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ORIGINAL ARTICLE

# Differences in physical function by body mass index in elderly Japanese individuals: The Fujiwara-kyo Study



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## KEYWORDS

Body mass index (BMI);  
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## Summary

**Objective:** This study examined differences in physical function according to body mass index (BMI) in elderly Japanese individuals.

**Methods:** Participants (1754 men and 1795 women aged  $\geq 65$  years) were divided into the following five BMI groups: low BMI ( $\leq 20.0$ ), low-medium BMI (20.1–22.5), medium BMI (22.6–25.0), medium-high BMI (25.1–27.5) and high BMI ( $\geq 27.6$ ). Physical function was measured according to BMI and sex, and associations between BMI and physical function were examined.

**Results:** Compared with the medium BMI group, handgrip strength (HGS), knee extension torque (KET), and knee flexion torque (KFT) were significantly lower in both sexes in the low BMI group, while KET and KFT were significantly higher among men in the high BMI group. One-leg standing time (OLST) with open eyes was significantly shorter among men in the high BMI group than in the medium BMI group. The high BMI group was significantly inferior to the medium BMI group in 10 m gait time (10MGT), OLST, and maximum one-step length to height ratio among women. All physical functions, except for 10MGT in men, were associated with BMI adjusted age and/or sex. Muscle strength showed a positive association with BMI in both sexes. There was a stronger association between BMI and physical performance in women compared to men.

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*Conclusion:* We found that BMI influences a variety of factors related to muscle strength and physical performance. Our findings may help contribute to the prevention of mobility impairments in elderly Japanese individuals.

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## Introduction

The terms overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health [1]; body mass index (BMI) is used as a tool for assessing overweight and obesity status worldwide [2]. Cut-off values for defining obesity among Asians differ between countries [3], with a BMI  $\geq 25.0$  indicating obesity among Japanese individuals [4]. The global age-standardised prevalence of overweight and obese individuals has increased since 1980, nearly doubling in 2008 [5]. Half of this increase occurred during the eight years between 2000 and 2008 [5]. The prevalence of overweight and obese individuals in Japan has increased over the last 10 years [6]. These individuals are at increased risk of developing chronic diseases, such as cardiovascular disease, diabetes mellitus, musculoskeletal disorders, and certain cancers [1]. Excessive body weight and obesity are among the leading global causes of mortality [7], with 15 kg of extra body weight increasing the risk of death by approximately 30% [8]. However, the relationship between BMI and cause-specific mortality is U-shaped, with the lowest mortality rates found in the range of 22.5–25.0 kg/m<sup>2</sup> among Europeans and North Americans [9], and within a similar range for Asians [10–12]. Normal BMI levels can help maintain good health.

In addition to its impact on mortality risk, obesity can limit the mobility of elderly people [13,14], and the risk for mobility and functional impairments rises with the severity of obesity in older adults [15]. Among older individuals whose BMI is greater than 35 kg/m<sup>2</sup>, physical performance is limited for activities such as walking, stair climbing, chair rise ability, and life-space mobility [16,17]. A decline in handgrip strength (HGS) is associated with other measures of decreased functional ability [18]. However, while a higher BMI is associated with poorer physical performance (e.g., chair rise, walking speed, standing balance), it is associated with stronger HGS [19]. Conversely, lower BMI is

associated with an increased risk of fracture [20]. BMI value of elderly Japanese individuals with sarcopenia or low muscle mass are lower than normal. Instrumental activities of daily living are disabled by sarcopenia and low muscle mass [21,22]. Marsh et al. [23] reported an association between low HGS and an increased risk of developing major mobility disability, as well as a U-shape relationship between baseline BMI and the risk of developing major mobility disability. Akune et al. [24] reported that both underweight and obese individuals were at an increased risk for need of care and decreased muscle strength and physical ability. The association between BMI and frailty also shows a U-shaped relationship, in which the level of frailty in elderly individuals increases among those with low and high BMIs [25].

Physical function and body composition change with age, and frailty and physical disability have a U-shaped relationship with BMI. Hence, we focused on the U-shaped relationship between BMI and physical function. This study aimed to investigate differences in physical functions (including muscle strength and physical performance) between various BMI categories in elderly Japanese individuals, in order to better understand conditions associated with low and high BMIs in this population.

## Materials and methods

### Subjects

Subjects included men and women aged over 65 years who participated in the Fujiwara-kyo cohort study [26,27]. Inclusion criteria included the ability to walk, with or without assistive devices, and the ability to communicate. The Administrative Centre of the Fujiwara-kyo Study recruited subjects from four cities in Nara, Japan, with the cooperation of various local resident associations and elderly people's clubs. A total of 4427 elderly individuals provided written informed consent and underwent

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