Title

Accelerometer-Measured Latent Physical Activity Profiles and Neurocognition Among Middle-Aged and Older Hispanic/Latino Adults in the Hispanic Community Health Study/Study of Latinos (HCHS/SOL)

Journal

The Journals of Gerontology Series B, 77(12)

ISSN

1079-5014

Authors

Vásquez, Priscilla M
Tarraf, Wassim
Chai, Albert
et al.

Publication Date

2022-12-29

DOI

10.1093/geronb/gbac161

Peer reviewed

Journals of Gerontology: Social Sciences
cite as: *J Gerontol B Psychol Sci Soc Sci*, 2022, Vol. 77, No. 12, e263–e278
https://doi.org/10.1093/geronb/gbac161
Advance Access publication October 11, 2022

Special Section: Interdisciplinary Aging Research to Address Health Disparities in Alzheimer's Disease and Related Dementias

Accelerometer-Measured Latent Physical Activity Profiles and Neurocognition Among Middle-Aged and Older Hispanic/Latino Adults in the Hispanic Community Health Study/Study of Latinos (HCHS/SOL)

Priscilla M. Vásquez, PhD, MPH,[1] Wassim Tarraf, PhD,[2] Albert Chai, BS,[3] Adit Doza, PhD, MA,[2] Daniela Sotres-Alvarez, DrPh,[4] Keith M. Diaz, PhD,[5] Zvinka Z. Zlatar, PhD,[6] Ramon A. Durazo-Arvizu, PhD,[7] Linda C. Gallo, PhD,[8] Mayra L. Estrella, PhD, MPH,[9] Elizabeth Vásquez, DrPh, MPH,[10] Kelly R. Evenson, PhD,[11] Tasneem Khambaty, PhD,[12] Bharat Thyagarajan, MD, PhD, MPH,[13] Richard H. Singer, DMD, MS, PhD,[14] Neil Schneiderman, PhD,[15] Martha L. Daviglus, MD, PhD,[16] and Hector M. González, PhD[3,*]

[1]Department of Urban Public Health, Charles R. Drew University of Medicine and Science, Los Angeles, California, USA. [2]Institute of Gerontology and Department of Healthcare Services, Wayne State University, Detroit, Michigan, USA. [3]Department of Neuroscience, University of California San Diego, La Jolla, California, USA. [4]Collaborative Studies Coordinating Center, Department of Biostatistics, Gillings School of Global Public Health, University of North Carolina, Chapel Hill, North Carolina, USA. [5]Department of Medicine, Columbia University Medical Center, New York, New York, USA. [6]Department of Psychiatry, University of California San Diego, La Jolla, California, USA. [7]Department of Pediatrics, University of Southern California, Los Angeles, California, USA. [8]Department of Psychology, San Diego State University, San Diego, California, USA. [9]Epidemiology, Human Genetics and Environmental Sciences, School of Public Health, University of Texas Health Science Center at Houston, Houston, Texas, USA. [10]School of Public Health, University at Albany, State University of New York, Rensselaer, New York, USA. [11]Department of Epidemiology, Gillings School of Global Public Health, Chapel Hill, North Carolina, USA. [12]Department of Psychology, University of Maryland Baltimore County, Baltimore, Maryland, USA. [13]Department of Laboratory Medicine and Pathology, University of Minnesota, Minneapolis, Minnesota, USA. [14]Department of Oral Science and Translational Research, College of Dental Medicine, Nova Southeastern University, Ft. Lauderdale, Florida, USA. [15]Department of Psychology, University of Miami, Coral Gables, Florida, USA. [16]Institute for Minority Health Research, College of Medicine, University of Illinois at Chicago, Chicago, Illinois, USA.

*Address correspondence to: Priscilla M. Vásquez, PhD, MPH, Department of Urban Public Health, Charles R. Drew University of Medicine and Science, 1731 E. 120th Los Angeles, CA 90059-2518, USA. E-mail: priscillavasquez@cdrewu.edu

Received: November 7, 2021; Editorial Decision Date: October 3, 2022

Decision Editor: Jessica Kelley, PhD, FGSA

Abstract

Objectives: Derive latent profiles of accelerometry-measured moderate–vigorous physical activity (MVPA) for Hispanic/Latino adults, examine associations between latent MVPA profiles and neurocognition, and describe profiles via self-reported MVPA.
Methods: Complex survey design methods were applied to cross-sectional data from 7,672 adults ages 45–74 years in the Hispanic Community Health Study/Study of Latinos (HCHS/SOL; 2008–2011). MVPA was measured via hip-worn accelerometers. Latent profile analysis was applied to derive latent MVPA profiles (minutes/day of week). Neurocognition

Published by Oxford University Press on behalf of The Gerontological Society of America 2022.

was assessed with the Brief-Spanish English Verbal Learning Test (B-SEVLT) Sum, B-SEVLT Recall, Controlled Oral Word Association Test (word fluency), and Digit Symbol Substitution (DSS) test. All tests were *z*-scored, and a global neurocognition score was generated by averaging across scores. Survey linear regression models were used to examine associations between latent MVPA profiles and neurocognitive measures. Self-reported MVPA domains were estimated (occupational, transportation, and recreational) for each latent profile.

Results: Four latent MVPA profiles from the overall adult target population (18–74 years) were derived and putatively labeled: No MVPA, low, moderate, and high. Only the high MVPA profile (compared to moderate) was associated with lower global neurocognition. Sensitivity analyses using latent MVPA profiles with only participants aged 45–74 years showed similar profiles, but no associations between latent MVPA profiles and neurocognition. The occupational MVPA domain led in all latent MVPA profiles.

Discussion: We found no consistent evidence to link accelerometry-measured MVPA profiles to neurocognitive function. Research to better characterize the role of high occupational MVPA in relation to neurocognition among Hispanic/Latino adults are needed.

Keywords: Epidemiology, Latinos, Occupational activity

The Hispanic/Latino population has a long and diverse history in the United States which ranges from residing in the United States since its inception to recent immigrant families. Historically, this population has been excluded from health-related research. Emerging research inclusive of Hispanic/Latino populations demonstrate disparate health outcomes and a disproportionate burden of disease, specifically as it relates to neurocognitive aging, Alzheimer's disease and related dementias (ADRD). In the United States an estimated 1.1 million older Hispanic/Latino adults are projected to have AD by 2030, and this is expected to increase by 832% or 3.5 million by 2060, the largest projected growth relative to their racial/ethnic counterparts (Wu et al., 2016). Continued identification of risk and protective factors are warranted. Given the rapid aging of the Hispanic/Latino population, the burden of disease, and risk factors for ADRD there is an urgency to identify potential avenues for prevention and intervention.

The National Institute of Aging (NIA) has developed the NIA Health Disparities Research Framework, which delineates different levels of analysis for investigating health disparities in research and strive toward achieving health equity (Hill et al., 2015). Their framework includes fundamental factors (ethnicity, gender, age, race, disability status, and identity), the lifecourse perspective, and different levels of analysis, including the biological, behavioral, sociocultural, and environmental levels (Hill et al., 2015). The behavioral level of analysis includes health behaviors and specifically physical activity (PA; Hill et al., 2015). In addition, priority areas for NIA include developing research that targets and gains further insight on protective factors such as PA, prevention and interventions for ADRD, and health disparities on diverse older adults (NIA, n.d.).

PA is an established health behavior linked to sustained health across the life span (Pate et al., 2010; Report, 2018). Current evidence suggests benefits of PA extend to neurocognitive function and reduce the risk of developing ADRD (Erickson et al., 2019; Report, 2018). The possible mechanism for the link between PA and neurocognitive function, and ultimately ADRD, includes exercise as a modifiable factor that can reduce neuropathological damage and increase or maintain cognitive reserve, especially in later life (Livingston et al., 2020). In addition, a posited mechanism of PA on neurocognitive function has been the role of PA on cardiovascular health and inflammation, and the impact of cardiovascular health on neurocognitive function (Crichton et al., 2014). Exercise and PA at various intensities are linked with reducing neuropathological damage, via associations with diabetes, hypertension, obesity, and depression (Livingston et al., 2020; Rethorst et al., 2017; Vásquez et al., 2021). Most research in the stated areas have focused on highly educated non-Hispanic whites populations, and have neglected populations experiencing health disparities, specifically Hispanics/Latinos (Laurin et al., 2001; Lautenschlager et al., 2008; Report, 2018). Evidence to date on the association between PA and neurocognition among Hispanic/Latino adults is limited, and findings are inconsistent (Halloway et al., 2017; Ottenbacher et al., 2014; Piedra et al., 2017; Vásquez et al., 2017). Using accelerometer data, no associations were observed between moderate–vigorous PA (MVPA) and neurocognitive function in Hispanic/Latino adults (Vásquez et al., 2017). In contrast, light-intensity self-reported PA and accelerometer-measured MVPA were separately associated with less neurocognitive decline among Hispanic/Latino adults (Halloway et al., 2017). A walking intervention trial demonstrated participation in the program was associated with improved neurocognitive function in older Hispanic/Latino adults (Piedra et al., 2017). Similarly, engaging in greater self-reported PA was positively associated with neurocognitive functioning, specifically memory, but not other domains (Ottenbacher et al., 2014). Inconsistent findings across studies may be due to different measurements including various devices and self-reported measures, small sample sizes, and neurocognitive measures.

The 2008 United States Physical Activity Guideline Recommendations have focused on engaging in MVPA (HHS, 2008), in part, emphasizing aerobic activities where adults are in movement for a sustained period. Importantly, physically active occupations can count toward meeting the guidelines, as can active transportation (walking or bicycling). The PA guideline recommendations are to engage in at least 150 min a week of moderate-intensity, or 75 min a week of vigorous-intensity aerobic PA, or an equivalent combination of moderate- and vigorous-intensity aerobic activity. Aerobic activity should be performed preferably throughout the week (HHS, 2008). The recent 2018 United States Physical Activity Guideline Recommendations have affirmed these recommendations and included possible benefits to neurocognitive function (Report, 2018). This evidence has been largely based on self-reported MVPA, and non-Hispanic/Latino populations. Self-reported MVPA can be categorized into different domains of activity, including occupational, transportation, and recreational PA, and these domains have been associated with health outcomes (Report, 2018). Research conducted among Hispanic/Latino adults has shown benefits of PA on several health outcomes, with some notable exceptions (Mossavar-Rahmani et al., 2020; Murillo et al., 2016; Palta et al., 2015; Rethorst et al., 2017; Singer et al., 2016; Vásquez et al., 2019, 2021). PA at various intensities are negatively associated with depressive symptoms (Rethorst et al., 2017), obesity (Palta et al., 2015), sleep apnea (Murillo et al., 2016), health-related quality of life (Vásquez et al., 2019), and cardiovascular health indicators (Mossavar-Rahmani et al., 2020) but not hypertension (Vásquez et al., 2021). Alternatively, research demonstrates increasing occupational and total hours worked per week were associated with being overweight/obese among Hispanic/Latino adults (Singer et al., 2016). Studies have also found differences in PA engagement by domain for Hispanic/Latino adults, specifically more occupational and less recreational PA and evidence suggests qualitative differences by domain (Marquez et al., 2009). Overwhelmingly, the research shows the benefits of increased PA at the varying intensities and also evidence to address contextual factors such as workplace and workload as it relates to health.

Accelerometry is a device used to capture the intensity of PA engaged by the wearer. Accelerometry provides data on the intensity of PA, while self-reported MVPA captures PA behaviors and due to these differences, the results from these data sources are often discordant (de Moraes Ferrari et al., 2020). Accelerometers provide a measurement which to an extent, reduce reporting bias and social desirability bias as well as increase objectivity. Advances in the measurement of MVPA using accelerometry has led to innovative analytic approaches, specifically latent profile analysis. Latent profile analysis allows for a data-driven approach to determine patterns in activity by using daily MVPA per day of the week (Evenson et al., 2015, 2017). The use of latent profile analysis allows for the examination of the clustering of MVPA across each day of the week along with relevant demographic characteristics rather than using an overall averaged value of minutes per day spent in MVPA (Vásquez et al., 2017; von Rosen et al., 2020). Capturing latent MVPA profiles which incorporate values for each day of the week would be able to determine potential opportunities for PA interventions based on specific patterns. Previous work on latent MVPA profiles have related the profiles to cardiovascular health and mortality (Evenson et al., 2017; Metzger et al., 2010; von Rosen et al., 2020). Among middle-aged and older adults, the low active profile was positively associated with all-cause mortality, while no associations were observed with the average or high active profiles (von Rosen et al., 2020). Another study observed the more active profiles to be associated with lower odds for all metabolic syndrome risk factors (Metzger et al., 2010). Another study found the more active classes had a lower risk of mortality in middle-aged and older adults (Evenson et al., 2017). However, to the authors' knowledge, this research has not yet been completed in a well-characterized large and diverse cohort of Hispanic/Latino adults in the United States, a population which may have different profiles of MVPA based on evidence demonstrating a predominance of occupational and transportation-based PA, or latent MVPA profiles with neurocognition as an outcome (Evenson et al., 2015; Metzger et al., 2008). The Hispanic/Latino population has a different composition of MVPA, as demonstrated by previous research on types of MVPA relative to the overall U.S. adult population (Arredondo et al., 2016; Marquez et al., 2009). These types of PA are qualitatively different, such that investigation of MVPA profiles in this demographic (race/ethnicity and age) can provide insight on whether there are associations with neurocognition even in the context of potential different profiles of MVPA.

Specific to neurocognition, in the Hispanic Community Health Study/Study of Latinos (HCHS/SOL), investigators examined the association between meeting PA guideline recommendations per accelerometer-measured MVPA and neurocognitive measures, but observed no associations (Vásquez et al., 2017). The present study builds upon the previous study by using latent profile analysis with accelerometer-measured MVPA data. Latent MVPA profiles allow for a more nuanced and in-depth assessment of the accelerometry data to examine the distribution and create profiles of MVPA, adding to the previous summarized value of MVPA and examine whether one or more of the derived profiles are associated with neurocognitive function in middle-aged and older Hispanic/Latino adults (Vásquez et al., 2017). In addition, HCHS/SOL studies have observed several relevant demographic and health variables that may influence MVPA and neurocognitive function, such as age, educational attainment, annual household income (González et al., 2015), and depressive symptoms (Camacho et al., 2018). The first aim of the present study is to derive latent MVPA profiles with days of the week while accounting for important demographic and health indicators among Hispanic/Latino adults, an underrepresented population in studies regarding latent MVPA profiles and neurocognition. Second, to examine the association between the latent MVPA profiles and neurocognitive function in middle-aged and older Hispanic/Latino adults. We hypothesized that individuals in latent MVPA profiles with higher amounts of accelerometer-measured MVPA would be associated with better neurocognitive function compared to those in latent MVPA profiles with lower amounts of MVPA.

Methods

Data

Baseline data from the HCHS/SOL, a cohort study of Hispanic/Latino adults in the United States, were collected on years 2008–2011 and used for the present study. HCHS/SOL was implemented at four sites (Bronx, NY; Chicago, IL; Miami, FL; San Diego, CA) and recruited individuals ages 18–74 years who self-identified as Hispanic/Latino (N = 16,415). The design of the study included a two-stage probability sampling approach that oversampled adults 45–74 years of age. Detailed information regarding study design, sampling, and implementation has been reported (Lavange et al., 2010; Sorlie et al., 2010). Neurocognitive measures were administered to participants 45–74 years of age at baseline (N = 9,623). This study was approved by the institutional review boards at each institution. Informed consent was obtained, and all examinations were conducted in the preferred language (Spanish or English) for all participants (González et al., 2015).

Neurocognitive Function

The neurocognitive battery was administered by trained bilingual staff in the participants' preferred language (Spanish or English). The neurocognitive tests administered were the: (a) Brief-Spanish English Verbal Learning Test (B-SEVLT) Sum, (b) B-SEVLT Recall (González et al., 2001, 2002), (c) Controlled Oral Word Association (COWAT or word fluency [WF]; Benton & Hamscher, 1989; Lezak et al., 2004), and (d) Digit Symbol Substitution test (DSS; Wechsler, 1981). To reduce participant burden, the original SEVLT and WF were abbreviated. Higher scores on all tests represent better performance, the ranges of scores for each test on the original metric are provided in Supplementary Table 1. All tests were z-scored to the target population to facilitate effect comparisons across the estimated models. More detailed information on the HCHS/SOL neurocognitive assessments have been reported (González et al., 2015). A global neurocognition was generated by averaging across the z-scores of the individual tests. In addition to the derived global neurocognition score, we modeled the B-SEVLT Sum, B-SEVLT Recall, WF, and DSS independently to examine possible differential associations between MVPA and specific domains of neurocognitive function.

Physical Activity

Accelerometer-measured MVPA

Accelerometer-measured MVPA data were used for the latent MVPA profile analysis of the present study. HCHS/SOL used the Actical accelerometer device (model 198-0200-03; Minimiter Respironics, Bend, OR). Participants were fitted with a belt and instructed to wear the accelerometer on the belt for 7 days at the hip above the iliac crest, and to remove it only for swimming, showering, and sleeping. The accelerometer recorded the duration, frequency, and intensity of PA from participants. The present study focused solely on moderate–vigorous intensities in order to align with overall PA guideline recommendations (HHS, 2008; Report, 2018). The accelerometer-measured moderate–vigorous intensity cut point used was 1,535 or more counts per minute of the raw accelerometer data (Matthews et al., 2016). Nonwear time of accelerometers was defined as consecutive zero counts for at least 90 min, allowing for short time intervals with nonzero counts lasting up to 2 min if no counts were detected during both the 30 min upstream and downstream from that interval. Adherence to accelerometer-use was defined as having at least three wear days with a minimum of 10 hr per day (Colley & Tremblay, 2011). Previously reported using HCHS/SOL accelerometer data collected at baseline, 77% of participants were adherent to accelerometer-use (N = 12,750; Evenson et al., 2015). Importantly, there were some notable differences in accelerometer adherence where adherence was higher among participants who were married/partnered, first generation immigrants, male, older, employed/retired, by country of origin, preferred the Spanish language, had higher household income, lower sitting time, no stair limitations, higher occupational/lower recreational activity, and lower body mass index (Evenson et al., 2015). For the present study, the daily total minutes of accelerometer-measured MVPA per day of the week (e.g., Monday and Tuesday) with valid wear days (≥10 hr of wear) among HCHS/SOL participants 18–74 years old were used to derive the latent MVPA profiles described later (Analyses Section). The decision to include participants with adherent accelerometer data 18–74 years old allows for the opportunity to compare the derive latent MVPA profiles of the present study to existing studies on accelerometer-measured latent MVPA profiles with other populations (Evenson et al., 2015; Metzger et al., 2010). To account for bias due to missingness of accelerometer data, a sampling weight derived from inverse probability weighting was applied to the analyses described later (Analyses Section).

Self-reported MVPA

Self-reported MVPA data, which capture domains of MVPA, were used solely in post hoc analyses to further characterize the derived accelerometer-measured latent MVPA profiles. The Global Physical Activity Questionnaire (GPAQ) was administered by an interviewer to participants to capture minutes of PA engaged during a typical week for at least 10 min at a time. The domains captured were recreational MVPA, transportation-based moderate PA (MPA), and occupational MVPA. This questionnaire was both valid and reliable in capturing self-reported PA (Bull et al., 2009; Hoos et al., 2012). Recreational MVPA included sports, fitness, or recreational activities; transportation-based MPA included walking or bicycling as a usual means of travel; and occupational MVPA included activities during work such as heavy/light lifting, digging, climbing stairs, or brisk walking. Recreational MVPA, transportation-based MPA, and occupational MVPA were the variables used for the post hoc analyses described later (Analyses Section). More detailed information on PA in HCHS/SOL has been reported (Arredondo et al., 2016).

Potential Confounders

Analyses were adjusted for 10 potential confounders known to be associated with neurocognitive function and MVPA. The following measures were interviewer administered. Sociodemographic factors included were: (a) age in years, (b) sex (female and male), (c) education (less than high-school [HS], HS or equivalent, and more than HS), (d) annual household income (≤10K, >10–20k, >20–40k, >40–75k, 75k+, and unreported; the latter category was included to avoid missingness on this variable), (e) years residing in the United States (<10 years vs. 10+ years), (f) longest held occupation (nonskilled, service, skilled, professional/technical/administrative/executive/office staff, and "Other"; "other" includes farmer, driver, athlete, musician, and others), and (g) Hispanic/Latino background (Dominican, Central American, Cuban, Mexican, Puerto Rican, South American, and more than one background). Mental health factors included (h) depression symptoms (Centre for Epidemiologic Studies Depression Scale [CESD-10]) and (i) anxiety symptoms (State-Trait Anxiety Inventory [STAI-10]). Finally, we adjusted for (j) physical health using the 12-item Short Form Health Survey (SF-12) physical component subscale (PCS) questionnaire.

Analytic Sample

First, accelerometer-measured MVPA data from HCHS/SOL participants ages 18–74 years at baseline were used to derive latent MVPA profiles (described later). For the determination of accelerometer-measured latent MVPA profiles at baseline in HCHS/SOL (Unweighted *n* [U*n*] = 16,415), the present study excluded participants who did not complete accelerometry use (U*n* = 1,502), those who were nonadherent to the accelerometry protocol (*n* = 2,163), and were missing variables to derive the latent MVPA profiles (age [U*n* = 0], sex [U*n* = 0], education [U*n* = 26], and accelerometer wear time [U*n* = 0]), which yielded a sample size of U*n* = 12,724.

Second, for the analytic sample, data from participants 45–74 years were used (*n* = 7,929) to examine associations between latent MVPA profiles and neurocognition. We excluded participants without neurocognitive data (U*n* = 25) and those missing covariate data (U*n* = 232). The analytic sample size for examining the associations of accelerometer-measured latent MVPA profiles with the neurocognitive function was U*n* = 7,672.

Analyses

Latent profile analyses

Latent profile analyses (LPA) are a mixture modeling approach and person-focused classification technique that clusters individuals in heterogeneous populations into more homogenous groups (phenotypes) based on similarities in data patterns. LPA were applied on HCHS/SOL participants' daily MVPA accelerometer data to derive the latent MVPA profiles, which depict the MVPA pattern per day of the week for Hispanic/Latino adults (18–74 years; Arguelles et al., 2015; Finch & Bronk, 2011; Hagenaars & McCutcheon, 2002; Masyn, 2013). Variables that were used to derive the latent MVPA profiles along with the accelerometer data were age, sex, education, and accelerometer wear time of each individual participant because these factors are linked to recorded PA levels. The age, sex, and education variables were also used as covariates in the regression model to account for any residual confounding. Sequentially, models were fit with two through six MVPA profiles, starting with two profiles upward. Optimal fit and determination of the number of satisfactory profiles were based on an iterative process (increasing the number of profiles incrementally until the optimal fit was achieved) and used fit assessment criteria (Finch, 2015; Nylund et al., 2007). Specifically, Akaike Information Criteria, finite sample corrected Akaike Information Criteria (AICC), Bayesian Information Criteria (BIC), adjusted Bayesian Information Criteria (aBIC), and entropy were determined for each estimated solution (Supplementary Table 2). After deciding on the optimal profile solution, the lead investigators (P. M. Vásquez and W. Tarraf) assessed the overlap and differences in the lower number and higher number of latent profile solutions. All models were estimated using Maximum Likelihood with Robust Standard Errors to account for potential violations of normality assumptions in the observed indicators and to account for data missingness. In line with previous work, we fixed the within-profile variance of the (a) weekday and (b) weekend measurements to equality (Metzger et al., 2008, 2010). LPA models were fit using data from the entire HCHS/SOL cohort (age 18–74 years) who had adherent accelerometer data as specified earlier. Participants were classified into the profile with the highest posterior class membership probability. To note, the investigators attempted to derive latent MVPA profiles that incorporated both accelerometry and self-reported MVPA, however, the two data sources did not converge. Therefore, self-reported MVPA data were used in post hoc analyses to assess the MVPA domains of each derived accelerometer-measured latent MVPA profile (as described earlier).

Descriptive statistics

Descriptive statistics were generated to characterize middle-aged and older Hispanic/Latino adults by accelerometer-measured latent MVPA profiles. Chi-square tests were used to assess group differences in categorical variables and *t* tests for continuous variables.

Association between accelerometer-measured latent MVPA profiles and neurocognitive function

Linear regression models were used to examine the associations of the accelerometer-measured latent MVPA profiles with neurocognitive function. For each neurocognitive outcome, the following were tested: (a) unadjusted models, (b) models adjusted for age, sex, education, years in the United States, and Hispanic/Latino background, and (c) full-covariates adjusted models that additionally account for income, occupation, anxiety symptoms, depression symptoms, and SF-12 PCS score.

Post-hoc analyses

Average marginal estimates of neurocognitive function by latent MVPA profiles were calculated and plotted using post hoc ANOVA techniques. Finally, *t* tests were used to describe each of the accelerometer-measured latent MVPA profiles with the three domains of self-reported MVPA (recreational, transportation, and occupational PA).

Sensitivity analysis

Based on potential differences in MVPA in the 45+ years age group, we conducted a sensitivity analysis restricting the development of latent MVPA profiles to only HCHS/SOL participants between 45 and 74 years (as opposed to 18–74 years). All analytic steps described earlier were repeated based on this specific reclassification. Fit statistics, latent MVPA profiles, regression estimates (Supplementary Table 4, Supplementary Figure 2 and Supplemental Figure 3), and self-reported MVPA by latent MVPA profiles (Supplementary Table 6 and Supplemental Figure 4) are presented in Supplementary Materials.

All analyses accounted for the complex design of the HCHS/SOL, including selection probabilities, clustering, and stratification (Lavange et al., 2010; Sorlie et al., 2010). Latent profile techniques that accommodate complex design data were conducted in the MPLUS V8 software (Asparouhov, 2005; Asparouhov & Muthen, 2006, 2008; Muthen & Muthen, n.d.; Vermunt & Magidson, 2003). All other analyses were performed using Stata Statistical Software, Release 14 (StataCorp LP, College Station, TX).

Results

MVPA Profiles

We fit two to six class solutions for the accelerometer-measured latent MVPA profiles of daily MVPA. The four-profile solution, derived from the entire HCHS/SOL population, provided optimal fit determined by the attenuation in AIC and BIC decline relative to other profile solutions (Supplementary Table 2) and the best interpretability compared to the other profile solutions. Within the four-profile solution, one of the latent MVPA profiles aligned with the 2008 PA guideline recommendation of 30-min of MVPA per day. Within the five-profile solution, the two lowest MVPA profiles had a small 5-min difference per day. Thus, the four-profile solution was qualitatively the most informative (Supplementary Figure 1). The derived accelerometer-measured latent MVPA profiles were putatively labeled (a) no MVPA (14%), (b) low MVPA (34%), (c) moderate MVPA (43%), and (d) high MVPA (9%; Figure 1). For the analyses with neurocognition among HCHS/SOL participants 45–74 years, the latent MVPA profiles were as follows: (a) no MVPA (22.9%), (b) low MVPA (35.8%), (c) moderate MVPA (34.9%), and (d) high MVPA (6.4%; Table 1; Figure 1). For the overall latent MVPA profiles, the average MVPA was largely consistent per day of the week within each derived profile: slightly more than 90 min/day for the high MVPA profile, 30 min/day for the moderate MVPA profile, about 10 min/day for the low MVPA profile, and close to zero min/day for the no MVPA profile. The high, moderate, and low MVPA profiles had lower averages minutes of MVPA on the weekend days. The estimated daily MVPA averages for these profiles were consistent for both the overall population 18–74 year old population as well as the 45–74 year old population, with slight differences. Finally, the moderate MVPA profile was used as the referent category for analyses with neurocognition as it most resembled the 2008 PA guideline recommendations for the U.S. general population.

Descriptive Characteristics of the Target Population by Latent MVPA Profiles

We observed significant differences in the demographic, socioeconomic, and health characteristics across MVPA profiles (Table 1). Those within the no MVPA profile were more likely to be older, female, of Cuban background, and to have held a skilled occupation or other occupation. The no MVPA profile also had the highest reported average of depressive symptoms (CESD-10) and lowest physical health status (SF-12 PCS). Those within the low MVPA profile were more likely to be female, of Mexican background, and to have held a nonskilled occupation. The low MVPA profile had the second lowest physical health status, and the low MVPA and high MVPA profiles had a similar average of reported depressive symptoms. Those within the moderate MVPA profile were more likely to be male, of Mexican background, and to have held a skilled occupation. The moderate MVPA profiles had the lowest reported depressive symptoms and the second highest physical health status. Those within the high MVPA profile were more likely to be younger, male, of Mexican background, and to have held a nonskilled occupation or skilled occupation. The high MVPA profile had the best physical health status across the latent MVPA profiles. While there was a statistically significant difference in years residing in the United States across latent MVPA profiles, the participants resided in

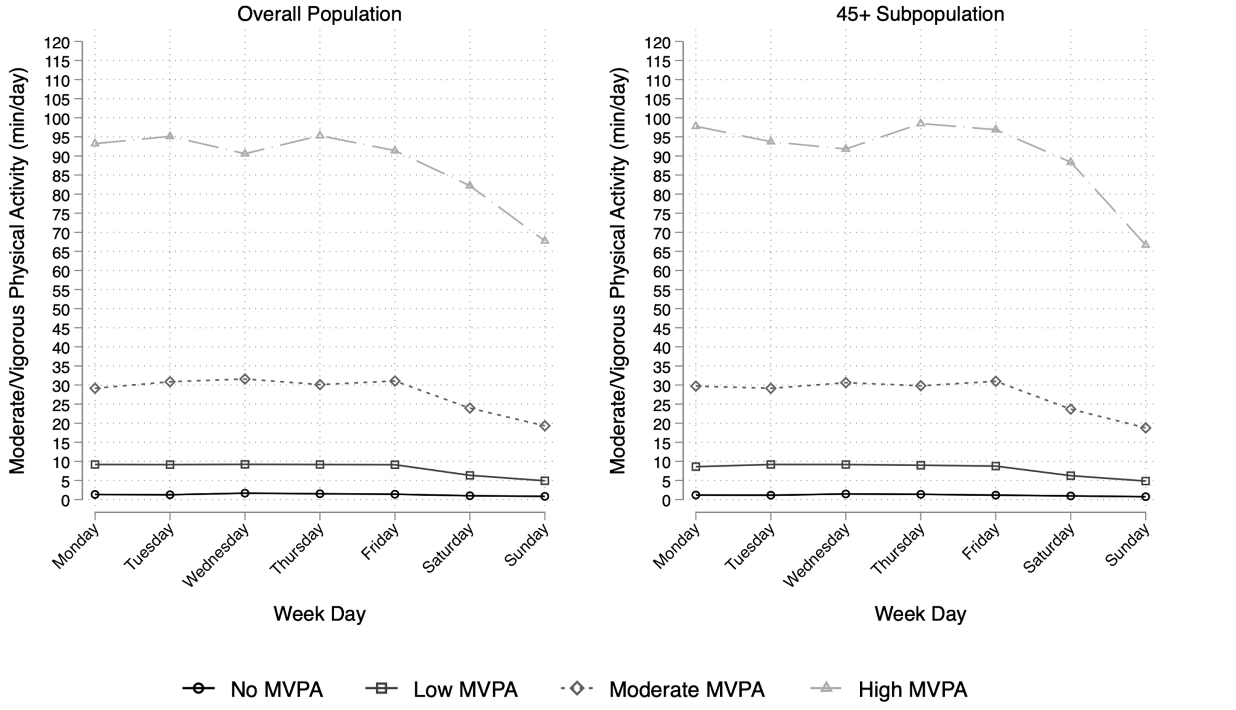

Figure 1. Minutes of accelerometer-measured MVPA each day of the week by the four latent MVPA profiles. MVPA = moderate–vigorous physical activity.

the United States for more than 10 years across all profiles. Group differences in education were largely nonsubstantive.

Associations of Accelerometer-Measured Latent MVPA Profiles With Neurocognition

Global neurocognition

In unadjusted models (model 1), compared to moderate MVPA profile, the no MVPA and high MVPA profile were associated with lower global neurocognition ($p < .05$, $p < .001$, respectively). In partially adjusted models (model 2), adjusting for age, sex, education, years in the United States, and Hispanic/Latino background, only the high MVPA profile was associated with lower (in *z*-score units) global neurocognitive function ($\beta_{GC} = -0.09$; standard error [*SE*] = 0.04; $p < .01$). This association was maintained in fully adjusted models after additionally controlling for income, occupation, and mental and physical health status (model 3, $\beta_{GC} = -0.07$; $SE = 0.03$; $p < .05$; Table 2, Figure 2).

B-SEVLT-Sum

In unadjusted models (model 1), compared to the moderate MVPA profile, the high MVPA profile was associated with a lower B-SEVLT-Sum score ($p < .01$), however, this association was no longer statistically significant upon adjustment to the additional covariates (model 2 and model 3).

B-SEVLT-Recall

In unadjusted (model 1) and partially adjusted (model 2) models, the high MVPA profile was associated will lower B-SEVLT-Recall scores. However, this association was attenuated in the fully adjusted model (model 3).

Word fluency (WF)

There were no observed associations of MVPA profiles and word fluency in unadjusted or adjusted models.

Digit symbol substitution test (DSS)

In the unadjusted model (model 1), the no MVPA profile was associated with a lower DSS score ($p < .001$). In partially adjusted model (model 2), the high MVPA profile was associated with a lower DDS score ($\beta_{DSS} = -0.09$; $SE = 0.04$; $p < .01$). However, in the fully adjusted model (model 3), this association was no longer statistically significant. Results are also presented with covariate coefficients in Supplementary Table 3a and b.

Post-hoc Analyses of Accelerometer-Measured Latent MVPA Profiles by Self-Reported MVPA

The average self-reported MVPA total time per day of engagement in occupational, recreational, or transportation-related MVPA are presented by accelerometer-measured latent MVPA profiles in Table 3 and Figure 3. There was a clear upper trend in the self-reported MVPA consistent with the corresponding accelerometer-measured latent MVPA profile. The domain with the highest amount of self-reported MVPA minutes per day was occupational MVPA followed by transportation MVPA. These findings were consistent for both the overall 18–74 year old population as well as the 45–74 year old population.

Table 1. Sociodemographic, Socioeconomic, and Health Characteristics of Hispanic/Latino Adults by Latent MVPA Profiles (N = 7,672); HCHS/SOL (2008–2011)

	No MVPA (n = 1,531)	Low MVPA (n = 2,869)	Moderate MVPA (n = 2,780)	High MVPA (n = 492)	Overall	p Value
	% (*SE*)	% (*SE*)	% (*SE*)	% (*SE*)	% (*SE*)	
Age						
45–49 years	14.83 (1.26)	25.37 (1.23)	30.23 (1.26)	32.39 (2.90)	25.10 (0.78)	<.001
50–59 years	33.59 (2.00)	40.16 (1.27)	42.02 (1.22)	43.37 (2.94)	39.51 (0.83)	
60–69 years	35.06 (1.82)	26.81 (1.30)	23.42 (1.17)	21.02 (2.84)	27.15 (0.81)	
70–74 years	16.53 (1.71)	7.65 (0.88)	4.33 (0.59)	3.23 (0.92)	8.25 (0.57)	
Sex						
Female	70.75 (1.59)	58.30 (1.38)	43.68 (1.29)	27.83 (2.84)	54.11 (0.76)	<.001
Male	29.25 (1.59)	41.70 (1.38)	56.32 (1.29)	72.17 (2.84)	45.89 (0.76)	
Hispanic/Latino background						
Central American	5.53 (0.65)	6.78 (0.65)	6.42 (0.58)	7.20 (1.94)	6.40 (0.43)	<.001
Cuban	40.45 (3.06)	29.28 (2.59)	15.50 (1.60)	11.00 (2.23)	25.86 (2.11)	
Dominican	5.39 (0.85)	8.13 (0.95)	13.54 (1.32)	12.93 (1.93)	9.69 (0.83)	
Mexican	29.13 (2.65)	32.73 (2.10)	35.73 (1.94)	32.35 (3.70)	32.93 (1.79)	
Puerto Rican	13.62 (1.44)	15.67 (1.18)	20.69 (1.50)	29.59 (2.93)	17.84 (1.02)	
South American	4.26 (0.60)	5.43 (0.54)	6.10 (0.58)	4.98 (1.27)	5.37 (0.38)	
More than one	1.63 (0.44)	1.98 (0.37)	2.02 (0.36)	1.95 (0.57)	1.91 (0.20)	
Education						
<High school/GED	42.62 (2.12)	38.30 (1.39)	40.22 (1.37)	39.80 (3.36)	40.06 (1.01)	.102
High school/GED	18.96 (1.43)	21.20 (1.14)	20.97 (1.04)	26.75 (2.74)	20.96 (0.72)	
>High school/GED	38.42 (1.94)	40.49 (1.42)	38.81 (1.36)	33.45 (2.95)	38.98 (0.92)	
Longest held occupation						
Nonskilled worker	19.28 (1.40)	24.10 (1.15)	26.53 (1.23)	27.99 (2.76)	24.09 (0.78)	<.001
Service worker	18.10 (1.46)	14.84 (0.96)	13.38 (0.93)	12.71 (2.52)	14.94 (0.63)	
Skilled worker	21.85 (1.94)	21.32 (1.01)	25.23 (1.28)	27.50 (2.73)	23.20 (0.80)	
Professional/technical, administrative/executive, or office staff	19.72 (1.58)	19.85 (1.23)	14.54 (1.08)	10.17 (1.70)	17.35 (0.77)	
Other	21.06 (1.61)	19.89 (1.11)	20.33 (1.36)	21.63 (2.64)	20.42 (0.76)	
Annual household income						
≤$10k	17.76 (1.42)	15.82 (1.07)	15.91 (1.03)	20.10 (3.06)	16.57 (0.72)	.017
>$10k–$20k	29.52 (1.75)	31.43 (1.34)	26.64 (1.30)	30.97 (2.70)	29.29 (0.86)	
>$20k–$40k	25.58 (1.67)	27.04 (1.09)	30.84 (1.29)	27.42 (2.52)	28.06 (0.79)	
>$40k–$75k	10.29 (1.19)	11.49 (0.96)	13.22 (1.01)	11.55 (2.19)	11.82 (0.66)	
More than $75k	4.86 (1.72)	4.96 (0.97)	6.59 (0.82)	4.35 (1.15)	5.47 (0.66)	
Not reported	11.98 (1.28)	9.26 (0.83)	6.79 (0.71)	5.61 (1.14)	8.79 (0.52)	
Years in the United States						
<10 years in United States	24.04 (1.78)	23.77 (1.49)	17.25 (1.13)	14.71 (2.14)	20.98 (1.01)	<.001
≥10 years in United States	75.96 (1.78)	76.23 (1.49)	82.75 (1.13)	85.29 (2.14)	79.02 (1.01)	
	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	p Value
Age in years	59.85 (9.70)	56.47 (10.16)	54.93 (9.39)	54.48 (9.06)	56.58 (10.03)	<.001
Years in the United States	24.67 (19.94)	24.62 (21.36)	26.57 (20.87)	27.82 (19.80)	25.52 (20.83)	<.001
Anxiety symptoms (STAI-10)	17.13 (6.90)	16.78 (7.31)	16.77 (7.22)	17.02 (6.86)	16.87 (7.17)	.34
Depressive symptoms (CESD-10)	8.10 (7.65)	7.37 (8.02)	6.77 (7.32)	7.07 (7.52)	7.31 (7.71)	<.001
Health status (SF-12)	43.76 (13.38)	47.07 (13.01)	48.77 (11.89)	49.20 (10.85)	47.04 (12.88)	<.001

Notes: HCHS = Hispanic Community Health Study; SOL = Study of Latinos; MVPA = moderate–vigorous physical activity; *SE* = standard error; *SD* = standard deviation; STAI = State-Trait Anxiety Inventory; CESD = Center for Epidemiologic Studies Depression scale; SF-12 = 12-item Short Form Health Survey. p Values are based on survey adjusted chi-square tests for categorical variables, and t tests for continuous measures.

Table 2. Associations Between Latent MVPA Profiles and Neurocognitive Function

	Model 1	Model 2	Model 3
	β (*SE*)	β (*SE*)	β (*SE*)
Latent MVPA profiles		Global neurocognition (*z*-score)	
No MVPA	−0.08* (0.03)	−0.02 (0.03)	−0.01 (0.03)
Low MVPA	0.02 (0.03)	0.01 (0.02)	0.02 (0.02)
Moderate MVPA	ref	ref	ref
High MVPA	−0.14*** (0.04)	−0.09** (0.04)	−0.07* (0.03)
Unweighted *N*	7,653	7,653	7,653
		B-SEVLT-Sum (*z*-score)	
No MVPA	−0.06 (0.04)	−0.02 (0.04)	0.00 (0.04)
Low MVPA	0.02 (0.03)	0.00 (0.03)	0.01 (0.03)
Moderate MVPA	ref	ref	ref
High MVPA	−0.15** (0.05)	−0.09 (0.05)	−0.07 (0.05)
Unweighted *N*	7,622	7,622	7,622
		B-SEVLT-Recall (*z*-score)	
No MVPA	−0.06 (0.04)	−0.02 (0.04)	−0.01 (0.04)
Low MVPA	0.03 (0.03)	0.00 (0.03)	0.01 (0.03)
Moderate MVPA	ref	ref	ref
High MVPA	−0.20** (0.06)	−0.14* (0.06)	−0.12 (0.06)
Unweighted *N*	7,629	7,629	7,629
		WF (*z*-score)	
No MVPA	−0.06 (0.04)	−0.00 (0.04)	0.00 (0.04)
Low MVPA	0.01 (0.03)	0.02 (0.03)	0.02 (0.03)
Moderate MVPA	ref	ref	ref
High MVPA	−0.08 (0.06)	−0.06 (0.05)	−0.04 (0.05)
Unweighted *N*	7,519	7,519	7,519
		DSS (*z*-score)	
No MVPA	−0.15*** (0.04)	−0.04 (0.03)	−0.04 (0.03)
Low MVPA	0.01 (0.03)	0.01 (0.02)	0.02 (0.02)
Moderate MVPA	ref	ref	ref
High MVPA	−0.10 (0.06)	−0.09* (0.04)	−0.05 (0.04)
Unweighted *N*	7,451	7,451	7,451

Notes: Model 1: unadjusted; Model 2: age, sex, education, years in the United States, and Hispanic/Latino background; Model 3: income, occupation, anxiety symptoms, depressive symptoms, and physical health status. β = coefficient estimate; *SE* = standard error; ref = Reference; MVPA = moderate–vigorous physical activity; B-SEVLT = Brief-Spanish English Verbal Learning Test; WF = word fluency; DSS = digit symbol substitution.
$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

Sensitivity Analysis on Latent MVPA Profiles Restricted to HCHS/SOL Participants 45–74 Years Old

When latent MVPA profile models were fit in the subpopulation 45–74 years old, fit statistics indicated that a similar four-profile solution provided good statistical and substantive fit to the data (Supplementary Table 4). The estimated profiles based on the solution were reflective of the ones generated in the primary analysis: (a) no MVPA (14.9%), (b) low MVPA (35.5%), (c) moderate MVPA (40.6%), and (d) high MVPA (9%; Supplementary Table 5 and Supplementary Figure 2). The primary difference was the under-classification of individuals 45–74 years in lower MVPA profiles compared to when the profiles were generated using a concordant age group. Supplementary Table 6 shows a cross tabulation of the classification of individuals 45–74 years based on profiles generated from the overall population versus the concordant 45–74 years. The descriptive characteristics using these sensitivity profiles are included in the Supplementary Table 5. Although the prevalence across profiles changed under the concordant classification, the overall differences across profiles, as discussed in the primary analysis, remained substantively unchanged.

Regression estimates from models fit to examine the association between age-concordant classification and neurocognitive function were also largely similar, with one notable difference (Supplementary Table 7). When age-concordant classifications are used the betas for the high MVPA profile (versus moderate MVPA) were not significant (Supplementary Table 7 and Supplementary Figure 3 for a plot of the average marginal estimates and confidence intervals). This suggests that calibrating classifications relative to a concordant age group is important in the context

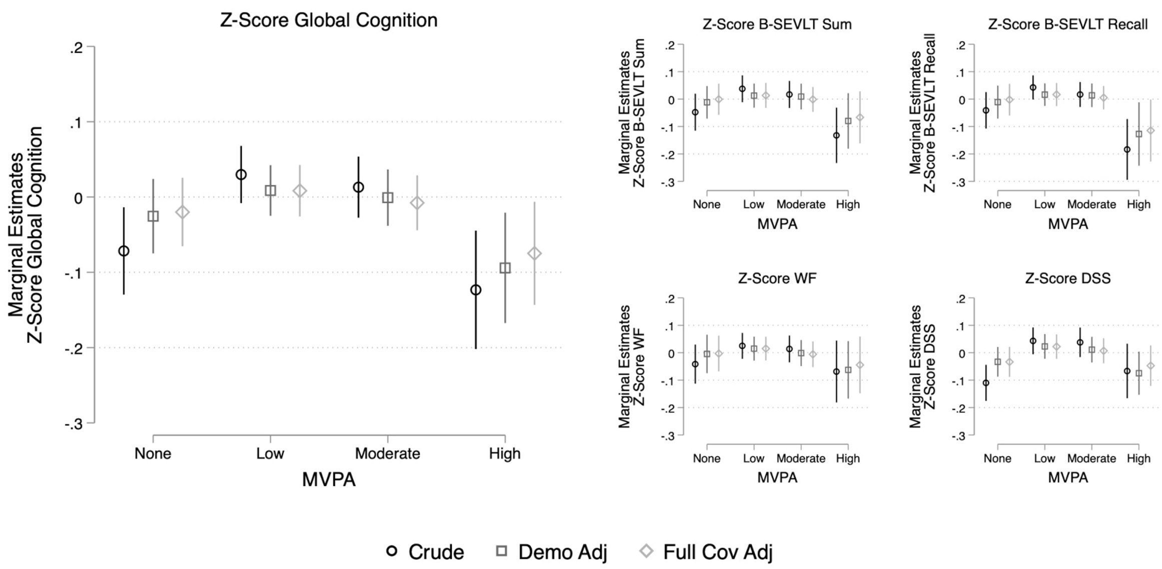

Figure 2. Neurocognitive performance (*z*-score) by latent MVPA profile. *Notes*: Partially adjusted: age, sex, education, years in the United States, and Hispanic/Latino background. Fully adjusted: demographics, annual household income, longest held occupation, anxiety symptoms, depressive symptoms, and physical health status. MVPA = moderate–vigorous physical activity; B-SEVLT = Brief-Spanish English Verbal Learning Test; WF = word fluency; DSS = digit symbol substitution.

Table 3. Average Self-Reported MVPA (GPAQ) Values for Different Domains by Latent MVPA Profiles

	No MVPA[a]	Low MVPA	Moderate MVPA	High MVPA	Total	*p* Value
	Mean (*SE*)	Mean (*SE*)	Mean (*SE*)	Mean (*SE*)	Mean (*SE*)	
Overall population[a]						
GPAQ work (min/day)	55.2 (5.1)	73.2 (3.5)	90.7 (3.8)	114.7 (8.6)	81.9 (2.5)	<.001
GPAQ recreational (min/day)	10.1 (1.2)	15.9 (1)	28.1 (1.2)	45.7 (3.6)	23 (0.8)	<.001
GPAQ transportation (min/day)	13.5 (1.2)	23.6 (1.4)	38.6 (2.4)	59.9 (5.1)	31.9 (1.3)	<.001
45+ subpopulation[a]						
GPAQ work (min/day)	46.2 (5.7)	56.3 (3.4)	75.2 (3.8)	92.5 (12.9)	63 (2.5)	<.001
GPAQ recreational (min/day)	7.6 (1.2)	9.2 (0.6)	17.9 (1.1)	23.4 (3.3)	12.8 (0.6)	<.001
GPAQ transportation (min/day)	14.1 (1.3)	25.6 (1.7)	37.3 (1.9)	62.2 (11.4)	29.5 (1.4)	<.001

Notes: *SE* = standard errors; MVPA = moderate–vigorous physical activity; GPAQ = global physical activity questionnaire.
[a]MVPA profile classifications generated using the overall HCHS/SOL population 18–74 years.

of health outcomes, particularly neurocognitive health. Self-reported MVPA per latent MVPA profiles are presented in Supplementary Table 8 and Supplementary Figure 4.

Discussion

Middle-aged and older Hispanic/Latino adults face current and future health disparities in neurocognitive health and ADRD. PA is an established lifecourse healthy behavior associated with reduced ADRD risk. Examination of the association of latent MVPA profiles and neurocognition can provide insight on potential avenues for prevention efforts to address neurocognitive function and ADRD. In our cross-sectional study, we observed four accelerometer-measured latent MVPA profiles among middle-aged and older Hispanic/Latino adults. The moderate MVPA profile closely resembled the minimum United States Physical Activity 2008 Guideline Recommendations of 30 min of MVPA for 5 days a week, which results in the overall recommended 150 min of MVPA per week (HHS, 2008). Surprisingly, we found that compared to a moderate MVPA profile, a high MVPA profile was associated with lower global neurocognition. In contrast, we observed no associations between latent MVPA profiles and individual neurocognitive measures. Those in the high MVPA profile, were more likely to be younger, male, of Mexican background, and to have held a nonskilled occupation or skilled occupation, and also had the highest self-reported physical health status score across the latent MVPA profiles.

The emergence of accelerometer-measured MVPA, combined with advanced statistical methods (e.g., latent profile analysis), has allowed for in-depth investigation of PA intensity in relation to health outcomes. For this study, we modeled Metzger et al., who derived accelerometer-measured

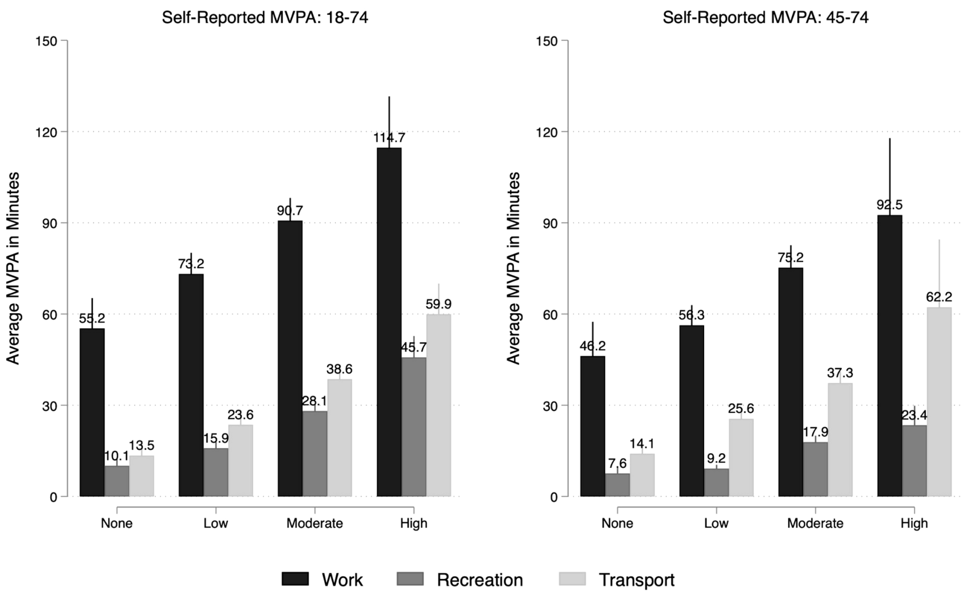

Figure 3. Average MVPA by domain of self-reported MVPA per accelerometer-measured latent MVPA profile. *Notes*: MVPA = moderate–vigorous physical activity; GPAQ = global physical activity questionnaire. *Reference Table 3 for average self-reported MVPA (GPAQ) values for different domains by latent MVPA profiles.

MVPA profiles using the nationally representative National Health and Nutrition Examination Survey (NHANES) data (Metzger et al., 2008, 2010). Mexican Americans were the Hispanic/Latino group primarily represented in the NHANES cycle data for the Metzger et al. analysis. The latent classes derived in Metzger et al. and prior studies and those derived in the present study were similar with the exception of the *weekend warrior* profile identification (Evenson et al., 2015; Jones et al., 2016; Metzger et al., 2008, 2010). The weekend warrior profile refers to participants who have relatively lower levels of MVPA during the week days but accumulate MVPA during the weekend days (Evenson et al., 2015; Jones et al., 2016; Metzger et al., 2008, 2010). While prior studies may be different in the devices used or cut points applied, such studies had higher overall MVPA minutes per day in the observed profiles, particularly in both the highest and lowest MVPA profiles (Evenson et al., 2016; Metzger et al., 2008, 2010). Importantly, in previous studies, at least *some* MVPA minutes were recorded for the study population, whereas in our study, 14% of Hispanic/Latino adults were in the no MVPA profile compared to the present study, where they averaged no MVPA on all days of the week (Evenson et al., 2016; Metzger et al., 2008, 2010). Overall, our findings still follow similar patterns found in previous research regarding the separation of the data into different profiles and maintained a defined average value of MVPA during each day of the week.

We utilized the self-reported domains of MVPA data to describe the accelerometer-measured MVPA profiles. Each accelerometer-measured MVPA profile had high levels of occupational followed by transportation-based MVPA, including the no MVPA profile. This finding aligns with previous research showing Hispanic/Latino adults attain more MVPA via occupational or transportation-based activity than recreational activity (Arredondo et al., 2016; Marquez et al., 2009). Many studies showed the lack of correlation between self-reported MVPA and accelerometer-measured MVPA, but the differences between the measures are an indication of the varied strengths and limitations of each measure (de Moraes Ferrari et al., 2020). The inclusion of self-reported MVPA in our study provides contextual information about the specific domains of PA present within our study population. Specifically, there may be a threshold of high MVPA via various occupations (nonskilled or skilled) that are physically demanding as well as additional factors within the work environments or circumstances that may be linked to neurocognitive function.

We observed among middle-aged and older Hispanic/Latino adults, the high MVPA profile, compared to moderate MVPA, was associated with lower global neurocognition. There were no associations between latent MVPA profiles and individual neurocognitive measures for the fully adjusted models. Potential reasons for the lack of association between latent MVPA profiles and neurocognitive measures are largely unknown but may be influenced by the nuances of self-reported MVPA that constitute each accelerometer-measured latent MVPA profile. Evidence suggests that domains of PA may be differentially associated with health outcomes (Engeroff et al., 2018). For instance, in previous studies moderate–vigorous leisure time PA was favorably associated with global neurocognitive function, executive function, memory, and maintaining neurocognitive function during old age

(Engeroff et al., 2018). Similarly, another study demonstrated higher levels of leisure time PA were associated with better scores in the Mini-Mental State Exam (MMSE; Willey et al., 2014). On the other hand, occupation-based PA has been associated with lower neurocognitive function, whereby engaging in more physically demanding occupations was associated with a lower neurocognitive function (Burzynska et al., 2020). Importantly, in understanding the qualitative differences between the domains of MVPA, questions remain. In occasions where individuals are engaging in high MVPA via occupation, what are the opportunities to either offset those potential negative effects and what would be the best alternative to mimic the beneficial effects of leisure time MVPA.

The high MVPA profile was characterized by socioeconomic factors that may influence the inverse association observed with neurocognition. The *lowest* percentage of Hispanic/Latino adults with >HS/GED education (33.45%), and the *highest* percentage of those among nonskilled (27.99%), skilled workers (27.50%), and "Other" occupations (21.63%), were observed in the high MVPA profile. Finally, the high MVPA profile had the highest percentage of those with an annual household income of less than $10,000 (20.10%) and the lowest percentage of those with an annual household income of more than $75,000 (4.35%). Still, while we controlled for some socioeconomic factors in the descriptive statistics annual household income and education were not significantly different across the profiles, and they likely do not capture entirely the effects of socioeconomic status in this study, thus more detailed socioeconomic variables may elucidate the effect on the association between MVPA and global neurocognition. In previous studies, lower socioeconomic status has been linked to lower neurocognitive function (Mungas et al., 2018; Shea et al., 2016; Zahodne et al., 2021). These socioeconomic factors are likely indicative of low control in the occupational environment, demanding both physically and mentally, and resulting in higher occupational stress. The role of stress is relevant in this study as higher stress has been associated with lower neurocognitive function, and the role of occupational stress specifically warrants further investigation (Marquine et al., 2021; Muñoz et al., 2021). Evidence to date has shown the impact of multilevel factors that can influence neurocognitive function and health, as well as the role of lifecourse exposures (i.e., educational quality). A person's occupation and the amount of MVPA required by their occupation may reflect their life experience and together may have a cumulative impact on neurocognitive health, as well as an immediate impact by over exacerbation via the amount of MVPA under potentially stressful conditions.

Although, the results of our study conflict with previous findings on the positive effects of engaging in MVPA, they highlight the importance of considering the *context* in which MVPA is performed. As Hispanic/Latino adults in our study accumulated MVPA mostly from engaging in occupational and transportation-based activities, a deeper understanding of the context in which MVPA is amassed can increase our understanding of the inverse association with global neurocognition for the Hispanic/Latino population. Further research is needed to clarify the association between latent MVPA profiles and the contextual factors that are involved in the types of MVPA community-dwelling middle-aged and older Hispanic/Latino adults engage in throughout their daily life. Finally, based on the sensitivity analysis with the derived accelerometer-measured latent MVPA profiles solely on participants ages 45–74 years, we observed no associations with neurocognition. This presents an added layer of complexity and question on the recommended best practices for middle-aged and older Hispanic/Latino adults and latent MVPA profiles.

Strengths of our study include the large and diverse cohort of middle-aged and older Hispanic/Latino adults. Additionally, we used accelerometer-measured MVPA and latent profile analysis to derive profiles of MVPA for Hispanic/Latino adults in the United States. Moreover, we examined four neurocognitive tests and a derived global neurocognitive measure. Limitations include the cross-sectional design, such that we cannot determine temporality or causation. Additionally, we attempted to use both accelerometer-measured MVPA and self-reported MVPA to derive the latent MVPA profiles, however, these measures were not correlated such that the models did not converge; therefore, we were unable to utilize both measures for the latent MVPA profiles. We used several neurocognitive measures; however, these do not capture all the possible domains for consideration. This study is not nationally representative; thus, the findings are not generalizable to all middle-aged and older Hispanic/Latino adults in the United States. We recognize that Hispanic/Latino adults are not a homogenous group, and there are critical differences that exist by background groups, nativity, and sex. Given the importance of these stratifications, more thorough research is needed to validate our as well as others' findings across these characteristics and include longitudinal measures of MVPA and neurocognitive function.

The overall health benefits of engaging in MVPA are well-established, but there is a need to develop tailored recommendations and approaches to target individuals in a manner that reflects their everyday context. Our study focused on middle-aged and older Hispanic/Latino adults, their latent MVPA profiles, and how the latent MVPA profiles were associated with neurocognition. The inverse association between the high MVPA profile and neurocognition, while counterintuitive, points to the need to further examine the accompanying contextual factors that may be contributing to neurocognition among middle-aged and older Hispanic/Latino adults. Further characterization of the high MVPA profile and a better understanding of the underlying mechanism for neurocognition are needed.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

Funding

P. M. Vásquez is currently supported by National Institute on Minority Health and Health Disparities of the National Institutes of Health under award number S21 MD000103. P. M. Vásquez was supported by National Institute on Aging of the National Institutes of Health (R01AG048642) and the San Diego Alzheimer's Disease Resource Center for advancing Minority Aging Research at the University of California San Diego (P30AG059299 National Institute on Aging), and the T32 Integrated Cardiovascular Disease Epidemiology Fellowship 5T32HL079891-13. W. Tarraf and H. M. González were supported by National Institute on Aging of the National Institutes of Health (R01AG048642 and R56AG048642). M. L. Estrella was supported by a Diversity Supplement from the NIH—National Heart, Lung, and Blood Institute for the Hispanic Community Health Study/Study of Latinos Chicago Field Center (75N92019D00012). Content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

The Hispanic Community Health Study/Study of Latinos is a collaborative study supported by contracts from the NHLBI to the University of North Carolina (HHSN268201300001I/N01-HC-65233), University of Miami (HHSN268201300004I/N01-HC-65234), Albert Einstein College of Medicine (HHSN268201300002I/N01-HC-65235), University of Illinois at Chicago—HHSN268201300003I/N01-HC-65236 Northwestern University), and San Diego State University (HHSN268201300005I/N01-HC-65237). The following Institutes/Centers/Offices have contributed to HCHS/SOL through a transfer of funds to the NHBLI: National Institute on Minority Health and Health Disparities, National Institute on Deafness and Other Communication Disorders, National Institute of Dental and Craniofacial Research, National Institute of Diabetes and Digestive and Kidney Diseases, National Institute of Neurological Disorders and Stroke, NIH Institution-Office of Dietary Supplements.

Conflict of Interest

None declared.

Acknowledgments

The authors thank the participants and staff of Hispanic Community Health Study/Study of Latinos for their important contributions. The study website is https://sites.cscc.unc.edu/hchs/.

Author Contributions

P. M. Vásquez in collaboration with W. Tarraf, H. M. González, and R. A. Durazo-Arvizu developed the research question. P. M. Vásquez worked with W. Tarraf, A. Chai, and A. Doza who conducted all analyses in collaboration with D. Sotres-Alvarez. P. M. Vásquez and W. Tarraf prepared the manuscript with the necessary changes based on coauthors feedback, and finalized the manuscript. R. A. Durazo-Arvizu, D. Sotres-Alvarez, K. M. Diaz, and K. R. Evenson were provide instrumental insight in the statistical analysis stage. H. M. González and Z. Z. Zlatar provided instrumental support in the development of the manuscript. L. C. Gallo, M. L. Estrella, E. Vásquez, T. Khambaty, B. Thyagarajan, R. H. Singer, N. Schneiderman, and M. L. Daviglus provided feedback on the manuscript that allowed for the finalization of this research.

References

Arguelles, W., Llabre, M., Sacco, R. L., Penedo, F. J., Carnethon, M., Gallo, L. C., Lee, D. J., Catellier, D. J., González, H. M., Holub, C., Loehr, L. R., Soliman, E. Z., & Schneiderman, N. (2015). Characterization of metabolic syndrome among diverse Hispanics/Latinos living in the United States: Latent class analysis from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL). *International Journal of Cardiology*, **184**(1), 373–379. doi:10.1016/j.ijcard.2015.02.100

Arredondo, E. M., Sotres-Alvarez, D., Stoutenberg, M., Davis, S. M., Crespo, N. C., Carnethon, M. R., Castañeda, S. F., Isasi, C. R., Espinoza, R. A., Daviglus, M. L., Perez, L. G., & Evenson, K. R. (2016). Physical Activity Levels in U.S. Latino/Hispanic Adults. *American Journal of Preventive Medicine*, **50**(4), 500–508. doi:10.1016/j.amepre.2015.08.029

Asparouhov, T. (2005). Sampling weights in latent variable modeling. *Structural Equation Modeling: A Multidisciplinary Journal*, **12**(3), 411–434. doi:10.1207/s15328007sem1203_4

Asparouhov, T., & Muthen, B. (2006). Comparison of estimation methods for complex survey data analysis. *Mplus Web Notes*, 1–13.

Asparouhov, T., & Muthen, B. (2008). Pearson and log-likelihood chi-square test of fit for latent class analysis estimated with complex samples. Mplus users' guide, technical appendix. Los Angeles, CA: Muthén & Muthén. Retrieved from. http://www.statmodel.com/download/Chi2Complex4.pdf.

Benton, A. L., & Hamscher, K. (1989). *Multilingual aphasia examination manual*. AJA Associates.

Bull, F., Maslin, T., & Armstrong, T. (2009). Global physical activity questionnaire (GPAQ): Nine country reliability and validity study. *Journal of Physical Activity and Health*, **6**(6), 790–804. doi:10.1123/jpah.6.6.790

Burzynska, A. Z., Ganster, D. C., Fanning, J., Salerno, E. A., Gothe, N. P., Voss, M. W., McAuley, E., & Kramer, A. F. (2020). Occupational physical stress is negatively associated with hippocampal volume and memory in older adults. *Frontiers in Human Neuroscience*, **14**(July), 1–9. doi:10.3389/fnhum.2020.00266

Camacho, A., Tarraf, W., Jimenez, D. E., Gallo, L. C., Gonzalez, P., Kaplan, R. C., Lamar, M., Khambaty, T., Thragarajan, B., Perreira, K. M., Hernandez, R., Cai, J., Daviglus, M. L., Wassertheil-Smoller, S., & Gonzalez, H. M. (2018). Anxious-Depression and Neurocognition among middle-aged and older Hispanic/Latino adults: Hispanic Community Health Study/Study of Latinos (HCHS/SOL) Results. *American Journal of Geriatric Psychiatry*, **26**(2), 238–249. doi:10.1016/j.jagp.2017.06.002

Colley, R., & Tremblay, M. (2011). Moderate and vigorous physical activity intensity cut-points for the Actical accelerometer. *Journal of Sports Sciences*, **29**(8), 783–789. doi:10.1080/02640414.2011.557744

Crichton, G. E., Elias, M. F., Davey, A., & Alkerwi, A. (2014). Cardiovascular health and cognitive function: The Maine-Syracuse Longitudinal Study. *PLoS One*, **9**(3), 1–9. doi:10.1371/journal.pone.0089317

de Moraes Ferrari, G. L., Kovalskys, I., Fisberg, M., Gómez, G., Rigotti, A., Sanabria, L. Y. C., Yépez García, M. C., Torres, R. G. P., Herrera-Cuenca, M., Zimberg, I. Z., Guajardo, V., Pratt, M., Pires, C. A. M., Colley, R. C., Solé, D., Fisberg, M., Kovalskys, I., Salas, G. G., Rigotti, A., … de Moraes Ferrari, G. L. (2020). Comparison of self-report versus accelerometer—Measured physical activity and sedentary behaviors and their association with body composition in Latin American countries. *PLoS ONE*, **15**(4), 1–15. doi:10.1371/journal.pone.0232420

Engeroff, T., Ingmann, T., & Banzer, W. (2018). Physical activity throughout the adult life span and domain-specific cognitive function in old age: A systematic review of cross-sectional and longitudinal data. *Sports Medicine*, **48**(6), 1405–1436. doi:10.1007/s40279-018-0920-6

Erickson, K. I., Hillman, C., Stillman, C. M., Ballard, R. M., Bloodgood, B., Conroy, D. E., Macko, R., Marquez, D. X., Petruzzello, S. J., & Powell, K. E. (2019). Physical activity, cognition, and brain outcomes: A review of the 2018 physical activity guidelines. *Medicine and Science in Sports and Exercise*, **51**(6), 1242–1251. doi:10.1249/MSS.0000000000001936

Evenson, K. R., Herring, A. H., & Wen, F. (2017). Accelerometry-assessed latent class patterns of physical activity and sedentary behavior with mortality. *American Journal of Preventive Medicine*, **52**(2), 135–143. doi:10.1016/j.amepre.2016.10.033

Evenson, K. R., Sotres-Alvarez, D., Deng, Y., Marshall, S. J., Isasi, C. R., Esliger, D. W., & Davis, S. (2015). Accelerometer adherence and performance in a cohort study of US hispanic adults. *Medicine and Science in Sports and Exercise*, **47**(4), 725–734. doi:10.1249/MSS.0000000000000478

Evenson, K. R., Wen, F., Metzger, J. S., & Herring, A. (2015). Physical activity and sedentary behavior patterns using accelerometry from a national sample of United States adults. *International Journal of Behavioral Nutrition and Physical Activity*, **12**(20), 1–13. doi:10.1186/s12966-015-0183-7

Finch, H. (2015). A comparison of statistics for assessing model invariance in latent class analysis. *Open Journal of Statistics*, **5**(April), 191–210. doi:10.4236/ojs.2015.53022

Finch, W. H., & Bronk, K. C. (2011). Conducting confirmatory latent class analysis using Mplus. *Structural Equation Modeling*, **18**(1), 132–151. doi:10.1080/10705511.2011.532732

González, H. M., Mungas, D., & Haan, M. N. (2002). A verbal learning and memory test for English- and Spanish-speaking older Mexican-American adults. *Clinical Neuropsychologist*, **16**(4), 439–451. doi:10.1076/clin.16.4.439.13908

González, H. M., Mungas, D. M., Reed, B. R., Marshall, S., & Haan, M. N. (2001). A new verbal learning and memory test for English- and Spanish-speaking older people. *Journal of the International Neuropsychological Society*, **7**(5), 544–555. doi:10.1017/s1355617701755026

González, H. M., Tarraf, W., Gouskova, N., Gallo, L. C., Penedo, F. J., Davis, S. M., Lipton, R. B., Argüelles, W., Choca, J. P., Catellier, D. J., & Mosley, T. H. (2015). Neurocognitive function among middle-aged and older Hispanic/Latinos: Results from the Hispanic Community Health Study/Study of Latinos. *Archives of Clinical Neuropsychology*, **30**(1), 68–77. doi:10.1093/arclin/acu066

Hagenaars, J. A., & McCutcheon, A. L. (2002). *Applied latent class analysis models*. Cambridge University Press. doi:10.1017/CBO9780511499531

Halloway, S., Wilbur, J., Schoeny, M. E., & Barnes, L. L. (2017). The relation between physical activity and cognitive change in older latinos. *Biological Research for Nursing*, **19**(5), 538–548. doi:10.1177/1099800417715115

HHS. (2008). *2008 Physical activity guidelines for Americans* (A. B. Rodgers [ed.]). U.S. Department of Health and Human Services. http://health.gov/paguidelines/pdf/paguide.pdf

Hill, C. V., Pérez-Stable, E. J., Anderson, N. A., & Bernard, M. A. (2015). The National Institute on Aging health disparities research framework. *Ethnicity and Disease*, **25**(3), 245–254. doi:10.18865/ed.25.3.245

Hoos, T., Espinoza, N., Marshall, S., & Arredondo, E. (2012). Validity of the Global Physical Activity Questionnaire (GPAQ) in adult Latinas. *Journal of Physical Activity and Health*, **9**(5), 698–705. doi:10.1123/jpah.9.5.698

Jones, S. A., Wen, F., Herring, A. H., & Evenson, K. R. (2016). Correlates of US adult physical activity and sedentary behavior patterns. *Journal of Science and Medicine in Sport*, **19**(12), 1020–1027. doi:10.1016/j.jsams.2016.03.009

Laurin, D., Verreault, R., Lindsay, J., MacPherson, K., & R, K. (2001). Physical activity and risk of cognitive impairment and dementia in elderly persons. *Archives of Neurology*, **58**, 498–504. doi:10.1001/archneur.58.3.498

Lautenschlager, N. T., Cox, K. L., Flicker, L., Foster, J. K., Van Bockxmeer, F. M., Xiao, J, Greenop, K.R., & Almeida, O.P. (2008). Effect of physical activity on cognitive function in older adults at risk for Alzheimer disease. *JAMA*, **300**(9), 1027–1037. doi:10.1001/jama.300.9.1027

Lavange, L., Kalsbeek, W., Sorlie, P., Aviles-Santa, L., Kaplan, R., Barnhart, J., Liu, K., Giachello, A., Lee, D. J., Ryan, J., Criqui, M. H., & Elder, J. P. (2010). Sample design and cohort selection in the Hispanic Community Health Study/Study of Latinos. *Annals of Epidemiology*, **20**(8), 642–649. doi:10.1016/j.annepidem.2010.05.006

Lezak, M., Howieson, D. B., & Loring, D. W. (2004). *Neurological assessment*. Oxford University Press.

Livingston, G., Huntley, J., Sommerlad, A., Ames, D., Ballard, C., Banerjee, S., Brayne, C., Burns, A., Cohen-Mansfield, J., Cooper, C., Costafreda, S. G., Dias, A., Fox, N., Gitlin, L. N., Howard, R., Kales, H. C., Kivimäki, M., Larson, E. B., Ogunniyi, A., … Mukadam, N. (2020). Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. *Lancet*, **396**(10248), 413–446. doi:10.1016/S0140-6736(20)30367-6

Marquez, D. X., Neighbors, C. J., & Bustamante, E. E. (2009). Leisure time and occupational physical activity among racial/ethnic minorities. *Medicine and Science in Sports and Exercise*, **42**(6), 1. doi:10.1249/MSS.0b013e3181c5ec05

Marquine, M. J., Gallo, L. C., Tarraf, W., Wu, B., Moore, A. A., Vásquez, P. M., Talavera, G., Allison, M., Muñoz, E., Isasi, C. R., Perreira, K. M., Bigornia, S. J., Daviglus, M., Estrella, M. L., Zeng, D., & González, H. M. (2021). The association of stress, metabolic syndrome and systemic inflammation with neurocognitive function in the Hispanic Community Health Study/Study of Latinos and its sociocultural ancillary study. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, 77, 860–871. doi:10.1093/geronb/gbab150

Masyn, K. E. (2013). *The Oxford handbook of quantitative methods* (Vol. **2**). OUP USA. http://books.google.com.au/books?id=FjNCnQEACAAJ

Matthews, C. E., Keadle, S. K., Troiano, R. P., Kahle, L., Koster, A., Brychta, R., Van Domelen, D., Caserotti, P., Chen, K. Y., Harris, T. B., & Berrigan, D. (2016). Accelerometer-measured dose–response for physical activity, sedentary time, and mortality in US adults. *American Journal of Clinical Nutrition*, **104**(5), 1424–1432. doi:10.3945/ajcn.116.135129

Metzger, J. S., Catellier, D. J., Evenson, K. R., Treuth, M. S., Rosamond, W. D., & Siega-Riz, A. M. (2008). Patterns of objectively measured physical activity in the United States. *Medicine and Science in Sports and Exercise*, **40**(4), 630–638. doi:10.1249/MSS.0b013e3181620ebc

Metzger, J. S., Catellier, D. J., Evenson, K. R., Treuth, M. S., Rosamond, W. D., & Siega-Riz, A. M. (2010). Associations between patterns of objectively measured physical activity and risk factors for the metabolic syndrome. *American Journal of Health Promotion*, **24**(3), 161–169. doi:10.4278/ajhp.08051151

Mossavar-Rahmani, Y., Hua, S., Qi, Q., Strizich, G., Sotres-Alvarez, D., Talavera, G. A., Evenson, K. R., Gellman, M. D., Stoutenberg, M., Castañeda, S. F., Gallo, L. C., Perreira, K. M., Sanchez-Johnsen, L. A. P., & Kaplan, R. C. (2020). Are sedentary behavior and physical activity independently associated with cardiometabolic benefits? The Hispanic Community Health Study/Study of Latinos. *BMC Public Health*, **20**(1), 1–19. doi:10.1186/s12889-020-09497-5

Mungas, D., Early, D. R., Maria Glymour, M., Al Hazzouri, A. Z., & Haan, M. N. (2018). Education, bilingualism, and cognitive trajectories: Sacramento Area Latino Aging Study (SALSA). *Neuropsychology*, **32**(1), 77–88. doi:10.1037/neu0000356

Muñoz, E., Gallo, L. C., Hua, S., Sliwinski, M. J., Kaplan, R., Lipton, R. B., González, H. M., Penedo, F. J., Tarraf, W., Daviglus, M. L., Llabre, M. M., & Isasi, C. R. (2021). Stress is associated with neurocognitive function in Hispanic/Latino Adults: Results from HCHS/SOL socio-cultural ancillary study. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, **76**(4), E122–E128. doi:10.1093/geronb/gbz144

Murillo, R., Reid, K. J., Arredondo, E. M., Cai, J., Gellman, M. D., Gotman, N., Marquez, D. X., Penedo, F. J., Ramos, A. R., Zee, P. C., & Daviglus, M. L. (2016). Association of self-reported physical activity with obstructive sleep apnea: Results from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL). *Preventive Medicine*, **93**, 183–188. doi:10.1016/j.ypmed.2016.10.009

Muthen, L., & Muthen, B. (n.d.). *Mplus user's guide 1998–2017 (8th ed.)*. Muthen & Muthen.

NIA. (n.d.). *The National Institute on Aging: Strategic directions for research, 2020–2025*. https://www.nia.nih.gov/sites/default/files/2020-05/nia-strategic-directions-2020-2025.pdf

Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural Equation Modeling*, **14**(4), 535–569. doi:10.1080/10705510701575396

Ottenbacher, A. J., Snih, S. Al, Bindawas, S. M., Markides, K. S., Graham, J. E., Samper-Ternent, R., Raji, M., & Ottenbacher, K. J. (2014). Role of physical activity in reducing cognitive decline in older mexican-american adults. *Journal of the American Geriatrics Society*, **62**(9), 1786–1791. doi:10.1111/jgs.12978

Palta, P., McMurray, R. G., Gouskova, N. A., Sotres-Alvarez, D., Davis, S. M., Carnethon, M., Castañeda, S. F., Gellman, M. D., Hankinson, A. L., Isasi, C. R., Schneiderman, N., Talavera, G. A., & Evenson, K. R. (2015). Self-reported and accelerometer-measured physical activity by body mass index in US Hispanic/Latino adults: HCHS/SOL. *Preventive Medicine Reports*, **2**, 824–828. doi:10.1016/j.pmedr.2015.09.006

Pate, R. R., Yancey, A. K., & Kraus, W. E. (2010). The *2008 Physical Activity Guidelines for Americans*: Implications for Clinical and Public Health Practice. *American Journal of Lifestyle Medicine*, **4**(3), 209–217. doi:10.1177/1559827609353300

Piedra, L. M., Andrade, F. C. D., Hernandez, R., Boughton, S. W., Trejo, L., & Sarkisian, C. A. (2017). The influence of exercise on cognitive function in Older Hispanic/Latino Adults: Results From the "¡Caminemos!" study. *Gerontologist*, **57**(6), 1072–1083. doi:10.1093/geront/gnw256

HHS, 2018 Physical Activity Guidelines Advisory Committee Scientific. (2018). *2018 Physical activity guidelines advisory committee scientific report*. https://health.gov/sites/default/files/2019-09/Physical_Activity_Guidelines_2nd_edition.pdf

Rethorst, C. D., Moncrieft, A. E., Gellman, M. D., Arredondo, E. M., Buelna, C., Castañeda, S. F., Daviglus, M. L., Khan, U. I., Perreira, K. M., Sotres-Alvarez, D., & Stoutenberg, M. (2017). Isotemporal of the association of objectively measured physical activity with depressive symptoms: Results from Hispanic Community Health Study/Study of Latinos (HCHS/SOL). *Journal of Physical Activity and Health*, **14**(9), 733–739. doi:10.1123/jpah.2016-0648

Shea, S., Lima, J., Diez-Roux, A., Jorgensen, N. W., & McClelland, R. L. (2016). Socioeconomic status and poor health outcome at 10 years of follow-up in the multi-ethnic study of atherosclerosis. *PLoS One*, **11**(11), 1–17. doi:10.1371/journal.pone.0165651

Singer, R. H., Stoutenberg, M., Gellman, M. D., Archer, E., Davis, S. M., Gotman, N., Marquez, D. X., Buelna, C., Deng, Y., Hosgood, H. D., & Zambrana, R. E. (2016). Occupational physical activity and body mass index: Results from the Hispanic community Health Study/Study of Latinos. *PLoS One*, **11**(3), 1–15. doi:10.1371/journal.pone.0152339

Sorlie, P. D., Avilés-Santa, L. M., Wassertheil-Smoller, S., Kaplan, R. C., Daviglus, M. L., Giachello, A. L., Schneiderman, N., Raij, L., Talavera, G., Allison, M., LaVange, L., Chambless, L. E., & Heiss, G. (2010). Design and implementation of the Hispanic Community Health Study/Study of Latinos. *Annals of Epidemiology*, **20**(8), 629–641. doi:10.1016/j.annepidem.2010.03.015

Vásquez, E., Strizich, G., Isasi, C. R., Echeverria, S. E., Sotres-Alvarez, D., Evenson, K. R., Gellman, M. D., Palta, P., Qi, Q., Lamar, M., Tarraf, W., González, H. M., & Kaplan, R. (2017).

Is there a relationship between accelerometer-assessed physical activity and sedentary behavior and cognitive function in US Hispanic/Latino adults? The Hispanic Community Health Study/Study of Latinos (HCHS/SOL). *Preventive Medicine*, **103**, 43–48. doi:10.1016/j.ypmed.2017.07.024

Vásquez, P. M., Durazo-Arvizu, R. A., Marquez, D. X., Argos, M., Lamar, M., Odoms-Young, A., Gallo, L. C., Sotres-Alvarez, D., Castañeda, S. F., Perreira, K. M., Vidot, D. C., Isasi, C. R., Gellman, M. D., & Daviglus, M. L. (2021). Association of accelerometer-measured physical ativity and cardiovascular health in the Hispanic Community Health Study/Study of Latinos (HCHS/SOL). *Hispanic Health Care International*., 20, 15-24 doi: 10.1177/1540415320985581

Vásquez, P. M., Durazo-Arvizu, R. A., Marquez, D. X., Argos, M., Lamar, M., Odoms-Young, A., Wu, D., González, H. M., Tarraf, W., Sotres-Alvarez, D., Vidot, D., Murillo, R., Perreira, K. M., Castañeda, S. F., Mossavar-Rahmani, Y., Cai, J., Gellman, M., & Daviglus, M. L. (2019). Moderate-vigorous physical activity and health-related quality of life among Hispanic/Latino adults in the Hispanic Community Health Study/Study of Latinos (HCHS/SOL). *Journal of Patient-Reported Outcomes*, **3**(1), 1–9. doi:10.1186/s41687-019-0129-y

Vermunt, J. K., & Magidson, J. (2004). Latent class analysis. In: M.S. Lewis-Beck, A. Bryman, and T.F. Liao (eds.), *The Sage Encyclopedia of Social Sciences Research Methods*, 549–553. Thousand Oaks, CA: Sage Publications.

von Rosen, P., Dohrn, I. M., & Hagströmer, M. (2020). Latent profile analysis of physical activity and sedentary behavior with mortality risk: A 15-year follow-up. *Scandinavian Journal of Medicine and Science in Sports*, **30**(10), 1949–1956. doi:10.1111/sms.13761

Wechsler, D. (1981). *WAIS-R manual*. Psycological Corporation.

Willey, J. Z., Moon, Y. P., Ruder, R., Cheung, Y. K., Sacco, R. L., Elkind, M. S. V, & Wright, C. B. (2014). Physical activity and cognition in the northern Manhattan study. *Neuroepidemiology*, **42**(2), 100–106. doi:10.1159/000355975

Wu, S., Vega, A. W., Resendez, J., & Jin, H. (2016). *Latinos and Alzheimer's Disease: New numbers behind the crisis*. USC Edward R. Roybal Institute on Aging and the LatinosAgainstAlzheimer's Network.

Zahodne, L. B., Sharifian, N., Kraal, A. Z., Zaheed, A. B., Sol, K., Morris, E. P., Schupf, N., Manly, J. J., & Brickman, A. M. (2021). Socioeconomic and psychosocial mechanisms underlying racial/ethnic disparities in cognition among older adults. *Neuropsychology*, **35**(3), 265–275. doi:10.1037/neu0000720