Experimental Gerontology 55 (2014) 107–112

Contents lists available at ScienceDirect

Experimental Gerontology

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

The association between physical activity and reduced body fat lessens with age — Results from a cross-sectional study in community-dwelling older adults

Yi Chao Foong [a,*], Dawn Aitken [a], Tania Winzenberg [a], Petr Otahal [a], David Scott [b], Graeme Jones [a]

[a] Menzies Research Institute Tasmania, University of Tasmania, Private Bag 23, Hobart, Tasmania 7000, Australia
[b] Australian Institute of Musculoskeletal Science, NorthWest Academic Centre, The University of Melbourne, Western Health, St Albans, Victoria 3021, Australia

ARTICLE INFO

Article history:
Received 27 November 2013
Received in revised form 21 March 2014
Accepted 9 April 2014
Available online 18 April 2014

Section Editor: Christiaan Leeuwenburgh

Keywords:
Body composition
Accelerometry
Physical activity
Community dwelling
Elderly

ABSTRACT

Introduction: The aim of this study was to describe the relationship between accelerometer-determined physical activity (PA) and adiposity in community-dwelling older adults. In addition, we were interested in comparing the extent of correlation between questionnaire and accelerometer determined PA.
Methods: 636 community-dwelling older adults (66 ± 7 years) were studied. Adiposity was measured using dual-energy X-ray absorptiometry and BMI was calculated. We measured minutes/day spent in sedentary, light, moderate and vigorous intensity activity using both questionnaires and Actigraph GT1M accelerometers.
Results: Participants spent a median of 583(IQR 522–646), 225(176–271), 27(12–45) and 0(0–0) minutes in sedentary, light, moderate and vigorous activities respectively. There was a non linear dose–response inverse relationship between activity intensity and adiposity. After adjusting for age, sex and other levels of PA, for every 10 minute increase in activity, total body fat decreased by 169 g(95% CI 61–277), 905 g(632–1178), and 2208 g(759–3657) for light, moderate and vigorous activities respectively. There was an interaction between age and activity; as age increased, the magnitude of the effects of light and moderate activities on adiposity decreased. Sedentary minutes were not associated with adiposity after adjusting for time spent at other PA intensities. Questionnaire measures of PA were weakly correlated with body fat measures when compared to accelerometer determined PA.
Conclusion: Both the amount and intensity of PA, but not sedentary time, have an independent dose–response association with adiposity. The association is much stronger using objective assessment compared to questionnaire. The magnitude of these associations decrease with age suggesting that physical activity programmes may need to be modified with increasing age.

1. Introduction

The prevalence of obesity amongst the elderly is rising rapidly in many countries across the world (Arterburn et al., 2004; Gomez-Cabello et al., 2011; Popkin and Doak, 1998). The combination of an ageing population and obesity is associated with a range of health conditions, including diabetes and cardiovascular disease (Huang et al., 2005; Inelmen et al., 2003; Wilson and Kannel, 2002). Obesity occurs when energy intake exceeds energy expenditure for an extended period of time. Energy expenditure is mainly a sum of basal metabolic rate, thermic effect of food and physical activity. Out of these physical activity is usually the most variable component (Westerterp, 1998). Therefore the level of physical activity is crucial in terms of one's risk for obesity. This is consistent with the results of several studies which have shown that physical activity is associated with a positive effect on adiposity (Krumm et al., 2006; Scott et al., 2009).

Whilst there is now emerging evidence on the associations between physical activity (PA) and adiposity in older adults, most of these have used either questionnaires or, less commonly, pedometers as the primary measurement tool (Hughes et al., 2002; Scott et al., 2011). The use of questionnaires to assess PA, particularly in an ageing population, may introduce a substantial risk of recall bias, and questions have been raised regarding their reliability and validity (Harris et al., 2009; Shephard, 2003; Tudor-Locke and Myers, 2001). Whilst prior studies by our group have shown that pedometer measured PA is significantly associated with body fat in community dwelling older adults, we were limited by the inability to assess the intensity of activity or sedentary time (Scott et al., 2009, 2011). The few studies which employed accelerometers as the measurement tool mostly focus on children or younger adults and not older community-dwelling adults (den Hoed and Westerterp, 2008; Dencker et al., 2006). The aim of this cross-sectional study, therefore,

* Corresponding author. Tel.: +61 3 6226 4256; fax: +61 3 6226 7704.
E-mail address: ycfoong@utas.edu.au (Y.C. Foong).

http://dx.doi.org/10.1016/j.exger.2014.04.006
0531-5565/

was to describe the association between accelerometer-determined PA and dual-energy X-ray absorptiometry (DXA) determined adiposity in a randomly selected sample of community-dwelling older adults. Secondly we aimed to compare the extent of correlation between questionnaire determined PA and accelerometer determined PA with adiposity. We hypothesized that PA would be inversely associated with adiposity and that the correlation between accelerometer determined PA with adiposity would be greater than that between questionnaire determined PA and adiposity.

2. Methods and procedures

2.1. Participants

This study was conducted as part of the Tasmanian Older Adult Cohort (TASOAC) study, a prospective, population-based study of community-dwelling older adults. Community-dwelling is defined as those who are not in assisted living units or nursing homes.

Participants aged between 50 and 80 years were randomly selected from the electoral roll in Southern Tasmania (population 229,000), with an equal number of men and women. The response rate was 57%. Exclusion criteria included contraindication for magnetic resonance imaging (MRI) (due to a focus being osteoarthritis of the knee) and institutionalisation. A total of 1100 subjects were enrolled in the study, and 1099 attended a baseline clinic between March 2002 and September 2004. Phase 2 follow-up data was collected for 875 participants approximately 2.7 years later. Phase 3 follow-up data was collected for 767 participants approximately 5 years later. The current study consists of a sample of participants ($n = 636$) who had complete accelerometer and adiposity measures at either Phase 2 ($n = 210$) or Phase 3 ($n = 426$). Additionally, PA questionnaire data was collected at both Phase 1 ($n = 1099$) and Phase 2 ($n = 874$).

The study was approved by the Southern Tasmanian Health and Medical Human Research Ethics committee, and written informed consent was obtained from all participants.

2.2. Anthropometrics

Height was measured to the nearest 0.1 cm (with shoes, socks and headwear removed) using a Leicester stadiometer (Invicta, Leicester, UK). Weight was measured to the nearest 0.1 kg (with shoes, socks and bulky clothing removed) using electronic scales (Heine, Dover, New Hampshire, USA). Body mass index (BMI) was calculated as weight in kilogrammes divided by the square of height in metres (kg/m^2). Overweight and obesity were defined as having a BMI equal to or greater than 25 and 30 respectively. Self report of calorie intake, smoking, alcohol intake, diabetes and hypertension was recorded by a questionnaire.

Each participant underwent a whole body scan by DXA using a Hologic Delphi densitometer (Hologic, Waltham, MA) from which soft tissue composition was determined. The analysis provided mass in grammes of total body fat and trunk fat. Participants were excluded from the DXA scans if their weight exceeded 130 kg because their bodies were too wide for the scan field ($n = 3$), if they were unable to remain supine for the duration of the scanning procedure ($n = 2$) or if they had an artificial limb ($n = 2$).

2.3. Physical activity

Physical activity (PA) was assessed once in every participant at either Phase 2 or Phase 3 as counts/day as determined by an accelerometer (ActiGraph GT1M). Each participant was instructed to wear an accelerometer for seven consecutive days following the clinic visit. Participants were only included in data analysis if they wore the accelerometer for at least five valid days, where a valid day was defined as having worn the accelerometer for more than 10 h. Of the 636 subjects, 39 had five valid days, 94 had six valid days and 503 had seven valid days. The total amount of time spent in the various activity intensities was averaged by the number of valid days to produce an average time spent in each activity category per day. Participants were provided with a diary in which they recorded start and finish times each day, as well as the duration and reason for any time where they took the accelerometer off. Circumstances where accelerometer readings could have been affected (i.e. driving on uneven ground) were also reported.

We assessed the absolute time our participants spent in sedentary (less than 250 cpm), light (251–1951 cpm), moderate (1952–5724 cpm) and vigorous ($\geq$5725 cpm) intensity activity. This corresponds to less than 1.5 metabolic equivalent (METs), 1.5–2.9 METs, 3–5.9 METs and greater or equal to 6 METs respectively (Crouter et al., 2006). We employed the sedentary activity cut-off proposed by Matthews (Matthew, 2005) and cut-offs for other categories as per the Freedson equation (Freedson et al., 1998). This data was collected in 1-minute epochs.

We also assessed PA using the Global Physical Activity Questionnaire (GPAQ) (Armstrong and Bull, 2006). Time spent in moderate and vigorous activities whilst at work and leisure was recorded. Participants were asked if they engaged in this type of activity for at least 10 continuous minutes, and if they replied in the affirmative, the number of days and amount of time in a typical day spent on the activity was recorded. Participants were asked to base their answers on a typical week in the past 12 months.

2.4. Statistical analysis

Adiposity variables (total body fat, trunk fat, BMI) were regressed on the amount of time spent in each category of PA intensity (sedentary, light, moderate, vigorous). Since age and sex were potential confounders of these associations, we adjusted each model for age and sex. Further models were constructed with all PA intensity variables together (adjusted for age and sex) to examine the independent effects of each level of activity intensity of PA on adiposity. There was no evidence of co-linearity in this model.

We tested for interactions between PA and age and PA and sex on body fat measures. We found that there was a significant PA–age interaction (both with continuous and categorized age) over all levels of PA intensity combined, and further analyses were modelled with interactions and presented as stratified by age tertiles. Raw accelerometer count data were also analysed to further verify the presence of the age by PA interaction. There were no PA–sex interactions.

Standard diagnostic checks of model adequacy were performed on all models. Residuals from all models were not normally distributed; this was rectified by analysing log transformed total body fat and BMI, and square-root transformed trunk fat. Back-transformed means and 95% confidence intervals are presented for all models and associations are shown at the mean of other model covariates where appropriate.

We performed Pearson's partial correlation analysis between PA and adiposity variables for questionnaire and accelerometer measured PA, controlling for sex and age. Results are presented as partial correlation coefficients.

A p-value of less than 0.05 was considered statistically significant. All statistical analyses were performed on Intercooled Stata 12.0 for Windows (StataCorp LP).

3. Results

Table 1 gives the characteristics of the study population. Median BMI was 27.4, and a majority (73.4%) of our participants were overweight or obese (BMI $\geq$ 25). The median time spent in sedentary, light, moderate and vigorous activities was 583, 225, 27 and 0 min/day respectively (only 24.4% of participants recorded any vigorous activity). Of note, those in the oldest age category had a greater percentage of participants who was overweight/obese, and was found to perform the least amount