Association between physical activity and cognition in Mexican and Korean older adults

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ABSTRACT

Introduction: As the world’s population ages, the prevalence of cognitive impairment associated with age increases. This increase is particularly pronounced in Asia and South-America. The objective of this study was to investigate separately the longitudinal association of physical activity and cognitive function in; older adults in Mexico and South Korea.

Materials and Methods: This is a secondary analysis of two surveys, The Mexican Health and aging Study (MHAS) (n = 5853) and Korean Longitudinal Study of aging (KLoSA) (n = 5188), designed to study the aging process of older adults living in Mexico and South Korea. Participants older than 50 years were selected from rural and urban areas achieving a representative sample. Physical activity was assessed using self-report. Cognition was assessed using Cross-Cultural Cognitive Examination (CCCE) and Minimental state examination (MMSE) in Mexico and South Korea respectively. Here we investigate the longitudinal association between physical activity and cognition during 3 years for MHAS and 4 years for KLoSA using multiple linear regression analyses.

Results: The prevalence of physical activity was 40.68 % in MHAS and 35.57 % in KLoSA. In the adjusted longitudinal multivariate analysis, an independent association was found between physical activity and MMSE score OR 0.0866 (CI 0.0266-0.1467 p-value 0.0047) in the Korean older adults, while there was no significant association in MHAS.

Conclusions: Physical activity could have a protective effect on the cognitive decline associated with aging in the Korean population.

1. Introduction

As the world population ages, the prevalence of age-associated cognitive decline and dementia increases (Orgeta, Mukadam, Sommerlad, & Livingston, 2019). This is not only detrimental for the affected individuals but also bears a major physical, economic and burden on the health care providers and society. Up to 47 million people worldwide live with dementia today which is expected to double by 2050 (ADI, 2019), and the increase is particularly pronounced in Asia and South-America (UN, 2019). Since therapeutic options for dementia are scarce, measures that prevent or delay this condition is of significant importance.

The rate of cognitive decline associated with aging is highly variable, likely explained by multiple factors, such as the molecular
background of the underlying changes in the brain, lifestyle and environmental factors.

Physical activity (PA) is known to improve cardiovascular functions with protective effects on the brain (Erickson et al., 2019; Jia, Liang, Xu, & Wang, 2019; Mandolesi et al., 2018). Also, skeletal muscles can release myokines that induce angiogenesis and promote neuroplasticity, especially in the hippocampus and medial temporal lobe (Iizuka, Machida, & Hirafuji, 2014).

Accordingly, it is not surprising that PA is one of many lifestyle factors identified as a modifiable risk factor for dementia (Livingston et al., 2017), and has been linked to cognitive decline in a dose-response relationship (Sanders, Hortobágyi, La Bastide-van Gemert, van der Zee, & van Heuvelen, 2019). Long term PA has been shown to slow down the progression in Alzheimer disease (Cui, Lin, Sheng, Zhang, & Cui, 2018).

Importantly, most studies of the association between PA and dementia have been conducted in Western countries, whereas few studies are reported in Asia and even less in America Latina. These populations have different cultures, lifestyle habits including dietary and PA habits, and genetic makeup than those previously studied, and thus the association between PA and dementia may differ in these cohorts.

Therefore, we aimed to investigate the longitudinal association of PA and cognitive function in older adults in Mexico and South Korea.

2. Methods

2.1. Participants

This is a secondary analysis of two national studies; The Mexican Health and Aging Study (MHAS) (Wong, Michaels-Obregon, & Palloni, 2017) and the Korean Longitudinal Study of Aging (KLoSA) (Choi, Son, Cho, Park, & Cho, 2012). The studies were designed to evaluate the aging process in community-dwelling older adults. Both cohorts were representative for the older adults’ population in their countries, the male proportion was 46.5 % in MHAS and 40.23 % in KLoSA, and mean age was 68.6 years (± 6.8) in MHAS and 64.4 years (± 9.3) in KLoSA.

In both studies, face-to-face interviews were conducted, and subjects were given sets of questionnaires including sociodemographic characteristics, health-related issues, lifestyle habits, and cognitive function. Participants with incomplete data, who refused follow-up or with pre-existing cognitive impairment were excluded.

In the MHAS, participants were selected using a multistage cluster sampling method. In the present study, we used waves 2012 and 2015. Subjects scoring below the cut-off point established through normative data according to years of schooling and age for the Cross-Cultural Cognitive Examination (CCCE) (see below) in 2012 were considered to have pre-existing cognitive impairment and excluded from the analyses Fig. 1.

KLoSA started in 2006, with follow-up every 2-year. A stratified multistage probability sampling was used allowing to obtain a representative sample. The analysis was made on waves between 2012 and 2016. Subjects scoring below 24 on the Mini-Mental State Examination (MMSE) were considered to have cognitive impairment for KLoSA Fig. 1.

The recruitment of participants and methods used in MHAS and KLoSA have been described in detail elsewhere(Borda et al., 2019; Kim, Kim, Kwon, & Park, 2019).

2.2. Variables

2.2.1. Physical activity

In MHAS, participants were asked whether or not they took part in vigorous exercise three times a week or more, with vigorous exercise defined as any activity involving physical activity including sports or heavy housework, and were classified as either physically active or physically inactive based on this question. KLoSA participants were asked to report the frequency and duration of PA per week. KLoSA participants were asked to report the frequency and duration of PA per week, categorized as “physically inactive” if they did < 150 min per week, and defined as ‘physically active’ if they reported more than 150 min. per week. This is a standardized question that has been used extensively in the literature to define self-reported physical activity (Gerst, Michaels-Obregon, & Wong, 2011).

2.2.2. Cognitive functioning

Cognitive function was assessed using cognitive screening tests. In MHAS, CCCE was used, a screening test with > 94 % specificity and > 99 % sensitivity for dementia (Glosser et al., 1993; Mejía-Arango, Wong, & Michaels-Obregón, 2015), including verbal and visual memory, selective attention as well as executive function and motor control. This test is achievable also by illiterates of whom there are many among the older generations in Mexico. The score ranges from 0 to 80, with higher scores indicating better cognitive function. KLoSA subjects were screened using the MMSE a global cognitive measurement of cognitive function with a maximum score of 30 (Folstein, Folstein, & McHugh, 1975). Z-score scaling was used to standardize both scores to have uniformity in the way we display the results.

2.2.3. Confounding variables

Schooling was assessed in years as a continuous variable for MHAS and categorical for KLoSA (no education, less than high school, high school, higher than high school). Health-related variables were collected through self-report. Comorbidities were based on the sum of conditions hypertension, heart disease, respiratory disease, cerebrovascular disease, diabetes, arthritis, and malignancies. Depression was determined according to the MHAS depression questionnaire.

Fig. 1. Flowchart of the study sample A. MHAS B. KLoSA.
previously validated for this survey (Aguilar-Navarro, Fuentes-Cantu, Avila-Funes, & García-Mayo, 2007) and in KLoSA with the question: Have you ever had sad, blue or depression feelings that persist longer than 2 weeks during the past one year? Alcohol use was assessed as a self-report question, the answers were re-categorized as a dichotomous variable: current or past drinker and non-drinker.

2.3. Statistical analysis

Statistical analysis was completed using R software. Baseline characteristics were reported as frequencies and percentages for categorical variables or mean and standard deviation for continuous variables. For the bivariate analysis, to compare those who were physically active and those who were not, the Chi-square test was applied to categorical variables, whereas t-tests were utilised for continuous variables. Multiple linear regression models were fixed using PA as independent variable and cognition at the follow-up assessment as a dependent variable to allow comparisons between models, and including potential confounders such as age, gender, education, comorbidities, depression, baseline cognitive score and alcohol use as co-variates. The results were expressed as coefficients with 95 % confidence intervals. The primary analysis in both cohorts evaluated whether PA at baseline was associated with the follow-up score on the two cognitive tests. Both cohorts are analysed separately, and due to the different design and methods, we have not attempted to perform any combined analyses.

2.4. Ethical issues

The Institutional Review Boards of Ethics Committees of the University of Texas Medical Branch in the United States, the Instituto Nacional de Estadística y Geografía and the Instituto Nacional de Salud Pública in México approved the MHAS study. The Korean Longitudinal Study of Ageing was approved by the Research Ethics Committee of the Korea Labor Institute. Both surveys data are publicly available, and can be downloaded from the employment survey site with personal information removed. All study participants signed informed consent to participate and to have their data used for research purposes. The study adhered to the ethical guidelines of the Declaration of Helsinki.

3. Results

The cohort characteristics are shown in Tables 1 and 2. In Korea, the prevalence of physical activity (those who reported more than 150 min per week) was 35.57 %. Compared to the PA inactive group, the physically active group performed better on MMSE in 2016 (0.123 ± 1.05 vs 0.046 ± 0.90, p-value < 0.001). The physically inactive group had a higher proportion of women, less alcohol consumption, fewer years of education and a higher prevalence of depression (Table 1).

In MHAS, the prevalence of those reporting regular PA at least three hours a week was 40.68 %. Compared to the physically inactive group, the physically active group scored higher in CCCE in 2015 (0.099 ± 1.01 vs -0.063 ± 0.99, p-value < 0.001). They also had more years of education, had less depression and consumed less alcohol (Table 2).

The baseline and follow-up non-standardised cognitive scores for both populations are shown in Fig. 2.

At the follow-up, an independent association was found in the KLoSA between PA and MMSE score even after adjusting for confounders (0.0661 95 % CI 0.0095; 0.1228, p-value = 0.022) (Table 3).

In contrast, no independent association was found in the MHAS between PA and cognition after adjusting for confounders (0.0119 95 % CI – 0.0349; 0.0588, p value = 0.618) (Table 4).

4. Discussion

In this study, we investigated the association between physical activity and cognitive function in older adults living in the community in Mexico and South Korea. Our findings suggest a significant association in the Korean population, in which those who were defined as physically active performed significantly better on cognitive testing at follow-up compared to the physically inactive group. In contrast, no significant association between cognition and PA was found in the MHAS cohort. The positive correlation between physical activity and cognition implies that performing regular physical activity, in addition

| Table 1 | Characteristics of PA groups in the KLoSA Study. |
|---------|--------------------------------------------------|
| Variable | Physically inactive n (%) or mean ± sd | Physically Active n (%) or mean ± sd | P-Value | Total n (%) or mean ± sd |
| MMSE score 2015 | -0.123 ± 1.05 | 0.046 ± 0.90 | 0.0000 | -0.054 ± 1.00 |
| Education | | | | |
| no education | 82 (2.43) | 16 (0.71) | 0.0000 | 98 (1.47) |
| < high sch. | 1015 (30.02) | 443 (19.68) | 1458 (21.86) |
| > high sch. | 994 (29.40) | 841 (37.36) | 1835 (27.52) |
| Comorbidity | 0.87 ± 0.98 | 0.85 ± 0.93 | 0.3056 | 0.86 ± 0.96 |
| 0 | 1499 (44.34) | 993 (44.11) | 0.3170 | 3529 (52.92) |
| 1 | 1103 (32.62) | 756 (33.59) | 1859 (27.88) |
| 2 | 538 (15.91) | 374 (16.61) | 912 (13.68) |
| 3 | 192 (5.68) | 109 (4.84) | 301 (4.51) |
| 4 | 46 (1.36) | 18 (0.80) | 64 (0.96) |
| 5 | 2 (0.06) | 1 (0.04) | 3 (0.04) |
| 6 | 1 (0.03) | 0 (0.00) | 1 (0.01) |
| Alcohol | | | | |
| Yes | 1691 (50.01) | 1243 (55.22) | 2934 (43.99) |
| No | 1690 (49.99) | 1008 (44.78) | 2698 (40.46) |
| Depression | | | | |
| Yes | 173 (5.12) | 82 (3.64) | 255 (3.82) |
| No | 3208 (94.88) | 2169 (96.36) | 5377 (80.63) |
| Sex | | | | |
| Male | 1524 (45.08) | 1159 (51.49) | 2683 (40.23) |
| Female | 1857 (54.92) | 1092 (48.51) | 3986 (59.77) |
| Age | 64.62 ± 9.62 | 63.95 ± 8.73 | 64.35 ± 9.28 |

| Table 2 | Characteristics of PA groups in the MHAS Study. |
|---------|--------------------------------------------------|
| Variable | Physically inactive n (%) or mean ± sd | Physically Active n (%) or mean ± sd | P-Value | Total n (%) or mean ± sd |
| CCCE score 2015 | -0.063 ± 0.99 | 0.099 ± 1.01 | 0.0000 | 0.000 ± 1.00 |
| Years of education | 5.10 ± 4.27 | 5.63 ± 4.61 | 0.0000 | 5.30 ± 4.41 |
| Comorbidity | 1.06 ± 0.95 | 0.85 ± 0.88 | 0.0000 | 0.98 ± 0.93 |
| 0 | 1284 (38.22) | 995 (41.20) | 0.0000 | 2279 (36.92) |
| 1 | 1458 (43.17) | 900 (37.27) | 2354 (37.21) |
| 2 | 895 (22.88) | 413 (16.61) | 1308 (20.67) |
| 3 | 233 (5.96) | 91 (3.77) | 324 (5.12) |
| 4 | 41 (1.12) | 15 (0.62) | 59 (0.93) |
| 5 | 2 (0.05) | 1 (0.04) | 3 (0.05) |
| Alcohol | | | | |
| Yes | 2429 (93.03) | 1364 (89.91) | 3793 (59.95) |
| No | 182 (6.97) | 153 (10.09) | 335 (5.29) |
| Depression | | | | |
| Yes | 1379 (35.25) | 762 (31.55) | 4186 (66.16) |
| No | 2533 (64.75) | 1653 (68.45) | 2141 (33.84) |
| Sex | | | | |
| Male | 1540 (39.37) | 1402 (58.05) | 2942 (46.50) |
| Female | 2372 (60.63) | 1013 (41.95) | 3385 (53.50) |
| Age | 69.20 ± 9.75 | 67.61 ± 6.22 | 68.59 ± 6.79 |

Descriptive analysis and bivariate analysis. KLoSA. Korean older adults. Z-score scaling was used for CCCE. CCCE = Cross-Cultural Cognitive Examination, PA = Physical Activity.
Cognitive performance of Korean Older adults that were physically active.

| Variable                      | Korea (95% CI) p-value | Adjusted Beta (95% CI) p-value |
|-------------------------------|------------------------|-------------------------------|
| Physical Activity - Yes       | 0.1697 (0.1123; 0.2271) 0.000 | 0.0661 (0.0095; 0.1228) 0.022 |
| Education - No                |                        |                               |
| < High School                 | 1.2105 (0.9678; 1.4532) 0.000 |                               |
| High School                   | 1.0849 (0.8500; 1.3199) 0.000 |                               |
| Comorbidity - 0               | 0.0180 (0.0125; 0.1612) 0.449 |                               |
| 1                             | 0.0209 (−0.0474; 0.0893) 0.800 |                               |
| 2                             | −0.0776 (−0.1670; 0.0118) 0.283 |                               |
| 3                             | 0.0180 (−0.1252; 0.1612) 0.449 |                               |
| 4                             | −0.0896 (−0.3999; 0.2112) 0.753 |                               |
| 5                             | −0.5120 (−2.2283; 1.2043) 0.716 |                               |
| 6                             | 1.1360 (−0.5867; 2.8588) 0.343 |                               |
| Alcohol - Yes                 | −0.0384 (−0.1065; 0.0294) 0.170 |                               |
| Depression - Yes              | −0.1834 (−0.3393; −0.0275) 0.149 |                               |
| Sex - Male                    | 0.0848 (0.0125; 0.1571) 0.019 |                               |
| Age                           | −0.0298 (−0.0336; −0.0258) 0.000 | 0.2534 (0.2241; 0.2828) 0.000 |
| MMSE 2012                     |                        |                               |

Multivariate analysis for the association between the physically active group and the Longitudinal cognitive performance in Korean Older Adults - KLoSA.
This study has some limitations. Firstly, this study is based on self-reported measurements of physical activity allowing memory bias. Secondly, variables such as physical activity, cognition, education, and depression were measured using different methods in the studied populations, which may have led to different associations between PA and cognition. Thirdly, PA is incompletely defined regarding the type, duration, or intensity. Although self-reported PA is widely used in the literature, we acknowledge its limitations in obtaining an exact measure of PA.

PA is a complex behaviour that is indeed difficult to assess, and using self-report may limit the validity of the information provided by the participants (recall bias). It is especially challenging to recall light and moderate-intensity physical activity. Thus, self-report may lead to dilute the estimated associations because of misclassification of individuals (Andersen, 2004). Hence our results may have underestimated the association between PA and cognition in MHAS. Cognition and Physical activity were assessed in different ways in both surveys. In MHAS PA was defined as “vigorous” based on sports or heavy household, whereas in KLoSA all types of PA were included. However, both high and low exercise intensities have shown the potential to improve cognition and other health domains (Langhammer, Bergland, & Rydwik, 2018; Saez de Asteasu, Martinez-Velilla, Zambom-Ferraresi, Casas-Herrero, & Izquierdo, 2017; Sanders et al., 2019).

Due to several differences between the measurements used in both surveys we did not intend to directly compare the two cohorts and all analyses have been performed separately.

This study encompasses several strengths. It investigates the longitudinal association with a 3-year (Mexico) and 4-year (Korea) follow up, enabling us to see the effects of self-reported physical activity over time. It is also based on cohorts with large and representative cohorts. Lastly, it investigates two different regions in the world both with a growing number of people living with dementia.

Physical activity is a cheap, accessible intervention with a potential to benefit older adults’ health, including cognition. Actions for implementing said intervention and more studies to describe intervention characteristics and precise mechanisms are needed.

5. Conclusion

We found a positive longitudinal correlation between physical activity and cognition in South Korean subjects older than 50 years. This implies that performing regular physical activity could have a protective effect on the cognitive decline associated with aging. More studies with objective and standardized measurements in different geographical areas are required to better understand the association between PA and cognition in elderly people.

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CRediT authorship contribution statement

Vera Aarsland: Conceptualization, Formal analysis, Methodology, Visualization, Writing - review & editing. Miguel Germán Borda: Conceptualization, Methodology, Visualization, Writing - review & editing. Dag Aarsland: Methodology, Visualization, Writing - review & editing, Supervision. Elkin García-Cifuentes: Methodology, Writing - original draft, Writing - review & editing. Sigmund Alfred Andersen: Methodology, Visualization, Writing - review & editing. Diego Alejandro Tovar-Rios: Formal analysis, Writing - review & editing. Camilo Gomez-Arteaga: Visualization, Writing - review & editing. Mario Ulises Perez-Zepeda: Methodology, Visualization, Writing - review & editing, Supervision.

Declaration of Competing Interest

The authors declare no conflict of interest.

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V. Aarsland, et al.  

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