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Associations of distinct levels of physical activity with mobility in independent healthy older women

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ABSTRACT

Background: Older adults have twice as many disabilities and four times as many physical limitations as people < 60 years of age. Positive influence of physical activity to prevent these limitations has been presented in some studies. However, the indispensable combination of physical abilities and body composition parameters to maintain independence in later life and their relationship with physical activity has not been studied thoroughly.
Objective: The main aim of this study was to determine possible differences in body composition and mobility parameters among older women with various levels of engagement in physical activity. In addition, the relationships between mobility and distinct levels of physical activity were evaluated in healthy older women.
Methods: Eighty-one healthy older women aged from 65 to 91 years participated in this study and were allocated to three groups according to weekly moderate-to-vigorous physical activity (MVPA) time in 10 min bouts: highest MVPA (H-MVPA) (n = 27), middle MVPA (M-MVPA) (n = 40) and lowest MVPA (L-MVPA) (n = 14). Body composition (fat mass [FM] and fat free mass [FFM]) variables were assessed with dual-energy X-ray absorptiometry (DXA), objective physical activity data were collected with accelerometers and mobility tests were carried out to assess static and dynamic balance, lower limbs strength and aerobic capacity.
Results: No differences in body composition parameters were observed between studied groups ($p > 0.0025$). Women in L-MVPA covered significantly shorter distance during the six-minute walk test (6MWT) compared to H-MVPA ($p = 0.000$) and M-MVPA ($p = 0.003$) groups, performed timed-up-and-go (TUG) slower compared to H-MVPA group ($p = 0.003$) and five-times-sit-to-stand (FTSTS) test slower compared to H-MVPA ($p = 0.006$) and M-MVPA ($p = 0.009$) groups. There were no differences in body composition and mobility parameters between women in H-MVPA and M-MVPA groups. Regardless of bout duration, MVPA was correlated with mobility (TUG $r = -0.47$; FTSTS $r = -0.37$; 6MWT $r = 0.53$) parameters, whereas no relationships was observed with light physical activity (LPA).
Conclusion: MVPA is associated with body composition and mobility parameters, while LPA is not related to any measured body composition nor mobility parameters. Accordingly, healthy older women could benefit from MVPA to maintain body composition and mobility parameters to preserve independence in later life.

1. Introduction

Loss of skeletal muscle mass and function (Paterson and Warburton, 2010; Strasser et al., 2009), increased share of fat mass (Pisciottano et al., 2014; St-Onge and Gallagher, 2010), evolved probability of developing disturbances in balance and gait (Bullo et al., 2015) and prevalence of chronic diseases (Paterson and Warburton, 2010) are the characteristics of aging. One factor affecting those changes could be decreased commitment in everyday physical activity, which commonly decreases with aging (Strasser et al., 2009). Older adults are among the most sedentary segment of the society (Paterson and Warburton, 2010). It is not clear what level and amount of physical activity could decrease the negative aspects of aging, although the overall beneficial effect has been proven (Hirvensalo et al., 2000; Milanović et al., 2013). Older adults have twice as many disabilities and four times as many physical limitations as people < 60 years of age (Milanović et al., 2013). Moreover, it has been demonstrated that physically inactive healthy older adults have two times higher mortality risk compared with same age physically active older adults (Hirvensalo et al., 2000).

Disabilities in later life are often related to sarcopenia - loss of skeletal muscle mass and function accompanied by increasing age (Cruz-Jentoft et al., 2010), which is further interrelated with a decrease

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in physical activity (Cruz-Jentoft et al., 2010; Montero-Fernández and Serra-Rexach, 2013). As an index of sarcopenia, multiple approaches have been proposed and most commonly a combination of appendicular lean mass (ALM) obtained by the sum of upper and lower limbs fat free mass (Baumgartner et al., 1998) and muscle function (hand grip strength and gait) is used. In addition, relative muscle mass, calculated as ALM percentage of total body mass, has been associated with physical performance among older adults (Bijlsma et al., 2014). In addition to changes in skeletal muscle mass, a considerable matter of becoming dependent in later life also lies in deteriorated balance, flexibility and gait (Novak and Vute, 2013).

For older adults, current recommendation for gaining health benefits from physical activity is at least 150 min of moderate-to-vigorous physical activity (MVPA) per week (Taylor, 2014). Multiple studies have shown the beneficial contribution of physical activity in older age. Greater engagement in physical activity has been reported to maintain skeletal muscle mass (Pinto et al., 2014), reduce the decline in muscle strength and power output (Bocalini et al., 2009) and prevent a decline in balance, flexibility and gait performance (Bullo et al., 2015). It has been shown that older adults who met the criteria of ≥150 min of MVPA per week had more favorable values for body composition parameters (e.g., lower BMI) compared to those who did not meet the criterion (Loprinzi et al., 2015). Likewise, there are studies exploring the effect of physical activity on body composition, strength, balance and gait separately (Bullo et al., 2015; Novak and Vute, 2013; Bocalini et al., 2009). However, the combination of physical abilities and body composition parameters needed to cope with everyday activities in later life and their relationship with physical activity have not been thoroughly studied.

The aim of this study was to determine possible differences in body composition and mobility parameters among older women with different weekly MVPA levels. Another aim was to evaluate the relationship between distinct levels of physical activity and mobility to specify the level of physical activity, which has the highest positive effect on physical abilities.

2. Materials and methods

2.1. Participants

Participants of this study were older women aged from 65 to 91 years, recruited from the community. Advertisements were presented in local senior centers and training groups. Interested individuals completed a telephone interview before recruitment. Study subjects had the following inclusion criteria: age 65 years or older, living independently in the community and had been weight stable over the last six months (Rava et al., 2017). In addition, it was determined that subjects did not have any cardiac illnesses, neurological illnesses, joint replacements or other illnesses, which could interfere with motor functions or the ability to give informed consent before inclusion to the study (Bijlsma et al., 2014; Guadagnin et al., 2015). All participants signed informed consent before any study procedures. The study was approved by Research Ethics Committee of The University of Tartu and conducted in accordance with Helsinki Declaration.

Overall, 81 women, who met all of the inclusion criteria volunteered to participate in this study. Participants were allocated to three groups according to the accelerometer obtained MVPA data: highest MVPA (H-MVPA) (n = 27), middle MVPA (M-MVPA) (n = 40) and lowest MVPA (L-MVPA) (n = 14) groups. Participants who had a sum of 150 min and more of MVPA in at least 10 min bouts were part of H-MVPA group and participants who did not have any MVPA bouts with the duration of at least 10 min were included in L-MVPA group. All other participants (who had sum of MVPA in 10 min bouts in between 10 and 149 min) were part of M-MVPA group (Heesch et al., 2008; Yorston et al., 2012).

This is a cross-sectional and observational design study whereas participants completed all tests during two sessions. At the first measurement session, anthropometric and body composition measurements were conducted. In addition, participants started seven day accelerometer tracking after the first measurement session. Mobility tests were conducted one week after the first session, when study participants had completed seven days accelerometer tracking.

2.2. Anthropometry and body composition

Body height was measured with an inextensible and fixed vertical bar (Soehnle, Backnang, Germany) to the nearest 0.1 cm and body mass was measured by a medical electronic scale (Soehnle, Backnang, Germany) to the nearest 0.1 kg. Body mass index (BMI, $kg{\cdot}m^{-2}$) was calculated as body mass (kg) divided by body height squared (m^2). Whole body composition was measured using dual-energy X-ray absorptiometry (DXA) (Hologic Discovery QDR Series, Waltham, MA, USA). Whole-body fat mass (FM) was expressed in kg and as body fat%, and fat free mass (FFM, kg) was defined as the sum of bone mineral content and fat free soft tissue parts. Appendicular skeletal muscle mass was quantified as a sum of upper and lower limbs lean mass (ALM, kg) (Brady et al., 2014). As an index of sarcopenia, appendicular lean mass index (ALMI, $kg{\cdot}m^{-2}$) was calculated as ALM divided by body height squared (Baumgartner et al., 1998). In addition, ALM and BMI ratio was derived (ALM_{BMI}) (Spira et al., 2015). Relative muscle mass (RMM, %) was calculated as ALM percentage of the total body mass (Bijlsma et al., 2014).

2.3. Mobility

Five-times-sit-to-stand test (FTSTS) was used to assess dynamic balance, functional mobility (Goldberg et al., 2012) and lower limb strength (Bohannon et al., 2010). Participants started the test in a sitting position in a standard height adjustable chair with no armrest. Seat height was adjusted relative to the study participant knee angle of 90°. Participants were instructed to cross both arms across the chest, start from the seated position, stand up and sit down 5 times in succession as fast as they could, thereby it was emphasized that stand up position means full stand – upright trunk with the hips and knees extended. Time from the starting position to the final standing position was recorded (Goldberg et al., 2012).

A timed up-and-go test (TUG), which requires both static and dynamics balance (Barry et al., 2014), was performed on a standard chair with no armrest. Subjects were asked to stand-up from the chair, walk straight around a cone, located 3 m ahead, return and sit down to the chair as fast as possible. Time spent on performing the test was measured (Maden-Wilkinson et al., 2015).

Aerobic capacity was assessed with six-minute walk test (6MWT) (McPhee et al., 2013; Vilaça et al., 2014). The test was performed on a 20 m circuit and participants were instructed to walk as fast as they could, to cover the maximal distance possible within 6 min. Running was not allowed. Distance covered in the 6 min walk was recorded (McPhee et al., 2013; Vilaça et al., 2014).

2.4. Physical activity

Physical activity was measured by accelerometer (Actigraph, Pensacola, FL, USA). Accelerometer was worn on the right hip attached by an elastic, adjustable band. Participants were instructed to wear accelerometer for seven consecutive days during waking hours and remove accelerometer only for water activities (shower, bathing, swimming) and during sleeping hours (Jürimäe et al., 2010). Participants were asked to maintain regular daily activities during physical activity measurement period. The interval of time (epoch) used was set to 15 s, data were uploaded to a computer and analyzed afterwards. Days with < 10 h accelerometer wear time were omitted from the further analysis (Foong et al., 2016), also participants with less than four days of valid accelerometer data were excluded (Johansson et al.,