1.58 ± 1.12		1.09 ± 0.98		1.11 ± 0.95		<.01
Hypertension									
No	529	37.65	121	33.61	215	42.66	193	35.67	.01
Yes	876	62.35	239	66.39	289	57.34	348	64.33	
Heart failure									
No	1,064	76.16	229	64.15	399	79.64	436	80.89	<.01
Yes	333	23.84	128	35.85	102	20.36	103	19.11	
Heart attack									
No	1,302	92.87	326	90.30	470	93.25	506	94.23	.07
Yes	100	7.13	35	9.70	34	6.75	31	5.77	
Stroke									
No	1,314	93.59	324	89.75	477	94.46	513	95.35	<.01
Yes	90	6.41	37	10.25	28	5.54	25	4.65	
Mortality									
No	979	69.38	122	33.61	281	55.53	394	72.69	<.01
Yes	614	43.52	241	66.39	225	44.47	148	27.31	

Note: BMI = body mass index; SPPB = Short Physical Performance Battery.

Association Between Baseline Participant Characteristics and Physical Performance Trajectories

Table 2 presents the multinomial logistic regression results predicting risk of trajectory class membership. Older participants were more likely to be in the low-declining or high-declining trajectory relative to the high-stable trajectory. In comparison to female participants, male participants had a reduced risk of being classified in the low-declining (RRR = 0.55, 95% CI = 0.35–0.86) or high-declining (RRR = 0.66, 95% CI = 0.46–0.94) trajectories over the study period. Foreign-born status reduced the risk of classification into the low-declining trajectory (RRR = 0.63, 95% CI = 0.42–0.95) or high-declining trajectory (RRR = 0.70, 95% CI = 0.50–0.99). High depressive symptoms, diabetes, higher number of other comorbid health conditions, and obesity (BMI ≥ 30) significantly increased the risk of classification in the low-declining trajectory class but not in the high-declining trajectory class. Arthritis significantly increased the risk of being in both a low-declining and high-declining trajectory class by over twofold.

Table 2. Association of Baseline Participant Characteristics With SPPB Trajectory Classes

	Low Declining*			High Declining*		
Baseline Characteristics	**RRR**	***p* Value**	**95% CI**	**RRR**	***p* Value**	**95% CI**
Age	1.25	<.01	1.19 1.32	1.15	<.01	1.09 1.20
Gender (ref.: female)						
Male	0.55	<.01	0.35 0.86	0.66	.02	0.46 0.94
Marital status (ref.: married)						
Not married	1.69	.02	1.10 2.60	1.06	.75	0.75 1.49
Education (ref.: ≥7 years)						
<7 years	1.73	.02	1.08 1.77	1.65	.01	1.13 2.42
Nativity (ref.: U.S. born)						
Foreign born	0.63	.03	0.42 0.95	0.70	.04	0.50 0.99
MMSE scores	0.85	<.01	0.81 0.88	0.92	<.01	0.89 0.96
Depressive symptoms (ref.: no)						
Yes	1.94	.01	1.17 3.22	1.51	.09	0.93 2.45
Diabetes (ref.: no)						
Yes	2.44	<.01	1.63 3.65	1.30	.14	0.91 1.84
Arthritis (ref.: no)						
Yes	2.61	<.01	1.73 3.92	2.04	<.01	1.46 2.84
Other comorbid health conditions	1.40	<.01	1.16 1.68	1.00	.97	0.84 1.18
BMI (ref.: normal weight)						
Underweight	4.69	.11	0.68 32.39	2.98	.18	0.61 14.61
Overweight	1.33	.28	0.79 2.22	1.22	.31	0.83 1.80
Obesity	2.83	<.01	1.67 4.80	1.45	.09	0.94 2.24

Note: BMI = body mass index; CI = confidence interval; MMSE = Mini-Mental State Examination; RRR = relative risk ratio. A BMI category for missing values was included. The results for missing category were not shown.

[a]High-stable physical performance was the referent group.

Mortality

The study follow-up period was approximately 9 years. Overall, the mean follow-up was 6.7 years, with 614 deaths ascertained during the study period. The unadjusted Kaplan–Meier curves (Figure 2) indicated the most favorable survival among participants in the high-stable trajectory and intermediate survival for those with a high-declining trajectory. Participants with a low-declining trajectory fared worst. The differences in survival between the groups were statistically significant (log-rank test, $p < .01$).

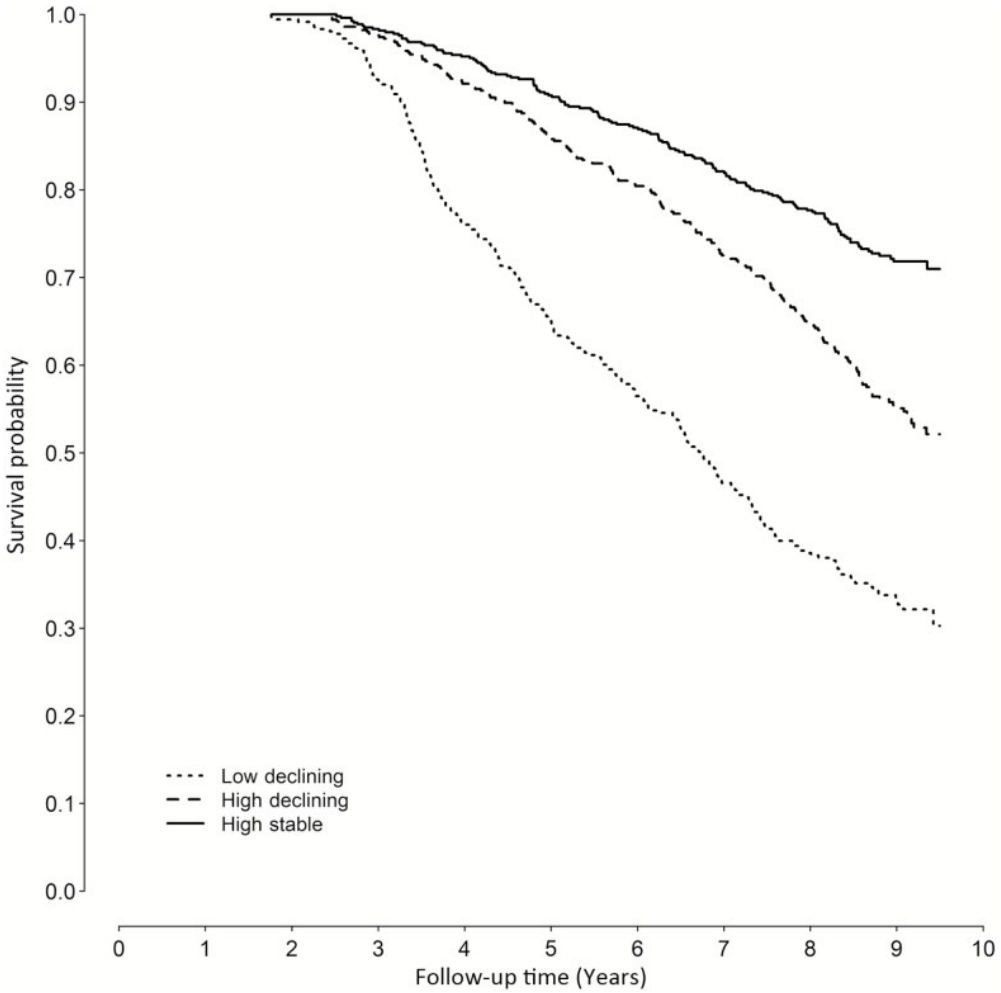

Figure 2. Kaplan–Meier survival curve according to trajectory classes of SPPB scores.

Table 3 shows the hazard ratios (HRs) for the association between physical performance trajectories and mortality. Model 1 presents the unadjusted HRs. Relative to the high-stable trajectory, the low-declining trajectory was associated with a HR of 3.65 (2.97–4.49) and high-declining trajectory was associated with a 78% increased risk of mortality. Model 2 was fully adjusted for all relevant covariates. Relative to the high-stable trajectory, the low-declining

trajectory was associated with a HR of 3.01 (95% CI = 2.34–3.87), whereas high-declining physical performance was associated with a 64% (95% CI = 1.32–2.03), higher risk of mortality. In the fully adjusted model, mortality risk was significantly greater among men, older participants, and participants with diabetes or heart failure. Foreign-born status and BMI in the overweight category were protective of mortality. Foreign-born status was an effect modifier as evidenced by the significant physical performance trajectory × foreign-born status interaction (p = .02). Our findings indicated that U.S.-born participants had a greater risk of mortality relative to foreign-born participants in the same trajectory class.

Table 3. Multivariable Regression Analysis Predicting Hazard of Mortality Over a 9.5-Year Period as a Function of Physical Performance Trajectory Class

	Model 1[a]			Model 2[a]			Model 3[a]		
Physical Performance Trajectory Class	**HR**	**95% CI**		**HR**	**95% CI**		**HR**	**95% CI**	
Low declining	3.65	2.97	4.49	3.01	2.34	3.87			
High declining	1.78	1.45	2.19	1.64	1.32	2.03			
Foreign born									
Low declining							2.65	1.87	3.75
High declining							1.14	0.81	1.59
U.S. born									
Low declining							3.30	2.42	4.49
High declining							2.07	1.57	2.74

Note: CI = confidence interval; BMI = body mass index; HR = hazard ratio. There was no violation of proportionality assumption assessed by the significance of a term of the predictor associated with the logarithm of survival time. Model 1 was unadjusted. Model 2 was fully adjusted for age, gender, marital status, education, nativity, cognitive functioning, depressive symptoms, diabetes, hypertension, heart failure, and BMI. Model 3 was fully adjusted and includes an interaction term of nativity and physical performance trajectory classes.

[a]High-stable physical performance was the referent group.

All tests of statistical significance were two sided with significance at $p \leq .05$. Analyses were performed with SAS version 9.4 (SAS Institute, Inc., Cary, NC).

Discussion

The current study builds on the current literature by assessing physical performance and mortality among older Mexican Americans (27). Using four waves of data (2004–2013) from the H-EPESE, we constructed physical performance trajectories and examined their association with mortality among Mexican Americans aged 75 and older. Our analysis produced three (low-

declining, high-declining, and high-stable) physical performance trajectory classes. The trajectories had vastly different intercepts and slopes that were statistically significant ($p < .05$). Those who were in the high-stable trajectory were generally in good health at baseline and did not show change over the study period. The high-declining trajectory showed the greatest change marked by a gradual decline, whereas those in the low-declining trajectory did not show marked decline or improvement over the study period. Greater risk of classification into low-declining and high-declining trajectory classes was among participants who were women, obese, or had other comorbid health conditions. Consistent with previous studies, foreign-born participants were more likely to be classified in the high-stable trajectory (28).

We observed a strong association between lower physical performance trajectories and mortality over a 9-year period. The association remained after adjusting for relevant covariates. These results are consistent with previous findings on the association of poor physical performance and adverse outcomes (27). Differences in mortality across trajectory classes suggest that these physical performance classes represent differences in underlying disease progression, and thus differences in mortality risk among older Mexican American adults. The findings point to important sociodemographic risk factors for lower physical capacity and increased risk of mortality. Lower levels of physical functioning and decreased lower extremity capacity may be useful indicators of mortality risk among older Mexican Americans (4).

We found that greater risk of poor physical performance in women relative to men was not paralleled with greater mortality risk. Previous research has shown that older women are at an increased risk of chronic conditions, declining physical performance and disability (29–32). Regardless of greater vulnerability to these conditions (29–31), and in particular lower physical performance in our analysis, women had a reduced risk of mortality relative to men. A survival disadvantage in elderly men has been previously reported (32,33), and the results we present here indicate that Mexican American women are living longer lives, but with poorer functional capacity.

The U.S. Mexican American population is heterogeneous in nativity, health, and functional capacity (34). We found that relative to U.S.-born Mexican Americans, foreign-born Mexican Americans were more likely to be classified into the high-stable trajectory class, and they were not at an increased risk of mortality. These findings corroborate previous research that found foreign-born individuals to have less mobility limitations (28) and a reduced risk of mortality when compared to their U.S.-born counterparts. Among those with a high-declining trajectory specifically, foreign-born status was protective of mortality, which may be partially explained by the "healthy immigrant effect." Older foreign-born Mexican Americans have a mortality advantage not observed among their U.S.-born counterparts (35), and previous research has demonstrated further differentials by gender and age of migration in physical performance and functional limitations in this subpopulation (27,34). Our results partially corroborate the nativity heterogeneity in physical performance trajectories among older U.S. Mexican Americans.

We readily acknowledge the limitations of this study. First, although the SPPB is objectively measured, most of the H-EPESE data on health outcomes are based on self-report which may be vulnerable to recall bias (36). Second, the use of composite scores for the study population limits ability to assess individual variability. The implication here is that the progression of physical

performance over the years for individuals classified within the same trajectory may differ despite belonging in the same trajectory class. In addition, trajectories may restrict generalizability to specific groups only. Despite these shortcomings, our findings are strengthened by use of a large, representative, longitudinal cohort of community-dwelling Mexican Americans residing in the southwestern United States.

As physical performance decreases with age and is associated with adverse health outcomes, it continues to be a public health burden among aging Mexican Americans. The findings of this study allow us to identify factors that are associated with decline, which can allow for more effective interventions that focus on maintaining or improving physical function in community-dwelling older adults. Based on these findings, interventions should not only focus on adults with poor physical functioning but also target older adults who have high physical performance scores, as they may be at risk of a steep decline over time. As noted in this research, physical decline increases the risk of mortality. Studies therefore need to continue to examine differential physical performance trajectories and their effects on morbidity and mortality. The research presented here and similar studies will increasingly become more important and hold significant implications for research, practice, and public health interventions.

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Conflict of Interest — None reported.

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