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Original article

Effect of physical activity at midlife on skeletal muscle mass in old age in community-dwelling older women: A cross-sectional study

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ABSTRACT

Background/Purpose: Measures to prevent the development of muscle mass decline should be initiated from midlife. However, the impact of physical activity at midlife on muscle mass in old age remains uncertain. The aim of this cross-sectional study was to determine whether physical activity at midlife influences muscle mass and physical performance in old age.
Methods: A total of 272 Japanese women aged 65 years and older were enrolled in the study. Information about physical activity levels at midlife and in old age were collected using a retrospective questionnaire. We calculated the skeletal muscle mass index in old age and recorded the participants' walking speed and hand grip strength in old age. We then classified the participants into four groups according to their physical activity levels at midlife and in old age and conducted multiple linear regression analysis to determine whether the physical activity levels at midlife and in old age were associated with skeletal muscle mass index and physical performance in old age.
Results: The participants in the groups that were physically inactive at midlife had a significantly lower skeletal muscle mass index in old age than those who were physically active at midlife ($p < 0.01$). Participants in the groups that were physically inactive in old age also had significantly slower walking speeds at old age than those who were physically active ($p < 0.01$). These associations remained significant after adjustment for age and body mass index.
Conclusion: Physical activity at midlife may be associated with a higher muscle mass in old age and physical activity in old age may be associated with higher walking speeds in old age.

1. Introduction

Muscle mass declines at approximately 1–2% per year after the age of 50 years.[1] Longitudinal studies have shown a clear decline in muscle mass, strength, and power beginning at approximately 35 years of age.[2] The age-related loss of skeletal muscle mass induces an increased risk of falls and fractures, physical disability, mobility disorders, and mortality.[3,4] To promote healthy aging, it is therefore important to develop ways of preventing muscle mass decline.

The beneficial effect of physical activity in preventing adverse health outcomes is widely endorsed. There is growing evidence that older adults who engage in physical activity are more likely to experience better physical function and have a longer active life expectancy than sedentary older adults.[5–7] Physical activity also has a positive impact on preventing muscle mass decline.[8] Physical activity is one of the most important modifiable factors associated with the risk of chronic morbidity and high mortality in the general population.

Recent studies have shown an association between physical activity at midlife and functional and health status in old age. The level of physical activity at midlife was related to better physical

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health and functioning and lower mortality risk.[9–12] Previous studies have also investigated the effects of midlife physical activity on different components of mobility[13–15] and the risk of institutionalization.[16] The benefits of physical activity at midlife appear to result from the maintenance of muscle strength,[13] cognitive function,[17] and other functions in old age. Furthermore, muscle mass in old age also appears to benefit from physical activity at midlife. Although it is important to prevent the development of muscle mass decline in old age and midlife, the effect of physical activity at midlife on muscle mass in old age remains uncertain.

The aim of this cross-sectional observational study was to determine whether physical activity at midlife was associated with muscle mass and physical performance in old age. We hypothesized that physical activity at midlife might prevent the decrease in muscle mass in old age.

2. Methods

2.1. Participants

Participants were recruited through a local press release requesting healthy community-dwelling volunteers. A total of 272 Japanese women aged 65 years and older (mean ± SD age 73.6 ± 5.5 years) living in the city of Kyoto enrolled in the study. Participants were interviewed and excluded if they met any of the following criteria: severe cognitive impairment; severe cardiac, pulmonary, or musculoskeletal disorders; and comorbidities associated with a greater risk of falls, such as Parkinson's disease and stroke. Written informed consent was obtained from each participant in accordance with the guidelines approved by the Kyoto University Graduate School of Medicine.

2.2. Assessment of physical activity

A questionnaire[13] was used to collect retrospective information about physical activity levels during midlife and old age. In the present study, we defined midlife as the period between the ages of 40 and 65 years. The questions were: 'How much physical activity did you have during midlife?' and 'How much physical activity do you have these days?' Similar to the approach used in the previous study, there were three response categories: no regular physical activity (0); regular physical activity (1); and regular sports (2). Regular physical activity/sports were defined based on a previous study[18] as activities/sports engaged in at a frequency of more than once a week. We defined light walking or moderate exercise (equivalent to less than approximately 4.0 metabolic equivalents) as physical activity and moderate or vigorous physical activities (equivalent to more than approximately 4.0 metabolic equivalents) as sports; these definitions were based on the International Physical Activity Questionnaire.[19] For each of the midlife and old age physical activity levels, Category 0 was defined as 'inactive' and Categories 1 and 2 (combined) were defined as 'active' in the analyses.

2.3. Skeletal muscle mass index

A bioelectrical impedance data acquisition system (Inbody 430; Biospace Co. Ltd, Seoul, Korea) was used to perform bioelectrical impedance analysis.[20] This system also uses an electrical current at multiple frequencies (5, 50, 250, 500, and 1000 kHz) to directly measure the amount of extracellular and intracellular water. The participants stood on two metallic electrodes and held metallic grip electrodes. Using segmental body composition, muscle mass was determined and used for further analysis. The skeletal muscle mass index (SMI) was calculated by dividing the muscle mass by height squared in meters (kg/m^2). This index has been used in several epidemiological studies.[4]

2.4. Measurements of physical performance

The following two measurements for the assessment of mobility and physical strength were made for each participant in the presence of experienced physiotherapists: (1) 10 m or 4 m walking test[21]; and (2) the hand grip strength (HGS) test.[22]

In the walking test, participants were asked to walk 10 m or 4 m at their normal walking speed. Walking time was calculated using a stopwatch to record the time taken to cover the central 10 m or 4 m of the walkway (2 m at the start and finish were used for acceleration and deceleration). Using the better walking time of two trials, the participants' walking speed (m/s) was calculated to obtain values for analyses.

In the HGS test, participants used a hand-held dynamometer with the arm held to the side of the body. The participants squeezed the dynamometer with maximum isometric effort. No other body movement was allowed. The HGS score was defined as the better performance of two trials.

2.5. Assessment of sarcopenia

For the present study we adopted the criteria of the European Working Group on Sarcopenia in Older People (EWGSOP).[23] The EWGSOP recommended defining sarcopenia as the presence of both low muscle function (slow walking speed equal to or less than 0.8 m/s; or low HGS equal to or less than 20 kg) and low muscle mass. For assessing low appendicular muscle mass, we divided the SMIs of the participants into quartiles and defined the first quartile as the cutoff for low appendicular muscle mass (SMI 5.55 kg/m^2).

2.6. Statistical analysis

Before analysis, we classified the participants into four groups according to physical activity levels in midlife and old age: Group I, physically inactive at both midlife and old age; Group II, physically active at midlife, but not at old age; Group III, physically inactive at midlife, but active at old age; and Group IV, physically active at both midlife and old age (Fig. 1).

Differences in the demographic variables among the four groups were examined using analysis of variance (ANOVA). When a significant effect was found, differences were determined with the Tukey–Kramer's post-hoc test. In addition, we entered four

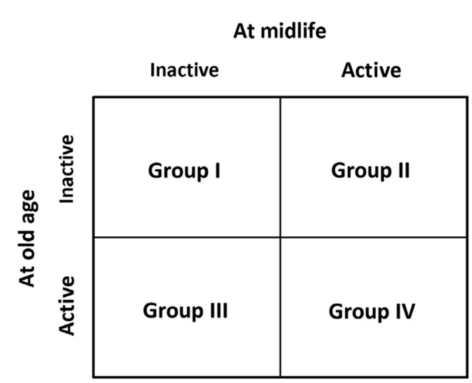

Fig. 1. Classification of participants in the four groups according to the midlife and old age physical activity levels: (Group I = physically inactive at both midlife and old age; Group II = physically active at midlife, but not at old age; Group III = physically inactive at midlife, but active at old age; Group IV = physically active at both midlife and old age).