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Featured Article

Objectively measured physical activity profile and cognition in Finnish elderly twins

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Abstract

Introduction: We studied whether objectively measured physical activity (PA) and sedentary behavior (SB) are associated with cognition in Finnish elderly twins.

Methods: This cross-sectional study comprised twins born in Finland from 1940 to 1944 in the Older Finnish Twin Cohort (mean age, 72.9 years; 726 persons). From 2014 to 2016, cognition was assessed with a validated telephonic interview, whereas PA was measured with a waist-worn accelerometer.

Results: In between-family models, SB and light physical activity had significant linear associations with cognition after adjusting for age, sex, wearing time, education level, body mass index, and living condition (SB: β-estimate, −0.21 [95% confidence intervals, −0.42 to −0.003]; light physical activity: β-estimate, 0.30 [95% confidence intervals, 0.02–0.58]). In within-family models, there were no significant linear associations between objectively measured PA and cognition.

Discussion: Objectively measured light physical activity and SB are associated with cognition in Finnish twins in their seventies, but the associations were attributable to genetic and environmental selection.

Keywords: Cognition; Physical activity; Twins; Accelerometry; Dementia; Genetics; Exercise; Actigraphy; Sedentary behavior; Aged

1. Introduction

In recent years, studies of objectively measured physical activity (PA) using accelerometers have shown that not only low PA but also sedentary behavior (SB) predisposes to health hazards [1,2]. Most studies of PA and cognition are based on self-reported PA. In such cross-sectional studies, PA has been associated with better cognition in the most robust studies (n > 2000 and a valid measure of PA and cognition) [3,4].

So far, only four studies appear to have assessed associations of objectively measured PA profiles with cognition in a cross-sectional study of an elderly population [5–8]. Kerr et al. [5] showed that moderate-to-vigorous physical activity (MVPA), measured using waist-worn accelerometers, was associated with a better processing speed and executive function performance (n = 217). Light physical

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activity (LPA), regardless of the amount, was not associated with cognition when models were adjusted for demographic variables. Barnes et al. [6] did not distinguish between the intensity of PA but found that elderly women in the lowest PA quartile performed worse on cognitive tests. In their study, PA was measured using a wrist-worn accelerometer in a large sample (n = 2736). The most extensive cross-sectional study of objectively measured PA and cognition is that of Zhu et al. (n = 7098) [7]. Using waist-worn accelerometers, they showed that higher levels of MVPA, but not LPA or sedentary time, were associated with better performance on cognitive tests in the elderly. These results were similar to the findings by Kerr et al. [5]. A smaller study (by Johnson et al. [8], n = 188, waist-worn accelerometer) contradicts the earlier findings. They found that LPA, but not sedentary time or MVPA, was associated with better executive functioning in community-dwelling older adults. Kerr et al. and Barnes et al. [5,6] did not analyze SB.

The majority of longitudinal studies on PA and cognition have relied on self-reported PA. A comprehensive meta-analysis of longitudinal studies provides support for the positive association of PA with a lower incidence of cognitive impairment [9]. Longitudinal studies of PA and cognition with objectively measured PA are scarce. Middleton et al. used doubly labeled water and calorimetry to measure energy expenditure during PA among 197 seniors with an average age of 75 years, with a follow-up of 5 to 8 years, and found a dose-response between higher baseline energy expenditure and a decreased incidence of cognitive impairment [10]. In one wrist-worn accelerometer study of 716 adults with an average age of 82 years at baseline, higher baseline levels of PA were associated with a reduced risk of Alzheimer's disease and mild cognitive impairment 4 years later [11]. In another study using waist-worn accelerometers, Zhu et al. found an association between baseline MVPA and later cognition, but no significant association of later cognition with baseline LPA or baseline sedentary time in their 3-year follow-up study that included 6452 older adults [12]. These short follow-up times imply that subclinical symptoms and signs of dementia may have affected the persons' motivation and ability to exercise, producing through reverse causality a spurious association or lack of it.

An association between PA and cognition may also be due to unmeasured confounders including genetic factors that are known to affect both cognition and PA [13]. One way of controlling for genetic confounding is to study relationships in twins, especially monozygotic twins who share the identical genomic sequences.

The aim of this study was to determine if subject's objectively measured PA and SB are associated with cognition in an elderly population of twins in Finland. Our twin study design enables us to assess the effect of genetics and childhood environment with separate between-family and within-family analyses.

2. Methods

2.1. Study population

Our study sample was selected from the Older Finnish Twin Cohort (FTC) study (Fig. 1). The FTC comprises all same-sex twins born before 1958, with both co-members alive in 1975 [14]. Comprehensive health questionnaires were sent to all cohort members in 1975 and in 1981. In 2014 to 2016, those born from 1940 to 1944 were interviewed using two cognition-screening telephonic interviews namely a telephonic assessment for dementia [15] and the Telephone Interview for Cognitive Status [16].

All those who participated in the telephonic cognition interview were offered the possibility of participating in an objective, 1-week PA and SB measurement with a waist-worn accelerometer (Hookie AM20; Traxmeet Ltd, Espoo). The accelerometer used a commonly used digital triaxial acceleration sensor (ADXL345; Analog Devices, Norwood, MA) and stored the raw acceleration signals with 100-Hz sampling frequency (±16 g measurement range and 0.004 g measurement resolution). These measurements were performed in a mean of 3.4 weeks (standard deviation [SD], 5.5) after the cognition interviews. The participants' mean age at the time of the telephonic interview was 72.9 (range, 71.1–75.0) years. The number of twins with completed cognition interview, accelerometer monitoring, and full information on all covariates was 726 (including both twins from 250 twin pairs, of which 110 were monozygotic, 125 were dizygotic, and 15 of unconfirmed zygosity).

The questionnaire studies in 1975 and 1981 were approved by the National Board of Health of Finland. Answering and returning the questionnaire was considered as consent to participate in the study. During the course of the cohort study, the participants were repeatedly informed about the study and could withdraw from it at any time if they so wished. Written informed consent was obtained from all who participated in the telephonic interview. The cognition interview and the accelerometer part of the study were approved by the Ethics Committee of the Hospital District of Southwest Finland.

2.2. Measurements of PA and SB

The accelerometers with the instructions for their use were mailed to the participants who provided consent. The participants were instructed to use the accelerometer during their waking hours for 1 week. After this, the accelerometer was mailed back to the UKK Institute in a prepaid envelope for analysis. A recent study from the UKK Institute showed that the mean amplitude deviation of the resultant acceleration during a 6-s epoch is a valid metric for analyzing the raw triaxial data from different accelerometer brands to describe