Experimental Gerontology 106 (2018) 173–177

Contents lists available at ScienceDirect

Experimental Gerontology

journal homepage: www.elsevier.com/locate/expgero

Can physical activity attenuate the negative association between sitting time and cognitive function among older adults? A mediation analysis☆

Antonio García-Hermoso[a], Robinson Ramírez-Vélez[b], Carlos A. Celis-Morales[c,d], Jordi Olloquequi[e], Mikel Izquierdo[b,f,*]

[a] Laboratorio de Ciencias de la Actividad Física, el Deporte y la Salud, Facultad de Ciencias Médicas, Universidad de Santiago de Chile, USACH, Santiago, Chile
[b] Centro de Estudios para la Medición de la Actividad Física "CEMA". Escuela de Medicina y Ciencias de la Salud, Universidad del Rosario, Bogotá D.C, Colombia
[c] BHF Glasgow Cardiovascular Research Centre, Institute of Cardiovascular & Medical Sciences, University of Glasgow, Glasgow G12 8TA, UK
[d] Centro de Investigación en Fisiología del Ejercicio - CIFE, Universidad Mayor, Santiago, Chile
[e] Facultad de Ciencias de la Salud, Universidad Autónoma de Chile, Talca, Chile
[f] Department of Health Sciences, Public University of Navarre, CIBER de Fragilidad y Envejecimiento Saludable (CB16/10/00315), Tudela, Navarre, Spain

ARTICLE INFO

Section Editor: Marzetti Emanuele

Keywords:
Cognitive impairment
Aging
Sedentary behavior
Physical inactivity

ABSTRACT

The purpose of this study was to examine the combined association of sitting time and physical activity with cognitive function and to determine whether moderate-to-vigorous physical activity (MVPA) is a mediator of the association between sitting time and cognitive function in a nationally representative sample of older adults from Chile. Data from 989 older adults (≥65 years old, 61.3% female) from the 2009–2010 Chilean Health Survey were analyzed. Physical activity and sitting time were measured using the Global Physical Activity questionnaire. Cognitive function was assessed using the modified Mini-Mental State levels Examination. Physical activity levels were categorized as "inactive" (< 600 metabolic equivalent value minutes per week) or "active" (≥600 metabolic equivalent value minutes per week). Sitting time was categorized as "sedentary", defined as ≥4 h of reported sitting time per day, or "non-sedentary", defined as < 4 h. We created the following groups (i) non-sedentary/active; (ii) non-sedentary/inactive; (iii) sedentary/active; and (iv) sedentary/inactive. Hayes's PROCESS macro was used for the simple mediation analysis. Compared with the reference group (individuals classified as non-sedentary/active), older adults who were classified as sedentary/active had elevated odds of cognitive impairment (OR = 1.90, [95% CI, 1.84 to 3.85]). However, the odds ratio for cognitive impairment was substantially increased in those classified as sedentary/inactive (OR = 4.85 [95% CI, 2.54 to 6.24]) compared with the reference group. MVPA was found to mediate the relationship between sitting time and cognitive function (Indirect Effect = −0.070 [95% CI, −0.012 to −0.004]).

Conclusion: The present findings suggest that, whether overall physical activity is high or low, spending large amounts of time sitting is associated with elevated odds of cognitive impairment and that MVPA slightly weakens the relationship between sitting time and cognitive function.

1. Introduction

The association between age and cognitive decline has been documented (Deary et al., 2009), however the relation is weak because the declines may reflect quantity more than quality (Salthouse, 2012). In this way, very robust inverted-U relations between age and different measures of achievement have been reported in many different domains (Salthouse, 2012). Among the factors that contribute to the onset of cognitive decline, age, poor diet, unhealthy lifestyle choices, and mood disorder appear to be key drivers (Wimo and Prince, 2010). Efforts are being made to attenuate age-related declines in cognition and its associated health burden, such as a decreased quality of life (Friedman et al., 2017). In terms of brain function, physical inactivity and poor dietary habits can disrupt cognition, with studies reporting deficits in learning, memory and executive functioning in inactive subjects compared with active individuals (Steinberg et al., 2015).

Sedentary behavior is any waking behavior characterized by an energy expenditure ≤1.5 metabolic equivalents while sitting or lying down (Barnes et al., 2012). Sitting time is an important predictor of healthy aging and a potentially modifiable determinant of health

☆ Abbreviated title: Sitting time, cognition and MVPA in older adults

* Corresponding author at: Department of Health Sciences, Public University of Navarra (Navarra), Campus of Tudela, Av. de Tarazona s/n., 31500 Tudela, (Navarra), Spain.
E-mail address: mikel.izquierdo@gmail.com (M. Izquierdo).

https://doi.org/10.1016/j.exger.2018.03.002
Received 1 February 2018; Received in revised form 24 February 2018; Accepted 5 March 2018
Available online 14 March 2018
0531-5565/

(Owen et al., 2010). On this topic, many (Falck et al., 2017; Ku et al., 2017) but not all studies have shown that the association of sedentary behaviors and health outcomes is partially independent of levels of physical activity (Ekelund et al., 2016; Katzmarzyk et al., 2009). Droga et al. have suggested that sedentary behavior is significantly associated with decreased odds of successful aging among middle-aged and older adults, independent of physical activity (Dogra and Stathokostas, 2012). A recent systematic review published by Falck et al. suggests that sedentary behavior earlier in life is a risk factor for cognitive impairment and therefore dementia later in life (Falck et al., 2017).

Although physical activity has been shown to be positively associated with cognitive function (Gow et al., 2012; García-Hermoso et al., 2017) by different several biological mechanisms (e.g., neurogenesis, angiogenesis, attention, memory, and synaptic plasticity) (Edwards and Loprinzi, 2017a), few studies have identified independent associations of physical activity and sitting time with cognitive function. Since levels of physical activity tend to decrease (Celis-Morales et al., 2016) and sitting time tends to increase (Aguilar-Farias et al., 2017) with aging, an investigation including both independent variables is warranted in this population. On this subject, a recent cross-sectional study suggests that physical activity attenuates the association between sedentariness and cognitive function (Edwards and Loprinzi, 2017b); however, another prospective study found that a relationship remained evident even after physical activity was adjusted for (Ku et al., 2017). Current international strategies for older adults highlight the importance of increased moderate-to-vigorous physical activity (MVPA) for maintaining cognitive health throughout the lifespan (Falck et al., 2017; Dogra et al., 2017). For example, physical activity may promote neural resilience by reducing age-related neural inflammation, ultimately helping to preserve cognitive function among older adults (Stranahan et al., 2012). Therefore, it is necessary to elucidate the potential mediating role of MVPA on the effects of sitting time on cognitive function. Our aim, therefore, was to examine the combined association of sitting time and physical activity with cognitive function and to determine whether MVPA is a mediator of the association between sitting time and cognitive function in a nationally representative sample of older adults from Chile. We hypothesize that higher levels of MVPA will mediate the negative effect of sitting time on cognitive function.

2. Methods

2.1. Study population

The 2009–10 Chilean National Health Survey was a representative household survey with a stratified multistage probability sample of 5416 non-institutionalized participants over 14 years old from the 15 regions in Chile, both urban and rural. The sample size was calculated with a 20% relative sampling error to estimate a national prevalence over 4%. One participant was randomly selected per household, and pregnant female were excluded. The response rate was 85%, with no replacements. Detailed information about the survey has been described elsewhere (Encuesta Nacional de Salud [ENS], 2009-2010). In this study, 1013 older adults (> 65 years) were evaluated. Of these respondents, 989 had recorded values for physical activity questionnaire. The study protocol and ethical consent forms were approved by the ethics committee of the Pontificia Universidad Católica de Chile and the Ministry of Health.

2.2. Measurements

Standardized protocols were used, and all investigators (nurses and research technicians) underwent joint training sessions prior to implementation of the survey.

2.2.1. Cognitive function

The modified Mini-Mental State Examination (mMMSE) instrument, which assesses orientation, attention, recent memory and language, was administered (Folstein et al., 1975). The mMMSE comprises six questions with a maximum total score of 19 points. For example, the question about the orientation became: "Where are we now?". Respondents with scores 13 or less were considered cognitively impaired (Quiroga et al., 2004).

2.2.2. Physical activity and sitting time

The Global Physical Activity Questionnaire was conducted via face-to-face interview and assesses sedentary behavior (total time spent sitting, i.e. sitting or reclining at work or at home, getting to and from places, or with friends, but does not include time spent sleeping) and three domains of physical activity (occupational, active-commuting, and recreational). Also, the questionnaire include the following single question: "How much time do you usually spend sitting or lying (reclining) on a normal day?" (Armstrong and Bull, 2006).

2.2.3. Anthropometrics assessment

Height was measured to the nearest 0.1 cm using a portable stadiometer, and weight was measured to the nearest 0.1 kg using a digital scale (Tanita HD-313®) with participants without shoes and in light clothing in their home. Body mass index (BMI) was calculated as [weight/height^2].

2.2.4. Covariates

Socio-demographic data were collected for all participants, including age, sex, education level (primary, secondary or beyond secondary), living alone (yes or no), alcohol intake as assessed by the Alcohol Use Disorders Identification Test (AUDIT) (Alvarado et al., 2009), area of residence (urban or rural), tobacco use, and depression in the past year. Past smokers were those who reported that they had smoked > 100 cigarettes in their lifetime but did not currently smoke cigarettes. The Composite International Diagnostic Interview, Short Form (CIDI-SF), was applied to establish a diagnosis of major depressive episode using the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria (Kessler et al., 1998). Finally, the AUDIT test identifies dangerous drinking behaviors through a summary score constructed from questions on drinking behavior including drinking frequency, quantity, and inability to stop drinking.

2.3. Statistical analysis

Statistical normality was tested using both statistical (Kolmogorov–Smirnov test) and graphical procedures (normal probability plots). Due to the skewed distribution, the mMMSE score was log-transformed.

To investigate the combined effects of physical activity and sitting time on mMMSE, physical activity was categorized as "inactive" (< 600 metabolic-equivalent value minutes per week) and "active" older adults (≥600 metabolic-equivalent value minutes per week) (Armstrong and Bull, 2006) and sitting time was categorized as "sedentary" and "non-sedentary" and defined as reporting ≥4 h of sitting time per day (Hallal et al., 2012). From these classification, we created the following groups (i) non-sedentary/active; (ii) non-sedentary/inactive; (iii) sedentary/active; and (iv) sedentary/inactive. ANCOVA models were used to assess mean differences in mMMSE scores among these categories, controlling for age, sex, BMI, social characteristics (educational level and living alone), alcohol and drugs use, tobacco intake, and depression. Pairwise post hoc hypotheses were tested using the Bonferroni correction for multiple comparisons.

Logistic regression models were employed to compare the prevalence of cognitive impairment (i.e. ≤13) across combined above-mentioned categories and adjusted by age, sex, BMI, social characteristics (educational level and living alone), alcohol and drugs use, tobacco intake, and depression.

Finally, to examine whether the association between sitting time