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Cross-sectional associations of objectively measured physical activity and sedentary time with sarcopenia and sarcopenic obesity in older men

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ABSTRACT

This study investigated associations between objectively measured physical activity (PA) with sarcopenia and sarcopenic obesity in older British men. Participants were men aged 70–92 years (n = 1286) recruited from UK Primary Care Centres. Outcomes included (i) sarcopenia, defined as low muscle mass (lowest two fifths of the mid-upper arm muscle circumference distribution) accompanied by low muscular strength (hand grip strength <30 kg) or low physical performance (gait speed ≤ 0.8 m/s); (ii) severe sarcopenia, required all three conditions; (iii) sarcopenic obesity defined as sarcopenia or severe sarcopenia and a waist circumference of >102 cm. Independent variables included time spent in PA intensities measured by GT3x accelerometers, worn during one week in 2010–12. Multinomial regression models were used for cross-sectional analyses relating PA and sarcopenia. In total, 14.2% (n = 183) of men had sarcopenia and a further 5.4% (n = 70) had severe sarcopenia. 25.3% of sarcopenic or severely sarcopenic men were obese. Each extra 30 min per day of moderate-to-vigorous PA (MVPA) was associated with a reduced risk of severe sarcopenia (relative risk [RR] 0.53, 95% confidence interval [CI] 0.30, 0.93) and sarcopenic obesity (RR 0.47 [95% CI 0.27, 0.84]). Light PA (LPA) and sedentary breaks were marginally associated with a reduced risk of sarcopenic obesity. Sedentary time was marginally associated with an increased risk of sarcopenic obesity independent of MVPA (RR 1.18 [95% CI 0.99, 1.40]). MVPA may reduce the risk of severe sarcopenia and sarcopenic obesity among older men. Reducing sedentary time and increasing LPA and sedentary breaks may also protect against sarcopenic obesity.

1. Introduction

Normal aging involves important changes to body composition, including decreased muscle mass and increased fat mass (Zamboni et al., 2008). The age-related loss of muscle mass combined with loss of muscular strength and/or function is referred to as sarcopenia and occurs in up to 29% of community-dwelling older adults (Cruz-Jentoft et al., 2014). Sarcopenia is associated with an increased risk of frailty, disability and mortality in older adults (Waters et al., 2010; Landi et al., 2013). The co-occurrence of sarcopenia and obesity, defined as sarcopenic obesity, may heighten effects on health outcomes (Atkins et al., 2014a; Dominguez & Barbagallo, 2007; Zamboni et al., 2008). As physical activity (PA) is associated with lower fat mass and increased muscular strength and function (Bann et al., 2015; Shephard et al., 2013; Kuh et al., 2005), it may significantly reduce the risk of sarcopenia and sarcopenic obesity, making it one of the most important modifiable risk factors. Resistance training is particularly beneficial for improving muscular strength and function in the elderly (Cruz-Jentoft et al., 2014).

A number of cross-sectional and longitudinal studies have investigated the association between PA and sarcopenia using predominantly self-reported measures of PA. These studies have consistently shown that higher overall levels of PA are associated with a reduced risk of sarcopenia and sarcopenic obesity (Ryu et al., 2013; Kim et al., 2013; Atkins et al., 2014a; Hughes et al., 2001). One study reported that the risk of sarcopenia and sarcopenic obesity can be reduced by up to 74% and 73% in regularly active men, respectively (Ryu et al., 2013). Although self-report measures provide useful information on context of PA, objective measures allow more reliable estimates of volume and intensity. While studies using objective measures are few (Shephard et al., 2013; Bann et al., 2014; Park et al., 2010) they appear to confirm previous findings using self-reported PA. A recent prospective study showed that high levels of objectively measured walking approximately halved the risk of sarcopenia (Shephard et al., 2013). The authors also observed additional reductions in risk with PA at a moderate-to-vigorous intensity. Other studies report positive associations between PA and the individual components of sarcopenia, including muscle mass (Abe et al., 2012; Bann et al., 2014), muscular strength and function

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(Kuh et al., 2005; Eibich et al., 2015). To date, the association between specific intensities of objectively measured PA with both sarcopenia and sarcopenic obesity has not been well explored. Studies have not addressed whether differences in sedentary time, breaks in sedentary time and light PA (LPA) are associated with these conditions, which is important as older adults spend the majority of their time sedentary or in LPA. In addition, the association of PA with severe sarcopenia (low muscle mass accompanied by low muscular strength and physical performance (Cruz-Jentoft et al., 2010)) has not yet been investigated. Therefore the primary aim of this study was to investigate how objectively measured PA levels of different intensities are associated with sarcopenia, severe sarcopenia and sarcopenic obesity in community-dwelling older British men. We also investigated whether self-reported resistance training was associated with these conditions. Finally, we explored associations between different intensities of PA with the individual components of sarcopenia and sarcopenic obesity, namely muscle mass, physical performance, strength and obesity.

2. Methods

2.1. Participants

The British Regional Heart Study (BRHS) is an ongoing prospective cohort study involving 7735 men from 24 towns in Great Britain. The cohort were recruited from primary care practices and initially examined in 1978–80 aged 40 to 59 years. In 2010–12, all 3137 surviving cohort members aged 72–91 years were invited to attend a physical examination, complete a lifestyle and medical history questionnaire and have their PA levels measured objectively.

3. Exposure measures: physical activity

3.1. Accelerometry data

Participants were instructed to wear a GT3X accelerometer (Actigraph, Pensacola, Florida, USA) over the hip for 7 days, during waking hours, removing only for water-based activities. Accelerometer data were treated using standard techniques described previously (Jefferis et al., 2014). Non-wear time was identified and excluded using the R package “Physical Activity” (Choi et al., 2011). Ninety minute bouts or more of consecutive zero counts were classified as non-wear time; during these periods, intervals of up to 2 min of non-zero counts were also classified as non-wear time if no activity counts were detected during the 30 min before and after that interval, allowing for accidental movement when the accelerometer was not being worn. Raw data from the vertical axis were integrated into 60 s epochs and used to derive counts per minute (CPM). Time (minutes per day) spent sedentary and in different intensities of PA were derived using standard CPM-based intensity threshold values for older adults of <100 for sedentary behaviour, 100–1040 for LPA and >1040 for moderate-to-vigorous PA (MVPA). Valid data required ≥3 days of ≥600 min of wear time.

3.2. Self-reported PA data

Participants self-reported their habitual PA levels, including how often they make journeys by foot or by bike, recreational activities and participation in sports. A total PA score was derived based on the frequency and type of activity, which has previously been validated (Wannamethee et al., 2002). Men were grouped as inactive, occasional (regular walking or recreational activity only), light (more-frequent recreational activities, sporting exercise less than once a week, or regular walking plus some recreational activity), moderate (cycling, very frequent weekend recreational activities plus regular walking, or sporting activity once a week), moderately vigorous (sporting activity at least once a week or frequent cycling, plus frequent recreational activities or walking, or frequent sporting activities only) or vigorous (very frequent sporting exercise or frequent sporting exercise plus other recreational activities). An additional question asked respondents to report their engagement in muscular strength/endurance training. This included lifting weights, doing push-ups and using exercise machines. Participants were classified as participating or not participating in muscular strength and endurance training.

Participants also completed a six-item version of the Duke Activity Status Index (DASI), which was used as a measure of general fitness. The DASI was developed to measure functional capacity and strongly correlates with peak oxygen uptake ($r = 0.80$) (Hlatky et al., 1989). The index comprised of questions regarding ability to participate in six activities of increasing intensity, weighted according to the MET value for each activity. A total score was calculated by adding the weighted scores for the six items.

4. Outcome measures

4.1. Anthropometric measures

Height (cm), weight (kg), waist circumference (WC) (cm), mid-upper arm circumference and triceps skinfold thickness (mm) were measured as previously described (Wannamethee et al., 2007). WC was used as a measure of obesity using a sex-specific cut point (>102 cm) (Anon, 1998). Muscle mass was derived from the mid-upper arm muscle circumference (MAMC) using the formula mid-upper arm circumference − (0.3142 × triceps skinfold thickness) (Miller et al., 2002).

4.2. Physical function and strength

Gait speed (m/s) was derived from a 3-metre walking test and was used as a measure of physical function. Grip strength (kg) was used as a marker of muscular strength and was measured using a Jamar Hydraulic Hand Dynamometer. Participants had three attempts for each hand and the highest score was used.

4.3. Definitions of sarcopenia and sarcopenic obesity

Sarcopenia and severe sarcopenia were defined using the European Working Group on Sarcopenia in Older People (EWGSOP) definition (Cruz-Jentoft et al., 2010). Both conditions required (i) low muscle mass (participants in the lowest two-fifths of the MAMC distribution were classified as having low muscle mass) and either (ii) low grip strength (<30 kg) or (iii) low gait speed (≤0.8 m/s) (Cruz-Jentoft et al., 2010). Severe sarcopenia required the presence of all three conditions (Cruz-Jentoft et al., 2010). To determine sarcopenia-obesity groups, men with sarcopenia and severe sarcopenia were collapsed into an overall sarcopenic group. They were then categorised into four groups: non-sarcopenic non-obese (WC ≤ 102 cm, not sarcopenic), sarcopenic non-obese (WC ≤ 102 cm, sarcopenic), non-sarcopenic obese (WC >102 cm, not sarcopenic), or sarcopenic obese (WC > 102 cm, sarcopenic).

5. Covariates

Men self-reported the following: social class, derived from longest held occupation; doctor diagnosis of medical conditions including angina, heart attack, heart failure, other heart conditions, bronchitis, depression, emphysema, osteoporosis, Parkinson's disease, cancer (excluding skin cancers), arthritis and stroke; cigarette smoking habits and alcohol intake. Number of medical conditions was categorised as low (<3) or high (≥3) according to the above medical conditions. Cigarette smoking was classified as current or recent smokers (given up in the last ten years), ex-smokers (gave up >10 years ago) and never smokers. Alcohol intake was classified as high (>15) or low (≤15 units of alcohol per week).