**Table 4**
Predictors of new LTCI service need certification during a 2-year follow-up period.

| | | Certified for LTCI requirement | | Non-certified for LTCI requirement | | Univariate analysis | | | Multivariate analysis | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | HR | 95%CI | P-value | HR | 95%CI | P-value |
| Gender | Female | 332 | 7.0% | 4405 | 93.0% | ref | | | ref | | |
| | Male | 204 | 6.1% | 3122 | 93.9% | 0.88 | 0.76–1.03 | 0.11 | 0.98 | 0.83–1.17 | 0.86 |
| BMI | Q1: <20.5 | 179 | 9.1% | 1796 | 90.9% | 1.53 | 1.21–1.92 | <0.01 | 1.41 | 1.11–1.79 | <0.01 |
| | Q2: 20.5–22.6 | 120 | 5.9% | 1915 | 94.1% | 1.00 | 0.78–1.29 | 1.00 | 1.01 | 0.78–1.30 | 0.92 |
| | Q3: 22.7–24.7 | 121 | 6.0% | 1892 | 94.0% | ref | | | ref | - | |
| | Q4: >24.7 | 140 | 6.9% | 1900 | 93.1% | 1.13 | 0.88–1.44 | 0.35 | 1.09 | 0.85–1.39 | 0.51 |
| Frailty checklist | Q1: <2 | 91 | 4.1% | 2106 | 95.9% | ref | | | ref | | |
| | Q2: 2–3 | 105 | 5.5% | 1802 | 94.5% | 1.36 | 1.03–1.80 | 0.03 | 1.30 | 1.30–1.73 | 0.13 |
| | Q3: 4–6 | 117 | 6.1% | 1800 | 93.9% | 1.51 | 1.15–1.99 | <0.01 | 1.41 | 1.06–1.86 | 0.01 |
| | Q4: >6 | 247 | 12.1% | 1795 | 87.9% | 3.04 | 2.38–3.87 | <0.01 | 2.63 | 2.05–3.39 | <0.01 |
| Serum albumin | Q1: <4.1 | 167 | 9.7% | 1555 | 90.3% | 1.75 | 1.36–2.24 | <0.01 | 1.36 | 1.05–1.75 | 0.02 |
| | Q2: 4.1–4.2 | 150 | 6.7% | 2076 | 93.3% | 1.19 | 0.92–1.53 | 0.18 | 1.04 | 0.81–1.35 | 0.75 |
| | Q3: 4.3–4.4 | 140 | 6.0% | 2200 | 94.0% | 1.09 | 0.84–1.40 | 0.52 | 1.01 | 0.78–1.31 | 0.93 |
| | Q4: >4.4 | 101 | 5.6% | 1694 | 94.4% | ref | | | ref | | |
| eGFR | Q1: <60.0 | 191 | 9.7% | 1772 | 90.3% | 1.99 | 1.55–2.54 | <0.01 | 1.63 | 1.26–2.09 | <0.01 |
| | Q2: 60.0–71.3 | 142 | 6.7% | 1983 | 93.3% | 1.37 | 1.06–1.77 | 0.02 | 1.25 | 0.96–1.62 | 0.10 |
| | Q3: 71.4–83.6 | 97 | 4.9% | 1871 | 95.1% | ref | | | ref | | |
| | Q4: >83.6 | 128 | 6.4% | 1879 | 93.6% | 1.29 | 0.99–1.68 | 0.06 | 1.17 | 0.89–1.53 | 0.26 |

The multivariate analysis was adjusted for gender, BMI, frailty checklist score, and serum albumin level.

a significantly larger number of subjects in the first quartile were certified as needing LTCI. Furthermore, previous studies have indicated that lower serum albumin levels are associated with future functional decline in older adults (Kalyani et al., 2012; Kane, Shamliyan, Talley, & Pacala, 2012). We assume that this result was caused by our study lacking sufficient power to demonstrate a contribution of low serum albumin to new LTCI service need certifications and by the small number of subjects with malnutrition in this cohort. Nonetheless, CKD was found to be significantly associated with new LTCI service need certification. Therefore, it should be noted that CKD may independently predict new LTCI service need certification in older adults.

We found that the subjects with the highest eGFR values (4th quartile) tended to have a higher risk of new LTCI service need certification, lower BMIs, and higher checklist scores than those in the 3rd quartile, although this difference was not statistically significant. Because eGFR is calculated using serum creatinine levels, a higher eGFR may indicate lower muscle mass, especially in

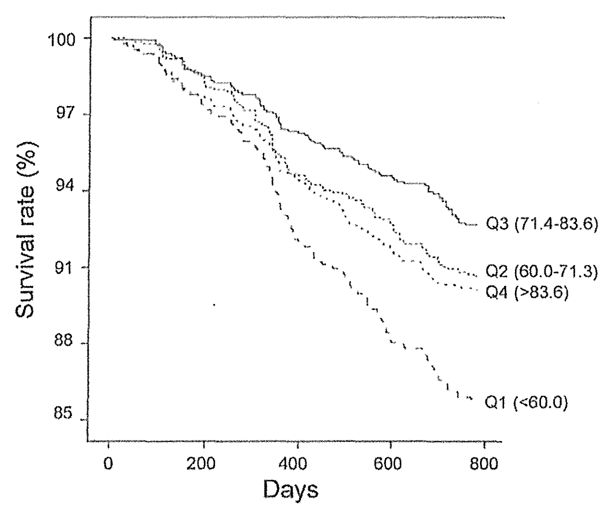


**Fig. 1.** Kaplan-Meier survival curves for new LTCI service need are shown for 4 groups according to eGFR quartile.

older adults. Therefore, it should be noted that older adults with elevated eGFR values may be frail. Further research is required to address the role of eGFR in frailty.

Malnutrition is known to be associated with frailty. Several studies have suggested that vitamin D deficiencies are common among patients with CKD (Reuben et al., 2002; Zuliani et al., 2001). Both vitamin D2 and D3 are first converted to 25-hydroxyvitamin D by hepatic vitamin D-25-hydroxylase and are then converted to the active form, 1,25-hydroxyvitamin D, by renal 1$\alpha$-hydroxylase (Zuliani et al., 2001). Reduced activation of vitamin D has been associated with the development of hypertension, left ventricular hypertrophy, heart failure, and vascular calcification (Holick, 2007). In addition, vitamin D deficiency has been associated with sarcopenia, falls, fractures, and dementia (Bischoff-Ferrari, 2012; Chonchol, Kendrick, & Targher, 2011; Cozzolino & Ronco, 2011). Therefore, we hypothesized that CKD was a risk factor for new LTCI service need certification.

Two limitations of this study warrant mention. First, we did not collect information about the subjects' comorbidities. Therefore, the effects of comorbidities on the risk of new certifications for LTCI service need remain unclear. Second, the study participants may have had a greater motivation and interest in health issues than the non-participants. Therefore, it is possible that the non-participants had a higher prevalence of CKD and frailty.

In conclusion, this is the first study to demonstrate that CKD is independently associated with new certifications for LTCI service need. In addition, a relatively high percentage of the subjects had moderate to severe CKD (eGFR <60 ml/min/1.73 m$^2$). Intervention studies are needed to explore whether treating CKD may delay or prevent new certifications for LTCI service need among older adults.

## Conflicts of interest

None of the authors have conflicts of interest or financial disclosures.

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ORIGINAL ARTICLE

# Age-dependent changes in skeletal muscle mass and visceral fat area in Japanese adults from 40 to 79 years-of-age

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**Aim:** The age-dependent loss of skeletal muscle mass is highly concerning in diverse aging populations. However, age-dependent changes in muscle mass and the visceral fat area have not been well documented in Asian populations. The aim of the present study was to evaluate the age-dependent changes in skeletal muscle mass and the visceral fat area in Japanese adults from 40 to 79 years-of-age.

**Methods:** This was a cross-sectional study. Healthy men ($n$ = 16 379) and women ($n$ = 21 660) aged 40–79 years participated in the present study. The skeletal muscle mass and visceral fat area were measured in the study participants by bioelectrical impedance. The muscle mass data were converted into the skeletal muscle mass index (SMI) by dividing the weight by the height squared (kg/m$^2$).

**Results:** The SMI showed an age-dependent decrease in both sexes. Between 40 and 79 years, the total SMI decreased by 10.8% in men and by 6.4% in women. The arm SMI decreased by 12.6% in men and 4.1% in women, and the leg SMI decreased by 10.1% in men and by 7.1% in women in the same period. In contrast, the visceral fat area showed an age-dependent increase in both sexes. The visceral fat area increased by 42.9% in men and by 65.3% in women. The multiple regression analysis showed that the SMI was negatively associated with visceral obesity in both sexes.

**Conclusions:** In Japanese adults, sex-specific changes in skeletal muscle mass are more prominent in the arm than in the leg. Furthermore, the age-dependent increases in visceral adipose tissue might lead to loss of skeletal muscle mass. **Geriatr Gerontol Int 2014; 14 (Suppl. 1): 8–14.**

**Keywords:** age-dependent, Japanese, skeletal muscle mass, visceral fat area.

## Introduction

Sarcopenia is an age-dependent loss of skeletal muscle mass, and is a serious medical concern in older populations.[1,2] Sarcopenia is characterized by an impaired state of health associated with mobility disorders, an increased risk of falls and fractures, an impaired ability to carry out activities of daily living, disabilities, and a loss of independence.[3–5]

Previous epidemiological studies of sarcopenia in several countries have shown a disease prevalence of 5–40% in older men and 7–70% in older women.[6–18] In general, the prevalence of sarcopenia is approximately 25% in older men and 20% in older women. Notably, previous work from this laboratory has shown that sarcopenia is highly prevalent among Japanese adults aged 80 years and older.[18] Because older adults have a greater potential for health problems than young adults, it is very important to begin prevention of sarcopenia early, possibly before the age of 65 years. Two previous studies from the USA and Europe have shown that the age-dependent loss of skeletal muscle mass starts at approximately 50 years-of-age, and that skeletal muscle mass declines by 6.6–23.3% until 79 years-of-age.[19,20] However, age-dependent changes in muscle mass in Asians are not well documented.

Visceral adiposity, which is the basis of metabolic syndrome and cardiovascular disease, is aggravated with age.[21] The visceral adipose tissue produces many inflammatory cytokines, such as tumor necrosis factor-alpha (TNF-α) and interleukin (IL)-6,[22] and expression of these inflammatory cytokines can lead to increased skeletal muscle breakdown.[23] Furthermore, previous studies have shown that increased visceral fat area is associated with decreased skeletal muscle mass in a

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small sample of older adults.[24] However, the association of skeletal muscle mass with age-dependent changes in visceral fat in a large population has not previously been shown.

The primary aim of the present study was to evaluate the age-dependent changes in skeletal muscle mass and visceral fat area using a large cross-sectional cohort of Japanese adults between 40 and 79 years-of-age. We also evaluated sex differences in skeletal muscle loss in the arms and legs. The secondary aim of the present study was to evaluate the association between the skeletal muscle mass and visceral fat area.

## Methods

### *Participants*

Participants were recruited by advertisements at several fitness and community centers. The participants in the present study were limited to visitors to these centers in the Kyoto, Osaka, and Hyogo prefectures in Japan. The inclusion criteria were an age of 40–79 years, living in the community and the ability to walk independently (including with a cane). The exclusion criteria were a certification of frailty status by the long-term care insurance service in Japan and artificial implants, such as cardiac pacemakers and replacement joints, which would interfere with accurate bioimpedance measurements. An interview was also used to identify those with the following exclusion criteria: severe cognitive impairment; severe cardiac, pulmonary, or musculoskeletal disorders; and comorbidities associated with greater risk of falls, such as Parkinson's disease or stroke. Because the purpose of the present study was to address physiological age-dependent changes in body composition, we excluded frail elderly and adults with those comorbidities. The present study was carried out in accordance with the guidelines of the Declaration of Helsinki, and the study protocol was reviewed and approved by the Ethics Committee of the Kyoto University Graduate School of Medicine.

Healthy men ($n$ = 16 379) and women ($n$ = 21 660) aged 40–79 years participated in the present study. The male participants were divided into eight groups according to age: 40–44 ($n$ = 3697), 45–49 ($n$ = 3151), 50–54 ($n$ = 2202), 55–59 ($n$ = 1952), 60–64 ($n$ = 2274), 65–69 ($n$ = 1683), 70–74 ($n$ = 1030), and 75–79 ($n$ = 390) years. The female participants were similarly divided into eight groups according to age: 40–44 ($n$ = 3828), 45–49 ($n$ = 3686), 50–54 ($n$ = 3597), 55–59 ($n$ = 3002), 60–64 ($n$ = 3490), 65–69 ($n$ = 2314), 70–74 ($n$ = 1269), and 75–79 ($n$ = 474) years.

### *Skeletal muscle mass index and visceral fat area*

A bioelectrical impedance data acquisition system (Inbody 720; Biospace, Seoul, Korea) was used to determine bioelectrical impedance.[25] This system uses an electrical current at different frequencies (5, 50, 250, 500, and 1000 kHz) to directly measure the amount of extracellular and intracellular water in the body. The study participants stood on two metallic electrodes and held metallic grip electrodes. Using segmental body composition and muscle mass, a value for the appendicular skeletal muscle mass was determined and used for further analysis. The muscle mass was converted into the skeletal muscle mass index (SMI) by dividing the weight by the height squared (kg/m$^2$). This index has been used in several epidemiological studies.[6,26] Additionally, the SMI of the arms and legs was calculated. The visceral fat area was determined by evaluating a transverse cross-section of the fourth and fifth abdominal lumbar area.

### *Statistical analysis*

Differences in the total SMI, arm SMI, leg SMI, and visceral fat area among the eight age groups were examined using an analysis of variance. Multiple regression models were applied to determine the relationship between the visceral fat area and the SMI, adjusted for age and weight in each sex. The data were managed and analyzed using SPSS (Windows version 18.0; SPSS, Chicago, IL, USA). A $P$-value of <0.05 was considered to show statistical significance for all analyses.

## Results

The mean age of the study participants was 54.5 ± 9.9 years, and 21 660 (56.9%) of the participants were women. The total SMI showed an age-dependent decrease in both sexes (men, $F = 251.1$, $P < 0.001$; women, $F = 135.6$, $P < 0.001$; Table 1). The percentage change in the total SMI at 40–44 years showed an age-dependent decrease in both sexes (Fig. 1, Table 1). In those aged over 65 years, the percentage change in the total SMI was greater in men than in women. In addition, the 20th percentile of total SMI in men and women aged 65–79 years was 7.02 kg/m$^2$ and 5.61 kg/m$^2$, respectively (Table 2).

To compare the age-dependent changes in muscle mass in the upper and lower limbs in this cohort, we analyzed the arm and leg SMI. The arm SMI showed an age-dependent decrease in both sexes (men, $F = 132.1$, $P < 0.001$; women, $F = 24.1$, $P < 0.001$; Table 1). The percentage change in the arm SMI using the 40–44 years group as a reference also showed an age-dependent decrease in both sexes (Fig. 2, Table 1).

Similarly to the arm SMI, the leg SMI also showed an age-dependent decrease in both sexes (men, $F = 273.2$, $P < 0.001$; women, $F = 192.2$, $P < 0.001$; Table 1). The percentage change in the leg SMI also showed an

**Table 1** Participant characteristics by age half decade

| | | Overall Men ($n$ = 16 379) Women ($n$ = 21 660) | | | 40–44 years Men ($n$ = 3697) Women ($n$ = 3828) | | | 45–49 years Men ($n$ = 3151) Women ($n$ = 3686) | | | 50–54 years Men ($n$ = 2202) Women ($n$ = 3597) | | | 55–59 Men ($n$ = 1952) Women ($n$ = 3002) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | % change over 40–44 years | Mean | SD | % change over 40–44 years | Mean | SD | % change over 40–44 years | Mean | SD | % change over 40–44 years | Mean | SD | % change over 40–44 years |
| Total SMI (kg/m²) | Men | 7.97 | 0.73 | – | 8.20 | 0.78 | – | 8.11 | 0.66 | −1.0 | 8.11 | 0.67 | −1.1 | 7.98 | 0.64 | −2.7 |
| | Women | 6.26 | 0.64 | – | 6.41 | 0.67 | – | 6.39 | 0.64 | −0.3 | 6.33 | 0.64 | −1.3 | 6.23 | 0.59 | −2.8 |
| Arm SMI (kg/m²) | Men | 2.08 | 0.28 | – | 2.14 | 0.31 | – | 2.11 | 0.26 | −1.4 | 2.11 | 0.26 | −1.2 | 2.08 | 0.24 | −3.0 |
| | Women | 1.47 | 0.22 | – | 1.49 | 0.24 | – | 1.49 | 0.23 | −0.5 | 1.47 | 0.22 | −1.4 | 1.46 | 0.21 | −2.3 |
| Leg SMI (kg/m²) | Men | 7.98 | 0.73 | – | 6.06 | 0.51 | – | 6.00 | 0.46 | −0.9 | 5.99 | 0.46 | −1.1 | 5.91 | 0.45 | −2.5 |
| | Women | 6.26 | 0.64 | – | 4.92 | 0.48 | – | 4.91 | 0.45 | −0.3 | 4.85 | 0.46 | −1.3 | 4.77 | 0.42 | −3.0 |
| Visceral fat area (cm²) | Men | 100.6 | 29.2 | – | 88.4 | 28.8 | – | 91.9 | 27.1 | 4.0 | 98.9 | 28.8 | 11.9 | 103.5 | 25.7 | 17.1 |
| | Women | 84.7 | 27.4 | – | 68.0 | 25.3 | – | 72.1 | 23.9 | 6.0 | 79.3 | 23.6 | 16.5 | 89.4 | 23.0 | 31.5 |

| | | 60–64 years Men ($n$ = 2274) Women ($n$ = 3490) | | | 65–69 years Men ($n$ = 1683) Women ($n$ = 2314) | | | 70–74 years Men ($n$ = 1030) Women ($n$ = 1269) | | | 75–79 years Men ($n$ = 390) Women ($n$ = 474) | | | ANOVA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | % change over 40–44 years | Mean | SD | % change over 40–44 years | Mean | SD | % change over 40–44 years | Mean | SD | % change over 40–44 years | $F$-value | $P$-value |
| Total SMI (kg/m²) | Men | 7.84 | 0.68 | −4.3 | 7.64 | 0.67 | −6.9 | 7.59 | 0.66 | −7.4 | 7.32 | 0.62 | −10.8 | 251.1 | <0.001 |
| | Women | 6.14 | 0.61 | −4.2 | 6.08 | 0.60 | −5.2 | 6.09 | 0.55 | −5.1 | 6.00 | 0.60 | −6.4 | 135.6 | <0.001 |
| Arm SMI (kg/m²) | Men | 2.05 | 0.25 | −4.4 | 1.99 | 0.25 | −6.9 | 1.96 | 0.24 | −8.5 | 1.87 | 0.26 | −12.6 | 132.1 | <0.001 |
| | Women | 1.45 | 0.22 | −3.1 | 1.44 | 0.21 | −3.6 | 1.46 | 0.20 | −2.5 | 1.43 | 0.21 | −4.1 | 24.1 | <0.001 |
| Leg SMI (kg/m²) | Men | 5.80 | 0.48 | −4.3 | 5.64 | 0.46 | −6.9 | 5.64 | 0.51 | −7.0 | 5.45 | 0.45 | −10.1 | 273.2 | <0.001 |
| | Women | 4.69 | 0.43 | −4.6 | 4.64 | 0.44 | −5.7 | 4.63 | 0.41 | −5.9 | 4.57 | 0.45 | −7.1 | 192.2 | <0.001 |
| Visceral fat area (cm²) | Men | 108.3 | 26.2 | 22.5 | 113.0 | 25.7 | 27.8 | 122.3 | 25.1 | 38.3 | 126.4 | 25.2 | 42.9 | 376.9 | <0.001 |
| | Women | 94.0 | 23.3 | 38.2 | 101.6 | 23.0 | 49.4 | 108.5 | 24.1 | 59.5 | 112.4 | 29.3 | 65.3 | 966.7 | <0.001 |

Percentage change of 40–44 years = (absolute change value / 40–44 years value) × 100. SMI, skeletal muscle mass index.

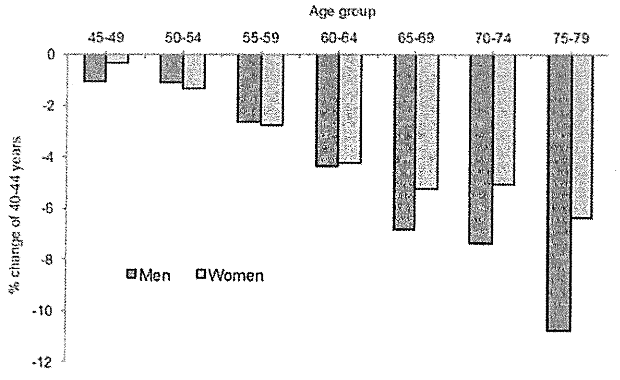


**Figure 1** The percentage of change in the total skeletal muscle mass index in each sex and each age group, using 40–44 years-of-age as a reference.

**Table 2** 20th percentile of total skeletal muscle mass index (kg/m²) in both sexes

| Age group (years) | 20th percentile of SMI Men | Women |
|---|---|---|
| 65–69 | 7.06 | 5.61 |
| 70–74 | 7.09 | 5.63 |
| 75–79 | 6.83 | 5.54 |
| 65–79 | 7.02 | 5.61 |

SMI, skeletal muscle mass index.

age-dependent decrease in both sexes (Fig. 2, Table 1). The age-dependent changes in the leg SMI were similar in men and women. However, the age-dependent changes in the arm SMI were greater in men than in women.

Next, we examined the age-dependent changes in visceral obesity. The visceral fat area showed an age-dependent increase in both sexes (men, $F = 376.9$, $P < 0.001$; women, $F = 966.7$, $P < 0.001$; Table 1). The percentage change from 40–44 years in the visceral fat area showed an age-dependent increase in both sexes (Fig. 3, Table 1).

To examine the association between skeletal muscle mass and visceral obesity, we carried out a multiple regression analysis using the SMI as an outcome. We found that the visceral fat area, age, and weight were significant and independent determinants of the SMI in both men ($\beta = -0.586$) and women ($\beta = -0.627$; Table 3). Therefore, the age-dependent change in the SMI was negatively associated with the visceral-fat area in both sexes.

## Discussion

The current cross-sectional study was carried out to evaluate the SMI in Japanese adults aged between 40 and 79 years. Our data show that the SMI decreased age-dependently in both sexes. Notably, regarding the age-dependent decreases in the total SMI and in those aged over 65 years, the percentage change in the total SMI was greater in men than in women. From 40 to 79 years, the total SMI decreased by 10.8% in men and by 6.4% in women. Previous epidemiological studies of body composition have shown that between 40 and 79 years, the fat-free mass decreases by 6.6–23.3% in both sexes.[19,20] The age-dependent increases in inflammatory cytokines, such as IL-6 and TNF-α, can result in increased skeletal muscle breakdown.[23] In contrast, the age-dependent decrease in anabolic hormones, such as testosterone, growth hormone, and insulin-like growth factor-1 (IGF-1), might lead to a loss of skeletal muscle

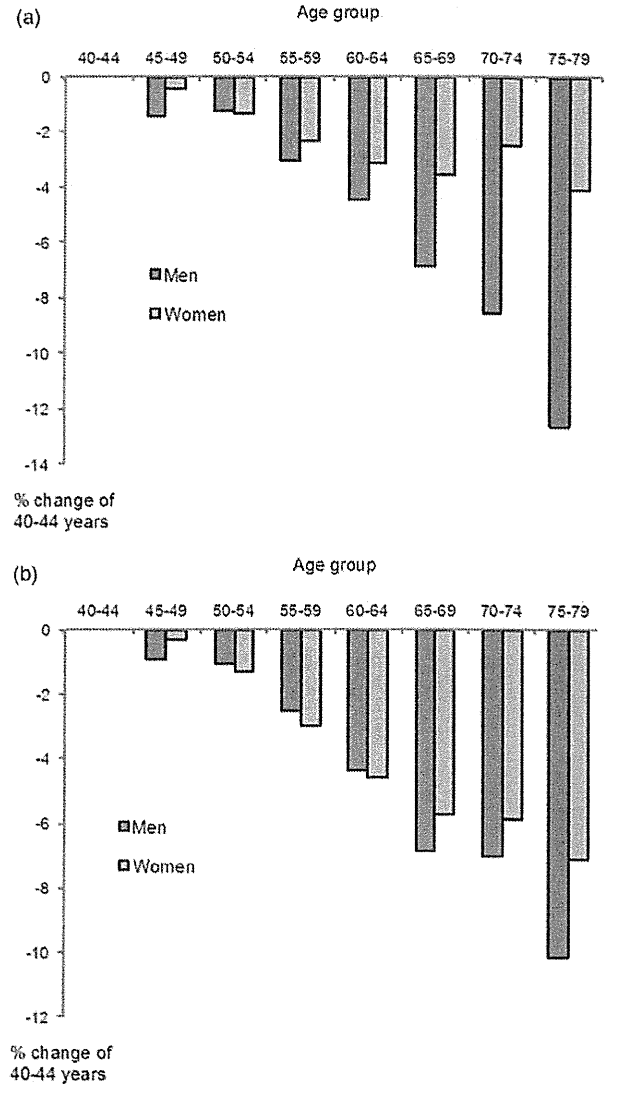


**Figure 2** The percentage of change in the (a) arm and (b) leg skeletal muscle mass index (SMI) in each sex and each age group using 40–44 years-of-age as a reference.

mass.[27,28] In addition, there is also an age-dependent decrease in the amount of physical activity and energy intake. These behavioral changes can enhance the age-dependent reduction in skeletal muscle mass.

Interestingly, in those aged over 65 years, age-dependent decreases in total SMI were greater in men than in women. Furthermore, this age-dependent sex difference was more prominent in the arm than in the leg. From 40 to 79 years, the arm SMI decreased by 12.6% in men and by 4.1% in women. This is consistent to the previous studies in Japanese older adults. Kitamura *et al.* reported that the arm lean tissue mass was 5.97 ± 0.75 and 5.01 ± 0.67 in men, and 3.56 ± 0.54 and 3.24 in women aged in their 40s and 70s, respectively.[29] Based on their data, the percentage change in the arm lean tissue mass in men is –16.0% and is –8.9% in women. However, there is no sex difference in the percentage change in the leg lean tissue mass. The mechanism of this sex difference in the arm and leg lean tissue mass change is not clear. In general, older Japanese women frequently use the upper limbs, such as when washing and cooking. However, older Japanese men usually do not carry out such work. Therefore, it is possible that these behavioral differences lead to greater age-dependent decreases in the arm SMI in men than in women. As another possibility, Baumgartner reported that the sex hormone signal is an important factor for muscle mass in men, but not in women; however, physical activity is an important factor for muscle mass in both sexes.[30] Furthermore, previous studies have shown that 20% of men older than 60 years, 30% of men older than 70 years, and 50% of men older than 80 years have serum testosterone levels below the normal range.[31] Thus, it is also possible that the sex hormone-dependent changes in muscle mass are greater in men than in women. Therefore, age-dependent gender differences in the SMI might be influenced by daily activity or alterations in sex hormone levels.

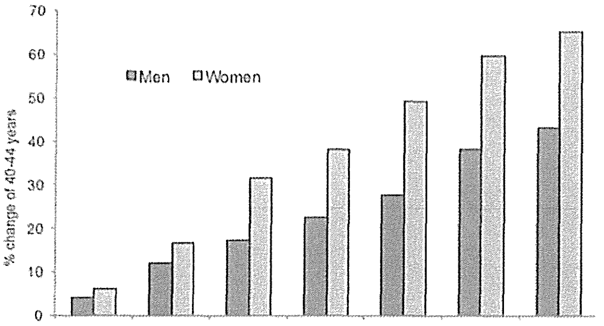


**Figure 3** The percentage of change in the visceral fat area in each sex and each age group using 40–44 years-of-age as a reference.

The present data show that aging is associated with a progressive increase in visceral fat area in both sexes. From 40 to 79 years of age, the visceral fat area increased by 42.9% in men and by 65.3% in women. Furthermore, the SMI was negatively associated with the visceral fat area when adjusted for age and body weight in both sexes. The visceral adipose tissue produces many catabolic factors, such as TNF-α and IL-6.[22] Therefore, the age-dependent increases in both visceral adipose tissue and inflammatory cytokines might lead to a loss of skeletal muscle mass. Recently, sarcopenic obesity has been defined as both low muscle mass and high adipose tissue in older adults, and the health-related risk is higher in sarcopenic obesity than in sarcopenia.[32] The current data show that the age-dependent changes in body composition can accelerate sarcopenic obesity. These results suggest that it is very important to begin prevention of sarcopenia and sarcopenic obesity as early as possible.

According to our analysis of this cohort, we found that the 20th percentile of total SMI in men and women aged 65–79 years was 7.02 kg/m$^2$ and 5.61 kg/m$^2$, respectively. These values were slightly higher than those determined by the young adult mean in our database (men 6.75 kg/m$^2$; women 5.07 kg/m$^2$).[18] That these values were lower than the 20th percentile of total SMI

**Table 3** Multiple regression analysis for the association with skeletal muscle mass index in both sexes

| Independent variables | Men<br>Adjusted $R^2$ value = 0.781**<br>standard regression value | Women<br>Adjusted $R^2$ value = 0.627**<br>standard regression value |
|---|---|---|
| Visceral fat area (cm$^2$) | –0.586** | –0.627** |
| Age (year) | 0.212** | 0.252** |
| Weight (kg) | 1.180** | 1.169** |

**$P < 0.01$.

is probably because we did not use the data of SMI in participants aged 80 years and older. Other studies on sarcopenia in Asia also show that the cut-off of SMI is 6.08–7.27 $kg/m^2$ in men and 4.79–5.80 $kg/m^2$ in women,[13,33–35] which is quite consistent with the present results. Thus, the 20th percentile of total SMI in men and women in our data can be used for the cut-off of SMI in Asians; however, further studies are required to address whether these cut-off points are associated with adverse health outcomes in Asian older adults.

There were several limitations to the present study that warrant mention. First, physical performance data were not measured. The European Working Group on Sarcopenia in Older People (EWGSOP) has recommended using the presence of both low muscle function (low physical performance or muscle strength) and low muscle mass to diagnose sarcopenia.[36] Therefore, the prevalence of sarcopenia could not be determined. Second, the study design was cross-sectional, and no outcome data are available. Further research with a longitudinal design will be required to clarify whether low muscle mass can predict adverse health outcomes in older Japanese adults. Third, the SMI measurement was estimated using BIA, which is not a method that is recommended by the EWGSOP for assessing muscle mass. However, it is very challenging to measure muscle mass in community-dwelling older adults using dual-energy X-ray absorptiometry (DXA); thus, BIA is a more practical screening method to use in large samples, especially in a community setting. However, to determine the specific effect of an intervention, a more accurate measurement, such as DXA, computed tomography, or magnetic resonance imaging, should be used in future studies. Serum outcomes were not measured. Therefore, the relationship between the SMI and hormone signals could not be determined. Finally, the participants in the present study were limited to visitors to fitness and community centers. Therefore, the participants of this study might not be a representative sample of community-dwelling adults.

In conclusion, the SMI showed an age-dependent decrease in both sexes, and the total SMI decreased by 10.8% in men and by 6.4% in women aged 40–79 years. Notably, age-dependent sex differences were more pronounced in the arm SMI; from 40 to 79 years, the arm SMI decreased by 12.6% in men and 4.1% in women. These results suggest that the age-dependent loss of skeletal muscle mass begins at approximately 40 years-of-age, and becomes prominent after 50 years-of-age in Japanese adults. Furthermore, the visceral fat area showed an age-dependent increase in both sexes, and the visceral fat area increased by 42.9% in men and by 65.3% in women of 40–79 years-of-age. Finally, the SMI was negatively associated with the visceral fat area in both sexes. Thus far, no studies have reported age-dependent changes and the association of muscle mass and visceral fat in Asian populations. Therefore, the current data could be used as the reference value for Asian adults.

## Acknowledgements

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## Disclosure statement

The authors declare no conflict of interest.

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ORIGINAL ARTICLE: EPIDEMIOLOGY, CLINICAL PRACTICE AND HEALTH

# Effect of physical activity on memory function in older adults with mild Alzheimer's disease and mild cognitive impairment

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**Aim:** It is very important to maintain cognitive function in patients with mild cognitive disorder. The aim of the present study was to determine whether the amount of physical activity is associated with memory function in older adults with mild cognitive disorder.

**Methods:** A total of 47 older adults with mild cognitive disorder were studied; 30 were diagnosed with mild Alzheimer's disease and 17 with mild cognitive impairment. The global cognitive function, memory function, physical performance and amount of physical activity were measured in these patients. We divided these patients according to their walking speed (<1 m/s or >1 m/s). A total of 26 elderly patients were classified as the slow walking group, whereas 21 were classified as the normal walking group.

**Results:** The normal walking group was younger and had significantly better scores than the slow walking group in physical performance. Stepwise multiple linear regression analysis showed that only the daily step counts were associated with the Scenery Picture Memory Test in patients of the slow walking group ($\beta = 0.471$, $P = 0.031$), but not other variables. No variable was significantly associated with the Scenery Picture Memory Test in the normal walking group.

**Conclusions:** Memory function was strongly associated with the amount of physical activity in patients with mild cognitive disorder who showed slow walking speed. The results show that lower physical activities could be a risk factor for cognitive decline, and that cognitive function in the elderly whose motor function and cognitive function are declining can be improved by increasing the amount of physical activity. **Geriatr Gerontol Int 2014; 14: 758–762.**

**Keywords:** memory function, mild cognitive disorder, older adults, physical activity, physical performance.

## Introduction

Mild cognitive impairment (MCI) is a condition of objective cognitive impairment based on neuropsychological testing in the absence of clinically overt dementia.[1] This condition is of interest for identifying the prodromal and transitional stages of Alzheimer's disease (AD)[2,3] and other types of dementia. Indeed, a study shows that more than half of MCI cases progress to dementia within 5 years.[1] However, it is reported that the cognitive function of people with MCI can recover to normal.[4,5] Indeed, one study showed that 38.5% of older adults with MCI recovered to normal within 5 years.[6] Therefore, it is very important to prevent the deterioration of MCI to dementia. Because no consensus has been established regarding pharmacological intervention for MCI, non-pharmacological intervention is expected. Accordingly, we need to establish a way to prevent deterioration or even improve cognitive function in MCI patients.

Recently, it has attracted attention that increasing the amount of physical activity can prevent the decline of cognitive function. Many studies reported that global cognitive function is associated with the amount of physical activity. Furthermore, previous reports have shown that physical frailty is associated with an increased risk of developing AD and MCI,[8,9] and can predict a future cognitive decline in older adults.[10] Additionally, people with dementia have been shown to be

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frail because of their poor mobility and body composition.[11,12] Thus, cognitive function and physical frailty are interrelated.

Accordingly, the cognitive decline in frail elderly patients can cause further decline of cognitive function and motor function. Therefore, it is important to maintain and improve the cognitive function of the frail elderly with mild cognitive disorder.

Several studies have shown the relationship between cognitive decline that can be observed at the early stage of dementia and the amount of physical activity. However, no study has addressed whether the association between cognitive function and the amount of physical activity depends on the level of motor function in MCI or mild AD patients.

Therefore, the aim of the present study was to determine whether there is an association between memory function and the amount of physical activity in older adults with mild cognitive disorder, stratified by their motor function.

## Methods

### *Participants*

We recruited patients from the memory clinic of the Department of Geriatric Medicine in Kyoto University Hospital, Kyoto, Japan. The diagnosis of AD or MCI was made according to the following criteria: AD, *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition, and the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association;[13,14] and MCI, Petersen's criteria.[15] Of the 47 patients with cognitive disorder, 30 were classified as mild AD and 17 as MCI by the criteria. In the present study, we did not set the upper and lower limits of the Mini-Mental State Examination (MMSE) for the diagnosis of MCI. The exclusion criteria used in the present study were vascular dementia, dementia with Lewy bodies, lacunar infarcts, Fazekas grade 3 periventricular hyperintensity/deep white-matter hyperintensity,[16] severe cardiac, pulmonary or musculoskeletal disorders, or the presence of comorbidities associated with an increased risk of falls, such as Parkinson's disease and stroke.

Written informed consent for the trial was obtained from each participant or his/her family members in accordance with the guidelines approved by the Kyoto University Graduate School of Medicine and the Declaration of Human Rights, Helsinki, 1975.

### *Walking speed*

Comfortable 10-m walking time (walking time) is a simple test developed to screen basic mobility performance in frail older adults. It has been reported that the elderly with a walking score greater than 10.0 s can suffer an increased risk of falling.

Therefore, we divided the participants into two groups according to their walking speed (cut-off: 1 m/s); 26 of the older adults were classified as the normal walking group, whereas 21 of the older adults were classified as the slow walking group.

### *Cognitive function measures*

Cognitive function was assessed by the MMSE and the Scenery Picture Memory Test (SPMT). MMSE is a global cognitive test that can be used to systematically and thoroughly assess mental status. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language. The maximum score is 30. A score of 23 or lower is indicative of cognitive impairment. SPMT is a short and simple memory test assessing the visual memory encoded as scenery, combined with verbal answers. Briefly, it uses a line drawing scenery picture of a living room in a house where 23 objects commonly observed in daily life are drawn on an A4 piece of paper. The examinee is instructed to look at the picture for 1 min and remember the items. After this encoding period, we distracted participants by asking them to carry out a brief digits forward test. Participants were then asked to recall the objects in the picture without time limitation. This recall time usually takes less than 1 min. The number of items recalled is the score for SPMT. Higher scores indicate better cognitive function. We have previously shown that SPMT is a quick and effective screen for MCI.[17]

### *Physical performance measures*

The participants were asked to carry out the three motor function tests that are widely used to identify the frail elderly. For each performance task, the participants carried out two trials, and the better performance of the two was used for the analysis. Physical performance assessments, such as walking time,[18] the Timed Up & Go (TUG) test,[19] the Functional Reach test,[20] the one-leg stand (OLS) test,[21] and the five chair stand test (5CS)[22] were carried out as previously described.

### *Physical activity measures*

In physical activity, a valid, accurate and reliable pedometer, the Yamax Power walker EX-510, was used to measure the free-living step counts.[23] The participants were instructed to wear the pedometer in their pocket on the side of their dominant leg for 14 consecutive days except when bathing, sleeping or carrying out water-based activities. This pedometer has a 30-day data storage capacity. We calculated the averages of their daily step counts for 2 weeks.

**Table 1** Comparison of demographic characteristics and measurements with the overall group, normal walking group, and slow walking group

| | All (= 47) | Normal walking (= 26) | Slow walking (= 21) | $P$-value |
|---|---|---|---|---|
| Age (years) | 76.9 ± 7.0 | 74.7 ± 7.2 | 79.6 ± 5.9 | 0.016* |
| Female sex, $n$ (%) | 28 (59.6%) | 17 (65.4%) | 11 (52.4%) | 0.38 |
| BMI | 21.7 ± 3.7 | 22.1 ± 3.7 | 21.1 ± 3.8 | 0.36 |
| Loneliness | 5 (10.6%) | 2 (7.7%) | 3 (14.3%) | 0.64 |
| Donepezil treatment | 41 (87.2%) | 24 (92.3%) | 17 (81.0%) | 0.39 |
| MMSE | 23.4 ± 3.6 | 23.0 ± 3.1 | 24.0 ± 4.2 | 0.37 |
| SPMT | 6.5 ± 4.7 | 6.7 ± 5.1 | 6.1 ± 4.4 | 0.68 |
| Physical activity | 4371.9 ± 3605.9 | 5264.0 ± 3476.9 | 3267.4 ± 3532.5 | 0.06 |
| 10 m walking time | 9.9 ± 2.3 | 8.2 ± 1.0 | 12.3 ± 1.6 | <0.001*** |
| TUG time | 9.5 ± 2.7 | 7.9 ± 1.4 | 11.4 ± 2.6 | <0.001*** |
| OLS | 11.9 ± 15.8 | 16.9 ± 19.3 | 5.8 ± 6.1 | 0.01* |
| 5CS | 11.1 ± 3.5 | 10.0 ± 2.2 | 12.4 ± 4.2 | 0.016* |

5CS, five chair stand test; BMI, body mass index; MMSE, Mini-Mental State examination; OLS, one leg standing; SPMT, Scenery Picture Memory Test; TUG, Timed Up & Go test. $^{*}P < 0.05$ $^{***}P < 0.001$.

### *Statistical analysis*

The $t$-test and $\chi^2$-test were used to compare the data between the normal and slow walking groups. Multiple linear regression analysis using a stepwise method was carried out to investigate whether physical activity, age, sex, body mass index, TUG, OLS and 5CS were independently associated with SPMT. The data were analyzed using SPSS software Windows version 20.0 (SPSS, Chicago, IL, USA). A $P$-value <0.05 was considered statistically significant for all analyses.

## Results

The demographic characteristics of the overall, normal and slow walking groups are summarized in Table 1. A total of 26 patients were classified as the normal walking group, and 21 patients as the slow walking group. There were no significant differences in sex, body mass index, loneliness, donepezil treatment, SPMT or physical activity between the two groups ($P > 0.05$). The normal walking group was younger (normal walking group 74.7 ± 7.2, slow walking group 79.6 ± 5.9, $P = 0.016$), and had significantly better scores than the slow walking group in TUG (normal walking group 7.9 ± 1.4 s, slow walking group 11.4 ± 2.6 s, $P < 0.001$), OLS (normal walking group 24.3 ± 24.3 s, slow walking group 5.8 ± 6.1 s, $P = 0.006$), 5CS (normal walking group 10.0 ± 2.2 s, slow walking group 12.4 ± 4.2 s, $P = 0.016$; Table 1). In the slow walking group, physical activity was significantly correlated with SPMT ($r = 0.471$, $P = 0.031$), as shown in Figure 1, but this correlation was absent in the normal walking group. In addition, there was a correlation between SPMT and physical activity after adjusted by age and sex in the slow walking group ($r = 0.493$, $P = 0.032$).

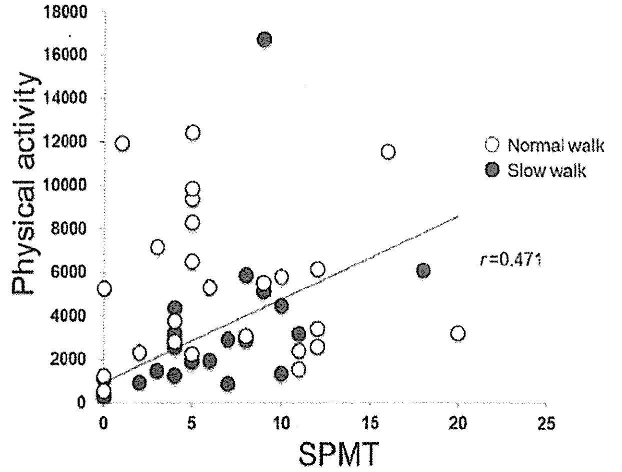


**Figure 1** Relationship between physical activity and the Scenery Picture Memory Test (SPMT) in the normal walking and slow walking groups. In the slow walking group, physical activity was correlated significantly with SPMT ($r = 0.471$, $P = 0.031$).

Stepwise multiple linear regression analysis showed that no item was significantly associated with SPMT in the normal walking group, whereas only physical activity ($\beta = 0.471$, $P = 0.031$) was significantly associated with SPMT in the slow walking group (Table 2).

## Discussion

The present study showed that memory function is strongly associated with the amount of physical activity

**Table 2** Stepwise multiple regression analysis for Scenery Picture Memory Test

| | Normal walking | | Slow walking | |
|---|---|---|---|---|
| | β estimates | *P*-value | β estimates | *P*-value |
| Daily step counts | – | – | 0.471 | 0.031* |
| Age | – | – | – | – |
| Sex | – | – | – | – |
| BMI | – | – | – | – |
| TUG time | – | – | – | – |
| OLS | – | – | – | – |
| 5CS | – | – | – | – |

Note: 5CS, five chair stand test; BMI, body mass index; OLS, one leg standing; TUG, Timed Up & Go test. $^{*}P < 0.05$.

only in the slow walking group with mild cognitive disorder. The present results show that lower physical activity could be a risk factor for cognitive decline in the elderly, and would strengthen the evidence to show the relationship between the amount of physical activity and cognitive function, as previously reported.[24] Additionally, the present study might show that the cognitive function of the elderly whose motor function and cognitive function are declining can be improved by increasing the amount of physical activity.

Physical activity might have an impact on cognitive function. The reasons why the SPMT, not MMSE, showed a correlation with physical activity might be explained as following. First, SPMT has been developed to screen mild cognitive disorder, whereas the MMSE is usually used for a broad range of cognitive impairment from normal to severe dementia. Because we only included patients with mild cognitive disorder, SPMT might be better to detect small correlated changes with other functions than MMSE. Second, SPMT shows good correlation not only with memory tests, but also with frontal function tests including word fluency test (Takechi *et al.* unpubl. observation). We speculate that efficient reminding of many objects from the scene requires the frontal function. Third, SPMT uses a line drawing scenery picture of a living room familiar to the elderly. It has been reported that aerobic exercise induces beneficial changes in brain structure and function that are correlated with improvements in cognition,[25,26] even in AD patients.[27,28] Physical activity, such as walking in and out of doors, might concomitantly give the patients visual stimulation. Because SPMT uses a picture of a living room familiar to the elderly, the degree of visual stimulation in daily living might have affected the results of SPMT. Thus, physical activity and the capacity to remember a visual scene might have shown a correlation. We suggest that increasing the amount of physical activity might result in beneficial biological changes to the brain structure and function or in beneficial physical changes to mobility and body composition. Therefore, increasing the step counts in a day could help to maintain and improve the cognitive function of older adults with mild cognitive disorder.

In the normal walking group with mild cognitive disorder, we found no significant association between memory function and the other variables. Other studies also show a lack of association of cognitive function with the amount of physical activity in older adults with similar ages to those in the present study.[7,29] Therefore, we need to consider effective strategies for patients with higher physical function.

There were several limitations of the present study. First, our limited sample size might introduce some error of inference, reduce the power of the analysis and limit generalization. Second, the present study was a cross-sectional study. Therefore, the relationship between the memory function and physical activity needs further investigation, such as an increase in physical activity levels for a certain period can improve the scores of SPMT, MMSE and other cognitive tests. Third, the definition of the normal walking group depended only on walking time in the present study. We might have to measure a frailty index, such as the Edmonton frail scale[30] or the Fried frailty assessment,[31] if we can extend our results to the frail elderly. Fourth, we used the SPMT, a visual memory test, as a cognitive test. However, we did not measure other factors, such as visual function and attention, that might have affected the present results. Therefore, it might be impossible to evaluate properly the relationship between physical activity and memory function. Thus, the results of the present study should be interpreted with caution.

In conclusion, the present study shows that cognition is associated with higher levels of physical activity only in patients with mild cognitive disorder who showed a slow walking speed. Our results suggest that increasing the amount of physical activity might prevent the deterioration of cognitive function. Further investigation, such as a prospective study, is required to confirm our results.

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## Disclosure statement

None of the authors have conflicts of interest or financial disclosures.

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Original article

# Comparison of frailty between users and nonusers of a day care center using the Kihon Checklist in Brazil

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ABSTRACT

*Background/purpose:* Day care centers are rapidly expanding in Brazil to meet the needs of the increasing older population. However, health profiles of their clients remain unclear. Therefore, this study aimed to investigate and compare the health conditions of users and nonusers of a day care center using a new frailty index, the Kihon Checklist.

*Methods:* This was a cross-sectional observational study. We recruited 59 users (mean age 81.1 ± 6.69 years) and 173 nonusers (mean age 69.9 ± 7.39 years). The nonusers were recruited at a recreational club and municipal health units, and the users were recruited at a day care center for the elderly in Brazil. Measurements consisted of questionnaires regarding sociodemographic and health-related characteristics and the Kihon Checklist.

*Results:* Compared with the nonusers, users had a higher prevalence of frailty ($p < 0.001$) and impairment of all specific domains (instrumental activities of daily living impairment, $p < 0.001$; physical inactivity, $p < 0.001$; seclusion, $p < 0.001$; cognitive deficit, $p < 0.001$; and depression, $p < 0.001$). The users were also more likely to be frail [odds ratio (OR), 14.226; 95% confidence interval (CI), 5.423–37.320; $p < 0.001$], dependence in instrumental activities of daily living (OR, 78.845; 95% CI, 19.569–317.674; $p < 0.001$), physically inactive (OR, 3.509; 95% CI, 1.467–8.394; $p = 0.005$), cognitively impaired (OR, 5.887; 95% CI, 2.360–14.686; $p < 0.001$), and depressed (OR, 5.175; 95% CI, 2.322–11.531; $p < 0.001$) than the nonusers.

*Conclusion:* The users of the day care center were frailer than nonusers, especially with regard to independence in instrumental activities of daily living, physical strength, cognitive function, and mood. Health care workers should use the Kihon Checklist to verify frequently the condition of elderly patients to prevent worsening of frailty.



## 1. Introduction

By 2050, the elderly population in Brazil is projected to represent approximately 30% of the total population, making Brazil one of the countries with the largest absolute number of elderly people worldwide.[1,2] These demographic changes will present a new challenge to the Brazilian health care system.[3]

In this context, noninstitutionalized care modalities that assist frail older persons are emerging in Brazil.[4] One example is day care centers that offer programs designed to meet the needs of elderly persons who require supervised care during the day but can return home in the afternoon or evening. Such institutions are rapidly expanding. However, the health profiles of the day care center attendees and their specific needs remain unclear due to the busy work schedule of the center staffs who do not have time required for the massive assessments for older adults.

Hence, this study sought to (1) investigate health conditions of the users of a day care center using a new frailty assessment tool known as the Kihon Checklist (KCL), a comprehensive and fast questionnaire, and (2) compare health profiles of the day care center users with those of elderly community-dwelling nonusers of such facilities.

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## 2. Methods

This is a cross-sectional observational study.

### 2.1. Participants

The inclusion criteria were as follows: community-dwelling adults aged 60 years or older, users or nonusers of day care services, who were able to respond to the questionnaire independently or by proxy. Individuals who did not match these criteria or did not want to participate were excluded. All participants received explanations regarding the research procedures and signed an informed consent form.

The nonusers of day care services were recruited at a recreational club and municipal health units, whereas the users were recruited at a day care center for the elderly with a maximum capacity of 30 participants per day. The prior criterion to attend the center included the need for support to perform daily activities. The center's professional team consists of medical doctors, nurses, physical therapists, social assistants, and volunteers. The main objectives of the institution are to provide proper care to the elderly, offering activities that preserve their dignity, and also to improve the quality of life of the participants and their families. All institutions were private and located in the same city in southern Brazil. Patient recruitment and data collection were carried out from June 2012 to April 2013.

The study protocol was approved by the Ethics Committee at Kyoto University Graduate School of Medicine, Kyoto, Japan (E-1575).

### 2.2. Assessments

The collected data were as follows: (1) sociodemographic information, including age, gender, living structure, educational level, and working status; (2) health-related characteristics, including body mass index (BMI), use and number of medications, frequency of medical consultation in the past 6 months, hospitalization in the past year, and life satisfaction; and (3) the translated and validated Brazilian Portuguese version of the KCL.[5]

The KCL was developed by the Japanese Ministry of Health, Labor, and Welfare, based on the needs of the Japanese long-term care insurance system. This checklist is used to screen frail older adults and identify those at higher risk of becoming dependent.[6–8] The checklist is a self-administered questionnaire that comprises 25 yes/no questions divided into instrumental activities of daily living (IADLs), physical strength, nutrition, eating, socialization, memory, and mood domains. A higher score indicates a frailer health condition. We determined the following cutoff points: for the KCL total score (sum of the scores of all questions) $\geq$7 points; IADL domain $\geq$3 points; physical domain $\geq$3 points, representing physical inactivity; nutrition domain score = 2 points, indicating malnutrition; additionally in question number 12, regarding body composition in the same domain, we adopted a cutoff of BMI <20.5; oral domain $\geq$2 points, suggesting oral dysfunction; socialization domain $\geq$1 point, representing seclusion; memory domain $\geq$1 point, suggesting cognitive impairment; and finally, mood domain $\geq$2 points, indicating depression. These cutoff points were adopted based on our previous findings that determined the KCL cutoffs associated with an elevated risk of requiring long-term care insurance service.[7,9] The time required to answer the KCL is approximately 15 minutes. Further details of the KCL have been described previously.[5]

### 2.3. Statistical analysis

Regarding sociodemographic and health-related characteristics, we analyzed the differences in age, BMI, and number of medications between users and nonusers of the day care service using an unpaired *t* test. For categorical variables (i.e., gender, living structure, educational level, working status, use of medication, medical consultation, hospitalization, and life satisfaction), we used the Chi-square test. For the variables that exhibited a significant difference ($p < 0.05$; i.e., living structure, working status, and life satisfaction), we dichotomized each item and conducted a Chi-square analysis separately for each category. Additionally, we analyzed the differences in KCL domains (mean scores) between groups using analysis of covariance (ANCOVA) adjusted for age.

We calculated the differences in the percentage of frail older adults (according to the KCL cutoff points) between the groups using the Chi-square test. We also performed a binary logistic regression analysis adjusted for age and gender, using each KCL domain as a dependent variable. For the total KCL score and for each domain, the robust condition was coded as 0 and frail condition as 1. The nonuser group was the reference group. Finally, to determine the variables with higher influence on day care use, we performed a binary logistic regression analysis (using the stepwise method), adjusted for age and gender, with "use of day care" (nonusers = 0 and users of day care service = 1) as the dependent variable. Dichotomous covariates included were the KCL variables that showed a significance in the previous regression analysis (using the enter method). Statistical significance was set at $p < 0.05$. All analyses were performed using the SPSS (version 21.0, SPSS; IBM Inc., Chicago, IL, USA).

## 3. Results

### 3.1. Sociodemographic and health-related characteristics

A total of 232 elderly persons met the criteria for the study (community, $n = 173$, mean age 69.9 $\pm$ 7.39 years; day care, $n = 59$, mean age 81.1 $\pm$ 6.69 years).

Among the 59 users of day care services, 18.6% utilized the day care center once a week, 48.8% twice a week, 25.6% three times per week, 4.7% four times per week, and 2.3% five times per week.

The users of day care services were older, and the majority lived with their children ($p < 0.001$). By contrast, most of the nonusers lived with their partners ($p = 0.017$). Additionally, most of the users were retired ($p < 0.001$), whereas some of the nonusers were still engaged in volunteer activities ($p = 0.044$). Furthermore, the nonusers of day care services had a higher BMI ($p = 0.004$) and were more satisfied with their lives than the users ($p = 0.013$) (Table 1).

### 3.2. Frailty condition

Differences were identified in the total mean KCL score ($p < 0.001$) and the mean KCL scores for all the domains between the two groups. Even when results for each domain were adjusted for age, the users of day care services were found to be frailer than the nonusers in terms of IADLs ($p < 0.001$), physical strength ($p < 0.001$), nutrition ($p = 0.001$), eating ($p = 0.01$), socialization ($p < 0.001$), memory ($p < 0.001$), and mood ($p < 0.001$) (Table 2).

Based on the results that identified frailty using the cutoff points, we observed that the users had a higher prevalence of frailty according to the total KCL score ($p < 0.001$) than the nonusers. Moreover, the user group contained more participants with IADL impairment ($p < 0.001$), physical inactivity ($p < 0.001$), seclusion ($p < 0.001$), cognitive deficit ($p < 0.001$), and depression ($p < 0.001$) (Table 3).

Results of the logistic regression, adjusted for age and gender, confirmed that the users of day care services were more likely to be frailer than the nonusers. Compared with nonusers, the day care

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**Table 1**
Sociodemographic and health-related characteristics of nonusers and users of a day care center.

| Variables | | Nonusers ($n = 173$) Valid % ($n$) | Users ($n = 59$) Valid % ($n$) | $p$ |
|---|---|---|---|---|
| Age | Mean ± SD | 69.9 ± 7.39 | 81.1 ± 6.69 | <0.001 |
| Gender | Female | 73.4 (127) | 71.2 (42) | 0.740 |
| Living structure | | | | 0.005 |
| | Alone | 18.5 (32) | 11.9 (7) | 0.239 |
| | With partner | 31.2 (54) | 15.3 (9) | 0.017 |
| | With child | 20.8 (36) | 45.8 (27) | <0.001 |
| | With partner and child | 23.1 (40) | 18.6 (11) | 0.473 |
| | Other | 6.4 (11) | 8.5 (5) | 0.467 |
| Educational level | | | | 0.117 |
| | Elementary school | 42.6 (72) | 55.2 (32) | |
| | Junior high school | 13.6 (23) | 12.1 (7) | |
| | High school | 13 (22) | 10.3 (6) | |
| | University | 26.6 (45) | 12.1 (7) | |
| | Other | 4.2 (7) | 10.4 (5) | |
| Working status | | | | 0.006 |
| | Formal Work | 11.7 (19) | 3.4 (2) | 0.079 |
| | Informal Work | 9.3 (15) | 3.4 (2) | 0.179 |
| | Volunteer work | 10.5 (17) | 1.7 (1) | 0.044 |
| | Retirement | 68.5 (111) | 91.5 (54) | <0.001 |
| BMI | Mean ± SD | 26.0 ± 4.53 | 24.0 ± 5.17 | 0.004 |
| Medication | Yes | 82.1 (142) | 84.7 (50) | 0.640 |
| Number of medications | Mean ± SD | 2.65 ± 2.60 | 3.39 ± 2.53 | 0.058 |
| Medical consultation (past 6 mo) | | | | 0.862 |
| | None | 13.6 (23) | 15.3 (9) | |
| | 1–2 times | 59.2 (100) | 59.3 (35) | |
| | 3–4 times | 18.3 (31) | 20.3 (12) | |
| | 5 times or more | 8.9 (15) | 5.1 (3) | |
| Hospitalization (past 12 mo) | Yes | 12.8 (22) | 15.3 (9) | 0.632 |
| Life satisfaction | | | | 0.013 |
| | Satisfied | 89.6 (155) | 78.0 (46) | 0.023 |
| | Fair | 6.4 (11) | 6.8 (4) | 0.910 |
| | Unsatisfied | 4.0 (7) | 15.3 (9) | 0.003 |

BMI = body mass index.

users were several times more likely to be frail [odds ratio (OR), 14.226; 95% confidence interval (CI), 5.423–37.320; $p < 0.001$], IADL dependent (OR, 78.845; 95% CI, 19.569–317.674; $p < 0.001$), physically inactive (OR, 3.509; 95% CI, 1.467–8.394; $p = 0.005$), cognitively impaired (OR, 5.887; 95% CI, 2.360–14.686; $p < 0.001$), and depressed (OR, 5.175; 95% CI, 2.322–11.531; $p < 0.001$) (Table 4).

We observed that among the five KCL variables found to be significant using the logistic regression analysis enter method (i.e., total KCL score, IADLs, physical strength, memory, and mood), only two were significant in the stepwise model: the KCL total score (OR, 5.201; 95% CI, 1.645–16.445; $p = 0.005$) and the IADL domain (OR, 37.368; 95% CI, 8.823–158.262; $p < 0.001$) (Table 5).

**Table 2**
Differences in the KCL domains' mean scores between users and nonusers of the day care center, adjusted for age.

| Variables | Nonusers ($n = 173$) | Users ($n = 59$) | $p$ |
|---|---|---|---|
| Total KCL score | 4.51 ± 3.62 | 10.9 ± 3.93 | <0.001 |
| IADL domain | 0.40 ± 0.69 | 2.90 ± 1.36 | <0.001 |
| Physical domain | 1.25 ± 1.15 | 2.02 ± 1.50 | <0.001 |
| Nutrition domain | 0.26 ± 0.46 | 0.47 ± 0.57 | 0.001 |
| Eating domain | 0.79 ± 0.91 | 1.10 ± 0.85 | 0.010 |
| Socialization domain | 0.30 ± 0.48 | 0.66 ± 0.66 | <0.001 |
| Memory domain | 0.67 ± 0.78 | 1.63 ± 0.87 | <0.001 |
| Mood domain | 0.87 ± 1.32 | 2.12 ± 1.39 | <0.001 |

IADL = instrumental activity of daily living; KCL = Kihon Checklist.

**Table 3**
Frail individuals in the nonuser and user groups, as determined by cutoff points.

| | Frail nonusers ($n = 173$) Valid % ($n$) | Frail users ($n = 59$) Valid % ($n$) | $p$ |
|---|---|---|---|
| Total KCL score | 27.2 (47) | 88.1 (52) | <0.001 |
| IADL domain | 1.7 (3) | 72.9 (43) | <0.001 |
| Physical domain | 13.9 (24) | 37.3 (22) | <0.001 |
| Nutrition domain | 0.6 (1) | 3.4 (2) | 0.118 |
| Eating domain | 23.7 (41) | 24.1 (14) | 0.946 |
| Socialization domain | 28.9 (50) | 55.9 (33) | <0.001 |
| Memory domain | 49.1 (85) | 86.4 (51) | <0.001 |
| Mood domain | 23.1 (40) | 64.4 (38) | <0.001 |

IADL = instrumental activity of daily living; KCL = Kihon Checklist.

## 4. Discussion

As expected, the day care center users were generally frailer than the nonusers, as demonstrated by the differences in the total KCL score; additionally, for all specific aspects of health (functional performance in IADLs, physical strength, nutrition, eating, socialization, memory, and mood), users were more impaired than nonusers, as indicated by the KCL domain mean scores.

However, both groups had similar percentages of participants meeting the cutoffs for frailty regarding nutrition and eating conditions; the participants also had a similar risk of malnutrition and oral disability. These findings may be supported by the BMI measures, which indicated that both groups were in the normal weight range. It was interesting to notice that the KCL mean scores differed between groups; however, when the data were categorized according to the cutoff points, no difference was observed between them. Hence, we suggest that both the mean scores and the cutoff points for the KCL should be used when analyzing such type of data. The mean scores can reveal even slight variations in the data, especially when dealing with small sample sizes, whereas the cutoff points can help manage large sample sizes with regard to the aspects of frailty in the analyzed population.

Participants also had a similar risk of seclusion regardless of the use of the day care center, indicating the importance of these centers to meet the social and emotional needs of the elderly, as such centers can alleviate feelings of loneliness, boredom, and solitude.[10]

The logistic regression results indicated that the need variables for Brazilian users of day care services focus on IADL functional independence, physical strength, cognitive function, and mood (Table 4), and this agrees with other research studies where a day care center is an option for disabled older people, who have functional disabilities, cognitive deficits, or mental frailties.[11,12] Moreover, apart from general frailty, the most relevant determinant of day care center use detected by logistic regression was functional impairment in IADLs. Such functional dependence was already

**Table 4**
Logistic regression analysis (enter method) adjusted for age and gender ($n = 232$).

| Day care center user group | Odds ratio | 95% confidence interval | $p$ |
|---|---|---|---|
| Total KCL score | 14.2 | 5.42–37.3 | <0.001 |
| IADL domain | 78.8 | 19.6–318 | <0.001 |
| Physical domain | 3.51 | 1.47–8.39 | 0.005 |
| Nutrition domain | 0.630 | 0.035–11.5 | 0.755 |
| Eating domain | 0.734 | 0.315–1.71 | 0.473 |
| Socialization domain | 1.75 | 0.822–3.71 | 0.147 |
| Memory domain | 5.89 | 2.36–14.7 | <0.001 |
| Mood domain | 5.18 | 2.32–11.5 | <0.001 |

IADL = instrumental activity of daily living; KCL = Kihon Checklist.

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**Table 5**
Logistic regression analysis (stepwise method) adjusted for age and gender ($n = 232$).

| Day care center user group | Odds ratio | 95% confidence interval | p |
|---|---|---|---|
| Total KCL score | 5.20 | 1.65–16.4 | 0.005 |
| IADL domain | 37.4 | 8.82–158 | <0.001 |

IADL = instrumental activity of daily living; KCL = Kihon Checklist.

stated as one of the criteria for eligibility for long-term care insurance in Japan.[7] Maintaining or enhancing the ability to perform daily activities and preventing dependence are the primary goals in the care of vulnerable older adults.[13]

Difficulties in performing IADLs preclude independent living, requiring support that is typically initially provided by the family. Such findings may be linked with the difference in living structure between the groups, considering that the majority of users lived with their children ($p < 0.001$), who may be their caregiver, whereas the nonusers lived with their partner ($p = 0.017$). In Brazil, the State attributes to the family the major role in home care for the disabled elderly,[3] exposing the family caregiver to high burdens that were frequently associated with physical disability, cognitive decline and functional impairment.[14–16] In this context, the family, as the primary caregiver, often seeks other sources of support to reduce its burden and distress,[17] and these sources include day care centers.

Interestingly, regardless of day care center use, the use and number of medications, frequency of medical consultation, and frequency of hospitalization were similar in both groups. This finding suggests the important role of day care centers from the societal perspective, as they contribute to curtailing national expenditures by delaying or preventing institutionalization, which is much more expensive.[18]

In brief, we identified differences in general health and also in all specific aspects of health between users and nonusers of a day care service center. The users of the day care center were frailer than the nonusers, and were also more likely to be physically and cognitively frail, to be functionally impaired in IADLs, and to have depression. These aspects of frailty do not seem to represent the main needs of elderly clients, but more so the main concerns of the family caregivers because of the heavy burden associated with these aspects. All these negative outcomes may influence life satisfaction, as our findings showed that the users of day care service centers were more unsatisfied with their lives ($p = 0.003$). Therefore, health care workers may use these findings to prevent worsening of frailty, making an effort to improve not only health but also well-being.

We verified these important differences between users and nonusers of day care service centers using only one type of assessment, the KCL, a fast and easy assessment tool that included all the important domains regarding the needs of the elderly. Therefore, we encourage the use of such assessment method as a fast screening tool for frailty in the elderly population; when the KCL results indicate an alarming condition, we suggest continuation and intensification of the investigation using specific instruments for the respective domain.

This study has several limitations related to its cross-sectional design and recruitment locations. As this study was carried out only in one region of Brazil, the results cannot be generalized to a national population. Additionally, the study included only one day care center. Moreover, we address the possible selection bias that may have occurred considering the predictable higher percentage of frailty in day care center user group; however, recruiting day care center users was the unique methodology to achieve the purpose of the present study. Further studies including more participants and institutions from different regions of Brazil are warranted.

## Conflicts of interest

The authors declare no potential conflicts of interest.

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ORIGINAL ARTICLE: EPIDEMIOLOGY, CLINICAL PRACTICE AND HEALTH

# Comparison of frailty among Japanese, Brazilian Japanese descendants and Brazilian community-dwelling older women

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**Aim:** To investigate frailty in Japanese, Brazilian Japanese descendants and Brazilian older women.

**Methods:** The collected data included sociodemographic and health-related characteristics, and the frailty index Kihon Checklist. We analyzed the differences between the mean scores of Kihon Checklist domains (using ANCOVA) and the percentage of frail women (using $\chi^2$-test). We carried out a binary logistic regression with Kihon Checklist domains.

**Results:** A total of 211 participants (Japanese $n = 84$, Brazilian Japanese descendants $n = 55$, Brazilian $n = 72$) participated in this research. The Brazilian participants had the highest total Kihon Checklist scores (more frail), whereas the Brazilian Japanese descendants had the lowest scores ($P < 0.001$). Furthermore, the Brazilian group had more participants with oral dysfunction ($P < 0.001$), seclusion ($P < 0.001$), cognitive impairment ($P < 0.001$) and depression ($P < 0.001$). They were more likely to be frail (OR 5.97, 95% CI 2.69–13.3, $P < 0.001$), to have oral dysfunction (OR 3.18, 95% CI 1.47–6.85, $P = 0.003$), seclusion (OR 9.15, 95% CI 3.53–23.7, $P < 0.001$), cognitive impairment (OR 3.87, 95% CI 1.93–7.75, $P < 0.001$) and depression (OR 6.63, 95% CI 2.74–16.0, $P < 0.001$) than the Japanese group.

**Conclusions:** The older Brazilian women were likely to be more frail than the participants in other groups. More than the environment itself, the lifestyle and sociodemographic conditions could affect the frailty of older Brazilian women. **Geriatr Gerontol Int 2014; ••: ••–••.**

**Keywords:** cross-cultural study, frailty, Kihon Checklist, older women.

## Introduction

Because the aging process is a worldwide trend, frailty has become a global concern. In general, there are two predominant approaches to define frailty: (i) frailty is treated as a count of health impairments;[1,2] and (ii) the frailty phenotype is identified to detect people who find themselves between the independent and the dependent life stages.[3]

Several assessments have been developed to identify frail older adults, such as the "Kihon Checklist" (KCL) proposed by the Japanese Ministry of Health, Labor and Welfare that identifies vulnerable older adults as those who have a higher risk of becoming dependent[4,5] based on the needs of the Japanese long-term care insurance (LTCI) system.[6] The KCL showed a good concurrent validity against the Fried's criteria for evaluating frailty, in which the KCL had a sensitivity of 60% and a specificity of 86.4%.[7] Furthermore, another study verified that the risk groups detected by the KCL were associated with lower ADL, lower subjective quality of life scores and higher scores on the geriatric depression scale.[8]

Despite the global concern on frailty, the features of each country have not been adequately explored. Therefore, it is intriguing to analyze such differences from a cross-cultural perspective. In the present study, we compared Japan and Brazil because of the different ethnic and cultural backgrounds. Brazil is a Latin American country with a miscegenated population. It is the largest and the most populous country in South

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America, and has become South America's leading economic power by exploiting vast natural resources and by utilizing the large labor pool; where Japan is an Asian, modern and industrialized country with a homogeneous population. Despite the recent economic slowdown; it still remains a major economic power.[9] The link between both countries started when the Japanese immigrated to Brazil in 1908, generating a community of approximately 1.3 million people of Japanese descent in Brazil.[10] Thereon, many Japanese descendants have experienced a different lifestyle in Brazil. Because of the lack of evidence regarding frailty in Japanese immigrants, we hypothesized that the living environment and culture play an important role in the aging process and the development of frailty; thus, the present study aimed to investigate frailty in native Japanese, Brazilian Japanese descendants and native Brazilian older adults.

## Methods

This was a cross-sectional observational study.

### *Participants*

The inclusion criteria were women living in the community, aged 60 years or older and able to respond to the questionnaires. The participants who did not match these criteria or those who did not want to participate in the research procedures were excluded from the present study.

The Japanese participants were recruited in the western area of Japan through a local press advertisement that requested community-dwelling older female volunteers to collaborate in this research. The Brazilian and Brazilian Japanese descendant participants were recruited by municipal health units and by a recreational club that promotes Japanese culture in the south part of Brazil, chosen because of the large population of Japanese subjects present in the region. Furthermore, the total population (Japanese region with approximately 1 500 000 citizens and Brazilian region with approximately 1 800 000 citizens) and the economic pattern (based on industry and tourism) of both regions were similar.[11,12]

The older women received oral and written explanations about the research procedures. Participation in this study was voluntary, and all participants signed an informed consent form. We recruited the participants from April to November 2012, and conducted data collection from June to November 2012.

A total of 228 older women were recruited to participate in the present study; however, 17 participants were excluded from the analysis (Brazilian $n = 7$, Brazilian Japanese Descendants $n = 4$, Japanese $n = 6$) because of age lower than 60 years and poor responses in questionnaires. The resulting 211 participants who met the criteria for the study (Brazilian $n = 72$, mean age $69.0 \pm 6.41$ years; Brazilian Japanese descendants $n = 55$, mean age $70.8 \pm 8.38$ years; and Japanese $n = 84$; mean age $73.2 \pm 4.21$ years). The study protocol was approved by the university ethical committee where it was carried out (E-1575, E-1470).

### *Assessments*

The participants answered a questionnaire regarding sociodemographic information, such as age, living arrangement, educational level and work status (worker, volunteer, retired); health-related characteristics, such as body mass index (BMI), use and number of medications, frequency of medical consultation in the past 6 months, hospitalization in the past year, self-rated health, life satisfaction and the frailty index KCL. The Japanese participants completed the original KCL version in the Japanese language, and the Brazilian and the Brazilian Japanese descendants completed the translated and validated KCL Brazilian Portuguese version.[13]

The KCL has 25 yes/no questions that are divided into the following domains: instrumental activities of daily living (IADL), physical strength, nutrition, eating, socialization, memory and mood. In the present study, we set the cut-off points based on our previous finding that determined the KCL cut-offs regarding an elevated risk for requiring LTCI service in community-dwelling older adults.[14] For the KCL total score (sum of the scores of all questions: 1–25), we used the cut-off of >6 points; in question number 12 (nutrition domain), we used the cut-off of BMI <20.5; and in the socialization domain, we used the cut-off as having one negative answer in question number 16 or question number 17 or more. To the best of our knowledge, there is no published cut-off point for the IADL domain; therefore, in the present study, we determined the cut-off point as a score higher than two points. For the other domains, the cut-off points remained the same, as scoring three points or more in the physical domain represents the clustering of physical inactivity; scoring two points in the nutrition domain indicates malnutrition; scoring two points or more in the oral domain suggests oral dysfunction; one point or more in the memory domain suggests cognitive impairment; and finally, scoring two points or more in the mood domain indicates depression.[4]

### *Statistical analysis*

Regarding sociodemographic and health-related characteristics, we analyzed the differences of age, BMI, and number of medications among Brazilian, Brazilian Japanese descendants and Japanese using one-way ANOVA and the Tukey post-hoc test. For categorical variables,