The role of physical activity and diabetes status as a moderator: functional disability among older Mexican Americans

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Abstract

**Purpose:** we investigate the temporal association between the rate of change in physical function and the rate of change in disability across four comparison groups: Those with and without diabetes who report >30 min of physical activity per day, and those who report <30 min of physical activity per day.

**Methods:** six waves of longitudinal data from the Hispanic Established Population for Epidemiologic Studies of the Elderly were utilised. At baseline, there were a total of 3,050 elder participants aged 65 years old or greater. The longitudinal rates of change in disability and physical function were compared by the diabetes status (ever versus none) and the physical activity status (less than or greater than or equal to 30 min per day).

**Results:** disability and physical function data were analysed using a latent growth curve modelling approach adjusted for relevant demographic/health-related covariates. There were statistically significant longitudinal declines in physical function and disability ($P < 0.001$) in all groups. Most notable, the physical activity status was an important moderator. Those with >30 min of activity demonstrated better baseline function and less disability as well as better temporal trajectories than those reporting <30 min of physical activity per day. Comparisons between diabetes statuses within the same physical activity groups showed worse disability trajectories among those with diabetes.

**Conclusions:** a longitudinal decline in physical function and disability is moderated most notably by physical activity. The diabetes status further moderates decline in function and disability over time. Increased physical activity appears to be protective of disability in general and may lessen the influence of diabetes-related disability in older Mexican Americans, particularly at the end of life.

**Keywords:** physical activity, diabetes, disability, Mexican Americans, ageing populations

Introduction

Functional disability, a key quality of life indicator among elderly [1] is defined as difficulty in performing basic activities of daily living (ADLs) and tasks needed for independent functioning in instrumental activities of daily living (IADLs) [2]. Forty percent of the elderly report at least one ADL limitation [3] and elderly Hispanics report greater numbers of disabilities compared with Non-Hispanic Whites, indicating a disparate burden [4].

Type 2 diabetes mellitus (DM) among elders has steadily increased, affecting nearly 20% over age 60. Those with DM are two to three times more likely to develop functional disability than those without DM [5] and more rapid functional declines noted among Mexican Americans [6]. Elders with diabetes are known to be less physically active [7]. Regular exercise among older people with diabetes lowers the risk of disability by 39% [8] and lack of regular physical activity has been shown to double the odds of functional disability [9].

Overall, the literature suggests that physical activity can reduce the progression of disability in older adults; however, few studies include follow-up periods longer than 6 years. Long-term effects of low-level physical activity on the progression of functional disability related to diabetes are not well understood among minority populations. The purpose of this study is to investigate the role of daily physical activity and DM as a moderator of a 10–12 year rate of change in functional disability. We investigate whether there are differential rates of change in functional disability by diabetes and physical activity statuses.

Methods

**Subjects**

Six waves of longitudinal data (1993–1994, $n = 3,050$; 1995–1996, $n = 2,438$; 1998–1999, $n = 1,980$; 2000–2001, $n = 1,682$; 2004–2005, $n = 1,166$ and 2008–2010, $n = 920$) from the Hispanic Established Population for Epidemiologic Studies of the Elderly (HEPESE) were used [10]. A total of 3,050 subjects residing in five southwestern states were recruited using area probability sampling procedures to represent the Mexican American elder population, with an 83% response rate. Our analytic sample for this study consisted of 2,166 individuals who completed the physical activity survey at the first follow-up. No statistical differences in percent diabetic or appreciable demographic differences were noted compared with the full baseline sample.

**Measures**

**Performance-oriented mobility assessment**

Three well-established, validated tasks were used: 10-foot timed walk, repeated chair stands and balance scores [11]. Scores for each measure were coded into four categories; 0 = inability to perform task, 1 = performs task moderately well, 2 = performs task OK, 3 = performs the task well and 4 = performs the task very well. These assessments were used as indicators in a latent measurement model of performance-oriented mobility assessment (POMA) at each wave. The latent POMA constructs were then used in a latent growth curve (LGC) model (described below) to
determine the rate of change in POMAs over the study period. This same method was used in a previously published report from this cohort [12].

Functional disability

Basic ADLs were assessed using the modified Katz Scale, [13]. IADLs were assessed using the modified OARS scale [14]. Respondents indicate whether they have difficulty performing common daily living tasks on a checklist. Endorsed items are counted and summed with a total of 10 for IADLs and 7 for ADLs. Higher values indicate more disability. These variables were used in an LGC model assessing the rate of change in disability across the study period.

Diabetes

A self-reported measure in response to the question: ‘Have you ever been told by a doctor that you have diabetes, sugar in your urine or high blood sugar?’ This was coded as 0 for no and 1 for yes only if they indicated that medication or insulin was being taken. Where possible, this was verified by asking participants to show the interviewers the medication during the intake session. We created a dichotomous variable representing the new incidence of diabetes over time. No indication of diabetes across the entire study period was coded as a 0. If respondents indicated that they had diabetes at any time during the study period they were coded as 1. This variable was used as part of the grouping variable distinguishing ever or never having diabetes. Self-reported diabetes is commonly used in epidemiologic studies and has been found to have high sensitivity and specificity in community-based studies [15].

Physical activity scale for the elderly

The physical activity scale for the elderly (PASE) assesses various leisure, household and other activities required in jobs or volunteer work. Measurements are in minutes per day. We coded <30 min as 0, and 30 min or more as 1. This was used as part of our grouping variable in conjunction with diabetes prevalence. The PASE is well validated instrument for the assessment of physical activity in epidemiologic studies [16]. PASE assessments were administered only at the first follow-up (n = 2166). Owing to the length of administration and since physical activity was not part of the original study design, PASE assessments were not included in subsequent follow-ups.

Model covariates

Model covariates included variables known to be associated with disability outcomes [17]. We controlled for age, gender, education, income, marital status, body mass index (BMI) based on measured height and weight [18], self-reported health, depression and cognitive status. Self-reported health was assessed using a four category response based on participants’ perception of their current health (1 = excellent, 2 = good, 3 = fair and 4 = poor) [19]. Depressive symptoms were ascertained using the Center for Epidemiologic Studies Depression Scale (CES-D) (higher scores indicate great depression) [20]; the cognitive status was assessed with the Mini-Mental Status Examination (scores under 24 indicating cognitive impairment) [21].

Analysis

POMAs, IADLS and ADLS were submitted to an LGC analysis, a well-documented strategy for assessing the rate of change in longitudinal data [22]. In this framework, the latent variables represent growth curve parameters describing the underlying pattern in the repeated measures. Two parameters are of primary interest; (i) the intercept representing the baseline values and (ii) the slope representing the rate of change. The fixed effect component estimates the average values of sample and the random effects estimate the variability around the average.

A multiple group analysis was performed to determine whether the rate of change in outcomes differed by the group status. The groups hypothesised to moderate the change trajectories were (i) <30 min a day of physical activity and no diabetes indicated (ii) ≥30 min of physical activity per day and diabetes is present (3) ≥30 min a day of physical activity and no diabetes indicated (4) ≥30 min of physical activity per day and diabetes is present.

The model fit was assessed using the Chi-square test, comparative fit index (CFI) and the root mean square error of approximation (RMSEA). Non-significant Chi-squares, or alternatively, CFI statistics over 0.95 or RMSEA statistics ≤0.05 identify models that provide a good model fit to the data [23]. The Amos Structural modelling software version 19 was used [24].

Missing data

Missing data are inherent in longitudinal research where loss to follow-up is often problematic. Analysing only cases with complete data needlessly degrades the final analytic sample, rendering reduced power and selection bias. Full information maximum likelihood (FIML) as implemented in AMOS [24] was used as a statistically sound alternative to eliminating subjects due to missing data and attrition. FIML is well-supported in the statistical literature and is currently one of the recommended state-of-the art procedures [25].

Results

Supplementary data available in Age and Ageing online (Appendix 1) present the descriptive statistics of the study variables in the entire sample. Twenty-three percent of participants reported having diabetes at baseline and 37% by the last follow-up. Approximately 60% reported fair to
poor health. Twenty-three percent report <30 min of general low-level activity per day. On average 49% of the participants reported having at least one IADL at baseline, increasing to 79% by the last follow-up. About 9% (8.6%) report at least one ADL at baseline, increasing to 52% by the last follow-up. A general decline in POMAS is noted over time.

Table 1 shows key demographic variables by the group status. Despite diabetes status; mortality, education and mental status among those with <30 min a day of physical activity was statistically poorer compared with those with >30 min of physical activity per day. Regardless of physical activity, BMI was higher among those with diabetes. A greater percentage report poor health among those with diabetes and low physical activity compared with all other groups. The results of the latent variable growth models are shown in Figures 1 and 2. The model fit for a non-linear model that includes a quadratic polynomial term was far better than a model of linear fit—indicating the necessity to account for non-linear trends in the data. The final adjusted models estimating the rate of change for IADLs, ADL and POMAS demonstrated the acceptable model fit: \( \chi^2 = 118 \) (df = 13), CFI = 0.95, RMSEA = 0.05; \( \chi^2 = 80 \) (df = 13), CFI = 0.94, RMSEA = 0.04; \( \chi^2 = 121 \) (df = 468), CFI = 0.93, RMSEA = 0.03, respectively. Statistical differences in the rate of change between groups were determined using a Chi-square difference test [23]. Figures 1 and 2 show the rate-of-change by group and which trajectories are significantly different from each other based on the Chi-square difference test. Intercept or baseline values for IADLs, ADL, and POMAS are significantly better among the groups reporting >30 min of physical activity compared with <30 min (\( P < 0.001 \)).

Although all groups experience significant increases in age-related disability over time (\( P < 0.001 \)), the disability trajectories among those with >30 min of physical activity were less steep. They not only begin at a lower prevalence rate, but they do not begin to show significant increases until the 4-year follow-up. The groups with <30 min of reported physical activity per day begin with more disability and immediately accumulate disabilities over time.

Within physical activity groups, the rates of change in disability are further affected by the diabetes status. Those with diabetes have steeper disability trajectories over time compared with non-diabetic persons within the same physical activity group. These differences are most pronounced at the later years of the study and show accelerated change. Comparing <30 min of physical activity per day with a history of diabetes (arguably the worst group), and >30 min of physical activity per day with no history of diabetes (arguably the best group), there is a significant difference of approximately three IADLs by the end of the follow-up period (Figure 1a).

The same general pattern can be seen for ADLs in Figure 1b. However, the only significant difference in trajectories was between the diabetes status of those reporting 30 or more minutes of physical activity per day. In that group, persons with diabetes had steeper accelerated trajectories despite their similar physical activity status. Given the diabetes status, those involved with >30 min of activity during the day, had better trajectories by the end of the study compared with those reporting <30 min.

Given a similar diabetes status, those with <30 min of physical activity had significantly greater declines in POMAs. Alternatively, those with >30 min of activity per day had significantly less rapid rates of decline (Figure 2).

### Table 1. Descriptive statistics by the physical activity and diabetes group status

<table>
<thead>
<tr>
<th>Less than 30 min of physical activity</th>
<th>Greater than 30 min of physical activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>No diabetes</td>
<td>Diabetes</td>
</tr>
<tr>
<td>(n = 281)</td>
<td>(n = 213)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mortality (%)</th>
<th>53.74a</th>
<th>57.75a</th>
<th>25.37b</th>
<th>28.28b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline age</td>
<td>76.9 (7.3)</td>
<td>74.13 (6.5)</td>
<td>72.18 (5.7)</td>
<td>70.6 (4.9)</td>
</tr>
<tr>
<td>Percent female</td>
<td>65.1</td>
<td>61.5</td>
<td>55.6</td>
<td>60.69</td>
</tr>
<tr>
<td>Highest grade of education</td>
<td>4.3 (3.7)a</td>
<td>4.0 (3.6)a</td>
<td>5.1 (3.8)b</td>
<td>5.33 (4.1)b</td>
</tr>
<tr>
<td>Percent married</td>
<td>45.2a</td>
<td>53.1b</td>
<td>57.3c</td>
<td>62.6c</td>
</tr>
<tr>
<td>Percent poor/fair education (%)</td>
<td>73.4a</td>
<td>81.0b</td>
<td>50.7c</td>
<td>64.9d</td>
</tr>
<tr>
<td>Percent income $\leq$10,000/year (%)</td>
<td>35.3a</td>
<td>41.2b</td>
<td>43.3b</td>
<td>49.24c</td>
</tr>
<tr>
<td>Body mass index</td>
<td>27.3 (5.4)a</td>
<td>29.4 (5.3)b</td>
<td>27.3 (4.8)a</td>
<td>29.1 (5.2)b</td>
</tr>
<tr>
<td>CES-D score</td>
<td>11.7 (9.7)a</td>
<td>12.3 (10.5)a</td>
<td>7.9 (8.6)b</td>
<td>9.06 (8.9)b</td>
</tr>
<tr>
<td>MMSE score</td>
<td>23.4 (4.6)a</td>
<td>24.3 (4.1)a</td>
<td>25.6 (3.8)b</td>
<td>25.7 (3.8)b</td>
</tr>
</tbody>
</table>

Notes: Comparisons with the same letter superscript are not significantly different. Those with different letters are significantly different at \( P < 0.05 \).

### Discussion

In older Mexican Americans, physical activity and diabetes status moderate the rate of decline in disability and physical function (POMA) over a 10–12-year period. Faster rates of decline are associated with individuals who reported <30 min of physical activity per day. However, given the same level of physical activity, the diabetes status accelerated that rate of decline relative to those who do not have diabetes. Similarly, given the same diabetes status, those who report <30 min of physical activity per day had a more rapid rate of decline relative to those who report >30 min of physical activity per day.

This study builds on other research showing an association between physical function and various disease outcomes [26, 27]. The prevention and treatment of functional disability related to diabetes in late life might be improved by increasing low levels of physical activity. The available evidence suggests that a rational exercise prescription for the prevention and treatment of disability should include the promotion of a physically active lifestyle and specific

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Figure 1. (a) Change in IADL between groups from baseline to the 10-year follow-up. (b) Change in ADL between groups from baseline to the 10-year follow-up. Note: $P$-values on graphs indicate significant trajectory differences between groups.

Figure 2. Change in POMAs between groups from baseline to the 10-year follow-up. Note: $P$-values on graphs indicate significant trajectory differences between groups.
exercises targeting aerobic capacity, strength and balance [28, 29]. However, there is not strong support that starting late-life exercise is an effective means of reducing disability [30]. The results of our study suggest that increased physical activity reported years earlier can reduce late-life disability.

Limitations
Since study participants were exclusively Mexican American, the results may not be generalisable to other elderly populations. Implementation of physical activity programmes in the community must consider not only who is at risk and the appropriate types of physical activity, but also the cultural and behavioural factors of the target population [30].

The use of self-report for the diabetes status may under represent the total number of participants who actually have the disease, this could potentially miss-identify more active diabetic seniors who prefer not to be labelled as diabetic or who have unknown disease symptoms. The study protocol asks respondents about taking diabetes medication and to validate the medication with visual inspection where possible. Indeed, 66 persons were excluded from the analysis who report having diabetes but were not taking medication.

Owing to administrative decisions, physical activity was included only during the first follow-up. We do not have information about changes in physical activity over time and how that relates to changes in disability. Despite this limitation, it is interesting that those who report a minimum of 30 min of physical activity per day at an earlier point in time demonstrate better disability profiles 10 years later. This suggests that earlier life activity may have lasting beneficial effects later. Given a range from 0 to 240 min of physical activity in this sample, we did not determine the optimal number of minutes that were associated with the best outcomes. Instead we determined a modest and reasonable amount of time to draw our comparisons. Future investigations will determine the association between the optimal numbers of minutes associated with the best outcomes.

Conclusions
Diabetes is a major cause of late-life disability among Mexican Americans age 65 and over. Our results indicate that modest physical activity (perhaps as little as 30 min a day) helps to slow long-term functional decline and disability, particularly among persons with diabetes. While questions remain about the optimal amount of physical activity and how public policy might implement physical activity programmes that work across a variety of situations and conditions specific to the elderly, modest physical activity among Mexican American elders may reduce the health cost and economic burden associated with functional decline and disability.

Key points
- Diabetes is a major cause of comorbidity among those Mexican Americans age 65 and over.
- Our results suggest that moderate (30 min/day) physical activity helps to slow a functional decline over time.
- Increased physical activity is protective of disability and may lessen disability in older Mexican Americans at the end of life.

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Supplementary data
Supplementary data mentioned in the text is available to subscribers in Age and Ageing online.

References


