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Higher levels of objectively measured sedentary behavior is associated with worse cognitive ability: Two-year follow-up study in community-dwelling older adults

Po-Wen Ku[a], Yi-Te Liu[b], Ming-Kuei Lo[c], Li-Jung Chen[d,*], Brendon Stubbs[e,f,g,**]

[a] Graduate Institute of Sports and Health, National Changhua University of Education, Taiwan
[b] Department of Sports, National Changhua University of Education, Taiwan
[c] Department of Leisure Business Management, Nan Kai University of Technology, Taiwan
[d] Department of Exercise Health Science, National Taiwan University of Sport, Taiwan
[e] Physiotherapy Department, South London and Maudsley NHS Foundation Trust, Denmark Hill, London SE5 8AZ, UK
[f] Psychological Medicine, Institute of Psychiatry, Psychology and Neuroscience, King's College London, De Crespigny Park, London Box SE5 8AF, UK
[g] Faculty of Health, Social Care and Education, Anglia Ruskin University, Chelmsford, UK

A R T I C L E I N F O

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A B S T R A C T

Background: A number of cross-sectional studies have suggested that higher levels of sedentary behavior (SB) are associated with worse cognitive abilities in older age. There is a paucity of longitudinal studies investigating this relationship utilizing objectively assessed SB. This study investigated the relationship between objectively assessed SB and future cognitive abilities in a cohort of older adults.
Methods: A longitudinal study over 22.12 ± 1.46 months including 285 community-dwelling older adults across 14 regions in Taiwan was undertaken. Cognitive ability was ascertained using a Chinese version of the Ascertain Dementia 8-item Questionnaire (AD8) and SB captured by 7 days accelerometer data. Multivariable negative binomial regression models adjusted for confounders were undertaken.
Results: 274 community-dwelling older adults finished the study (age = 74.6 ± 6.2, % female = 54.4%). At baseline, 20.1% (n = 55), 48.5% (n = 133) and 31.4% (n = 86) of the sample engaged in high (11+ h), medium (7–10.99 h) and low (< 7 h) of SB respectively. In the fully adjusted model, higher levels of SB were associated with an increased risk of worse cognitive ability at follow up (adjusted rate ratio (ARR)1.09 (95%CI:1.00–1.19)), with the strongest relationship evident in those engaging in over 11 h of SB (ARR 2.27 (95%CI:1.24–4.16)). The relationship remained evident after adjusting for depressive symptoms and physical activity.
Conclusion: Our data suggests that objectively assessed SB, particularly when over 11 h a day, is independently associated with worse cognitive ability over a two year period. Our data adds to the pressing reasons to reduced SB in older age.

1. Introduction

There is now robust evidence demonstrating that people are living longer, yet with more years with disability (Whiteford et al., 2013; Vos et al., 2013). As the number of older people increases, the total number of people affected by reduced or impaired cognitive abilities such as subjective memory complaints (Mitchell et al., 2014), mild cognitive impairment and dementia is also anticipated to increase (Fiest et al., 2016; Deckers et al., 2015). Given the deleterious impact of such cognitive deteriorations, including reduced independence, decreased quality of life, premature mortality, high levels of healthcare utilization and cost (Fiest et al., 2016; Prince et al., 2013), there is a need to identify potentially modifiable risk factors.

There is widespread acceptance that physical activity is a modifiable risk factor for future cognitive decline (Norton et al., 2014; Sallis and Bull, 2016). In the medical literature, there is increasing recognition that high levels of sedentary behavior (SB) are independent from physical activity, associated with a range of deleterious outcomes such as

* Correspondence to: L.-J. Chen, Department of Exercise Health Science, National Taiwan University of Sport, Taiwan.
** Correspondence to: B. Stubbs, Physiotherapy Department, South London and Maudsley NHS Foundation Trust, Denmark Hill, London, UK.
E-mail addresses: powen@cc.ncue.edu.tw (P.-W. Ku), ytliu@cc.ncue.edu.tw (Y.-T. Liu), kuei@nkut.edu.tw (M.-K. Lo), ljchen@gm.ntupes.edu.tw (L.-J. Chen), brendon.stubbs@kcl.ac.uk (B. Stubbs).

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cardiovascular disease, cancer and mortality (Biswas et al., 2015; de Rezende et al., 2014). There is however, a paucity of studies investigating SB and cognition in older adults (Ku et al., 2016a). Nonetheless, a recent systematic review found that SB may be associated with reduced cognition in older age in cross sectional studies (Falck et al., 2016). However, the authors (Falck et al., 2016) were unable to identify any published longitudinal study investigating the relationship between SB and cognitive impairment in older age. Since the publication of that systematic review, two recent prospective studies (Edwards and Loprinzi, 2017a; Edwards and Loprinzi, 2017b) have suggested that self-report SB is associated with worse cognition in older adults. Whilst helpful, both studies relied on the use of self-report measurement of SB which is not validated and has unconfirmed accuracy, particularly in the context of older people with impaired cognition. Thus, there is a need for studies relying on the use of more accurate and reliable objective means to identify the relationship between SB and cognitive ability in older age.

Given the aforementioned, we set out to conduct a prospective study investigating the relationship between objectively measured SB and cognitive ability in a cohort of community-dwelling older adults.

2. Methods

2.1. Study design and sample

The current study included data from a two-year follow-up study of a community-based project, conducted in Hunei District, Kaohsiung, the second largest city in Taiwan. This project was designed to examine the associations between objectively assessed physical activity and mental health among community-dwelling older adults (Ku et al., 2017). Between August and October 2012 (baseline), 285 community-dwelling older adults (aged 65 or older, mean ± SD = 74.5 ± 6.1 years) were invited to take part in the study and were subsequently assessed using standardized face-to-face household interviews and accelerometry (see details below). Across 14 villages of Hunei District, approximately 20 people were recruited from each community center using quota sampling. Individuals were drawn based on a national distribution according to sex and age in 2011 (Taiwan Ministry of Interior, 2012). The second-wave interviews were performed between May to July 2014. Among the baseline sample, 274 participants (96.1%) participated in the follow-up after an average of 22.12 ± 1.46 months (Ku et al., 2017). The research was approved by the National Taiwan University of Sport Institutional Review Board ethical committee (reference number: NTUPES-HSC-100-09). All participants provided written informed consent.

2.2. Measures

2.2.1. Cognitive ability

Cognitive ability was captured with the Chinese version of the Ascertain Dementia 8-item Questionnaire (AD8) (Galvin et al., 2005; Galvin et al., 2007). Respondents were requested to rate changes in memory, orientation, problem-solving abilities, and daily activities (yes = 1, no = 0) with a potential range between 0 and 8. A higher score indicated a worse cognitive ability on the AD8 (Galvin et al., 2005; Ganguli et al., 2014). The AD8 has demonstrated adequate reliability and validity among community-dwelling Taiwanese older adults has been verified (Yang et al., 2011). Within the current sample, the Cronbach's alpha for the AD8 ranged between 0.79 (first-wave) and 0.81 (second-wave).

2.2.2. Accelerometer-assessed sedentary time

The amount of time spent in SB was assessed using triaxial accelerometry (GT3X +, ActiGraph, Pensacola, FL, USA). Participants were instructed to wear the accelerometer on an elastic band on their waist at all times for 7 days, including 5 weekdays and 2 weekend days. In data analysis, a minimum of 10 h of monitoring on a minimum of 5 days was required for data inclusion (Koolhaas et al., 2017). If the accelerometer had recorded data contained < 5 valid days or had malfunctioned during wearing period, participants were requested to re-wear the accelerometer (Buman et al., 2010).

To get a better understanding on the relationships between SB and cognitive ability, the time spent in SB was then computed and converted into both continuous (hours/day) and categorical forms such as high (11 + h/day), medium (7–10.99 h/day), and low (< 7 h/day). The cut-off-pints were based on previous research suggesting that the cut-off point for risk be as low as 7 or 8 h a day and being sedentary for > 11 h a day may impair health (Australian National Preventive Health Agency, 2014). Physical activity parameters such as time spent in moderate-to-vigorous physical activity was also estimated and recoded as a covariate (150 + min/week: no vs. yes) for multivariable adjustment (US Department of Health and Human Services, 2008; UK Department of Health, 2011).

2.2.3. Covariates

Underlying covariates were identified and assessed at baseline based on previous reviews (Coley et al., 2008; Hamer and Chida, 2009; Ku et al., 2016b): comprising (1) socio-demographic variables: age, gender, years of formal education, marital status, and source of income (self [pension/savings] vs. offspring), which may reflect adult children's social and financial support. Adult children provide remittances which may increase older parents' financial stability and improve their mental well-being (Silverstein et al., 2006; Ku et al., 2007); (2) lifestyle factors: time spent in moderate-to-vigorous physical activity, smoking, alcohol consumption, and; (3) health and chronic diseases: weight status category using body mass index (BMI) (< 18.50, 18.50–23.99, 24–26.99, 27 +) (Taiwan Department of Health, 2003), number of comorbidities (0, 1, 2 +) including hypertension, stroke, diabetes, heart disease, cancer, chronic obstructive pulmonary disease, liver disease, renal disease, and arthritis etc.; depressive symptoms assessed by the 15-item Geriatric Depression Scale (GDS) using cutoff of 5 (yes vs. no) (Brink et al., 1982; Yesavage and Sheikh, 1986); and difficulties with activities of daily living (ADLs, no difficulties at all vs. some or great difficulties); D(4) cognitive ability at baseline; (5) mean accelerometer wear time (hours/day) (Hamer et al., 2014).

2.3. Data analysis

The sample size of the original study was determined for cross-sectional group comparisons. We therefore performed a post-hoc power analysis for negative binomial regression models using version 11.0 of Power Analysis and Sample Size Software (NCSS 2011, Kaysville, UT) for the longitudinal analysis. After adjusting for R-squared and over-dispersion parameter with the mean exposure time of 2 years, the total sample of 274 participants achieved 91.40% power at a 0.05 significance level to detect an incidence rate ratio of 1.53 (i.e. the average rate ratio based on our fully adjusted models).

The characteristics of the study sample were described using descriptive statistics. Mann Whitney U tests and Kruskal-Wallis tests were employed to examine the differences in cognitive ability in 2014 (follow-up) between categories of sedentary time and covariates in 2012 (baseline) due to the violation of normality. Variables with a p value (< 0.05) were then included in the subsequent multivariable regression models for adjustment.

To explore the simple correlations between objectively assessed SB (continuous and categorical) and cognitive ability in 2012 (baseline) and 2014 (follow-up) after adjusting for accelerometer wear time, partial correlation coefficients were calculated. Variables with a p value (< 0.05) were then included in the subsequent multivariable regression models for adjustment.

Given that the outcome variable was an over-dispersed count with a highly skewed distribution, multivariable negative binomial regression