Table 1 Subjects' general characteristics (total sample and stratified by quality of sleep)

Variables	Total (n = 145)	Self-reported quality of sleep Good (n = 115)	Poor (n = 30)	P
Age (years)	73 (70–77)	73 (70–77)	74 (70.7–77)	0.78
Female (%)	53.1	57.4	36.7	0.04
Educational level (%)				0.59
Elementary school	2.1	1.7	3.3	
Junior high school	30.3	29.6	33.3	
High school	52.4	51.3	56.7	
Technical school	4.8	5.2	3.3	
University	10.3	12.2	3.3	
Living situation (%)				0.57
Alone	9.0	9.6	6.7	
Only spouse	47.6	46.1	53.3	
Spouse and child	22.8	20.9	30.0	
Only child	7.6	8.7	3.3	
Other	13.1	14.8	6.7	
Work (%)				0.96
Does not work/retired	43.7	44.6	40.0	
Volunteer	4.2	4.5	3.3	
Regular work	4.2	4.5	3.3	
Farm work	42.3	41.1	46.7	
Other	5.6	5.4	6.7	
Financial satisfaction (%)				0.17
Satisfied	68.3	70.4	60.0	
Normal	17.9	14.8	30.0	
Dissatisfied	13.8	14.8	10.0	

Values are median (interquartile range) or percentages.

important health indicators as we did herein. The present study supported the hypothesis that QOS is associated with important health indicators, such as lifestyle characteristics, cognitive status, nutrition, depression, seclusion and QOL in Japanese community-dwelling older adults. In the present study, more males had a poor QOS, and no other significant differences were found for sociodemographic information between the groups. In addition, we found a small number of smokers and alcohol consumers, who accounted for less than half of our total participants (such differences were also not associated with QOS), and the participants presented similar characteristics regarding their health conditions.

A study carried out in Japan found that poor perceived QOS was associated with advancing age, and that more females complained of poor QOS than males; however, QOS in men decreased considerably at an older age.[14] We might be able to explain why males showed poorer QOS in the present study if we consider the intrinsic characteristics of these participants. Although the present study was not designed to specifically identify sex differences, we verified no statistical differences between males and females in all the health indicators and QOL variables (data not shown). However, when comparing only males according to their QOS, we found that those with poor QOS had shorter sleep duration, higher BMI and lower QOL (considering general health, bodily pain and vitality) than those with good sleep (data not shown). In the USA, a study verified an inverse linear association between sleep duration and higher BMI in adults,[15] and another study ascertained that short sleep duration was strongly associated with greater adiposity in older men and women.[16] In Japan, studies have found contrasting results regarding sleep and weight; one found an association of short sleep duration with reduced weight, whereas another found no association.[17,18] However, such studies did not specifically address QOS, focusing instead on sleep duration. Although the relationship between BMI and QOS is still not clear, we believe that it might have influenced our outcome.

Furthermore, Gu *et al.* found that living arrangements (living with a spouse or family member compared with living alone) appeared to be associated with QOS; moreover, current alcohol drinkers had a 27% higher odds ratio of reporting good QOS compared with those who did not drink alcohol.[19] Those discrepancies with other

Table 2 Bivariate comparisons for the subjects' lifestyle and health conditions (total sample and stratified by quality of sleep)

Variables	Total (n = 145)	Self-reported quality of sleep		P
		Good (n = 115)	Poor (n = 30)	
Smoking (%)	8.3	7.8	10.0	0.71
Alcohol drinking (%)	38.6	37.4	43.3	0.55
No. consultations in 6 months (%)				0.72
No	15.3	15.8	13.3	
Once or twice	20.1	21.1	16.7	
Three or four times	14.6	15.8	10.0	
Five or six times	26.4	23.7	36.7	
Seven or more	23.6	23.7	23.3	
No. medicines (%)				0.12
No	19.3	20.8	13.8	
One	19.3	18.9	20.7	
Two	21.5	18.9	31.0	
Three	11.1	14.2	–	
Four or more	28.9	27.4	34.5	
Morbidities (%)				
Lower back pain	10.3	10.4	10.0	1.00
Diabetes	12.4	12.2	13.3	1.00
Osteoporosis	8.3	7.0	13.3	0.27
Hypertension	44.1	42.6	50.0	0.46
Hyperlipidemia	15.2	14.8	16.7	0.77
Arthropathy	4.8	6.1	–	0.34
Respiratory problems	2.8	2.6	3.3	1.00
Comorbidities (%)	23.4	22.6	26.7	0.64

Values are percentages.

studies might be a result of the homogenous characteristics of the participants that we studied, as no differences were found for many conditions.

The term QOS is widely used in the literature; however, its use involves different interpretations (e.g. some studies consider it as an insomnia occurrence, whereas others use a subjective rate approach). Therefore, we will discuss QOS in a general approach, considering sleep disturbances and duration as interference factors in QOS. When comparing the QOS groups, a difference was found in the self-reported sleep duration, with a longer sleep duration indicating a better QOS. Studies suggested that older adults who slept 7–9 h per day (similar to the values that we found – good QOS 7 [6.5–8]) were more likely to be healthy than those with shorter (≤6 h) or longer (≥10 h) sleep durations.[19] In addition, older adults with a shorter sleep duration had sleep complaints more frequently, especially night-time complaints and feeling unrested in the morning. In contrast, a longer sleep duration was associated with daytime sleepiness, independent of health status.[20] Furthermore, both longer and shorter sleep durations were associated with mortality in Japanese adults.[17]

Although BMI and depression became non-significant when the analyses were adjusted by sex and sleep duration, associations were found in an unadjusted comparison. Studies have identified the association of sleep and BMI, as discussed earlier; however, it is not a consensus.[15–18] Additionally, Kang *et al.* verified that patients with depression had a significantly higher frequency of poor sleep.[2]

In terms of cognitive conditions, having a normal cognitive status (≥24 on MMSE) appeared to be a protective factor for a better QOS (odds ratio 0.24, 95% CI 0.07–0.83), which is consistent with other studies. A 1-year longitudinal study found that the sleep disturbances score was significantly associated with incident general cognitive impairment in women, and more so with incident non-amnestic cognitive impairment. In men, the global sleep condition was significantly associated with incident general cognitive impairment.[4] Furthermore, cognitive decline was associated with sleep disturbance in non-demented community-dwelling older women in a 15-year follow-up study carried out by Yaffe *et al.*[5] Such interactions might be explained by the strength of the circadian/homeostatic interaction on modulating sleep and cognition, which are deteriorated in older healthy people.[21]

For the QOL assessment, the physical component summary, and the domains of general health, bodily

Table 3 Bivariate comparisons for the subjects' health indicators and quality of life

Variables	Total (n = 145)	Self-reported quality of sleep Good (n = 115)	Poor (n = 30)	P
Self-reported sleep duration (h)	7 [6–7.5]	7 [6.5–8]	6 [5–7]	<0.001
BMI (kg/m^2)	23.1 [21.2–25.3]	23 [20.8–24.7]	23.7 [22.2–26.4]	0.04
Regular physical activity (%)	65.2	67	58.6	0.40
Pedometer count[†] (%)	50.3	49.6	53.3	0.71
MMSE (% at mild cognitive impairment)[‡]	19.0	10.4	23.3	0.07
MNA (% at risk of malnutrition)[‡]	24.8	27	16.7	0.24
GDS (% at risk of depression)[‡]	29.7	25.2	46.7	0.02
LSA[†] (%)	56.6	53	70	0.09
SF-8 Physical component summary	47.5 [42.9–51.1]	47.8 [43.5–51.8]	44.3 [40.7–48.7]	0.01
SF-8 Mental component summary	51.3 [47.6–55.2]	51.7 [47.9–55.3]	50.7 [46.2–53.2]	0.14
SF-8 General health	50.7 [50.7–50.7]	50.7 [50.7–50.7]	50.7 [41.1–50.7]	<0.001
SF-8 Physical functioning	48.5 [41.9–53.6]	48.5 [41.9–53.6]	48.5 [41.9–53.6]	0.41
SF-8 Role-physical	48.4 [42.5–53.9]	48.4 [42.5–53.9]	48.4 [42.5–53.9]	0.56
SF-8 Bodily pain	46.1 [46.1–60.2]	51.7 [46.1–60.2]	46.1 [44.1–46.1]	<0.001
SF-8 Vitality	54.4 [45.2–54.4]	54.4 [54.4–54.4]	45.2 [45.2–54.4]	<0.001
SF-8 Social functioning	54.7 [45.2–54.7]	54.7 [45.2–54.7]	45.2 [38.4–54.7]	0.26
SF-8 Mental health	50.2 [50.2–57.4]	50.2 [50.2–57.4]	50.2 [44.9–57.4]	0.09
SF-8 Role-emotional	49.0 [49–54.3]	54.3 [49–54.3]	49.0 [47.9–54.3]	0.46

Values are median (interquartile range) or percentages. [†]Percentage of those below the median (pedometer count – 6562 steps/day; Life-Space Assessment [LSA] – 86). [‡]Cut-off score for Mini-Mental State Examination (MMSE): 24; Mini-Nutritional Assessment (MNA): 12; Geriatric Depression Scale (GDS): 5. BMI, body mass index; SF-8, Short-Form 8.

pain and vitality were significantly different in the partially adjusted model (by sex and sleep duration). Those individuals with higher scores in such QOL domains were less likely to have a poor QOS. Our results regarding general health were in accordance with another study that verified that older adults with poor self-rated health were less likely to have good QOS (odds ratio 0.54, 95% CI 0.50–0.59).[22] However, in the fully adjusted model, only bodily pain and vitality remained significant.

Regarding bodily pain, a study stated that chronic pain and sleep difficulties were common in the older population living in the community; the authors observed strong and consistent associations between more severe and disseminated chronic pain and heterogeneous sleep complaints.[22] In a review study, Smith *et al.* also concluded that consistent evidence suggested that pain negatively impacts sleep both in the short- and long-term, and some evidence suggested that the relationship between pain and sleep might be reciprocal.[23] The direct relationship between pain and sleep quality is not often explored in clinical studies. Patients with chronic pain appear to be often prescribed analgesics at night or sedative pain medications, with most of the analgesics used for chronic pain and many of the sedative hypnotics used to promote sleep; however, both have direct analgesic and soporific effects.[23] Thus, the consideration of medications for pain and QOS might raise important concerns regarding the confounding effects. Moreover, medications often lead to a series of adverse drug reactions that health promoters might want to avoid, especially as a result of overdoses and polypharmacy in older adults.[24]

Furthermore, we did not find any evidence regarding vitality and QOS in the literature, and most of the articles investigated sleep with respect to the duration aspect. Goldman *et al.* found that individuals who slept ≤6 h/night had a 4.3% higher fatigue score than those who slept 7 h/night. Individuals with complaints of awakening too early in the morning had a 5.5% higher fatigue score than those without these complaints.[25] Such associations remained significant even after multivariate adjustment for multiple medical conditions. In such studies, the concept of fatigue used also included the levels of energy, vitality and strength.

Although the good QOS group had more people engaged in regular physical activity (good QOS group: 67% *vs* poor QOS group: 58.6%), we did not find significant differences regarding the practice of regular physical activity or pedometer counts, which could be as a result of our cross-sectional design. We believe that physical exercise is an appropriate therapeutic intervention to promote sleep benefits. A review study mentioned several lines of evidence: (i) moderate intensity endurance training in older sedentary men and women with sleep complaints was found to subjectively improve sleep quality; (ii) the duration of exercise was a consistent moderator variable on the acute effects of exercise

Table 4 Partially adjusted (by sex and sleep duration) multivariate logistic regression considering quality of sleep as a dependent variable, and sociodemographic, lifestyle and health condition variables as covariates

Variables	OR (95% CI)	*P*
Age	1.03 (0.93–1.14)	0.50
Smoking	1.29 (0.23–6.98)	0.76
Alcohol drinking	0.79 (0.29–2.17)	0.66
Comorbidities	2.81 (0.93–8.48)	0.06
BMI	1.10 (0.94–1.28)	0.20
Regular physical activity	0.55 (0.20–1.47)	0.23
Pedometer count†	0.68 (0.27–1.71)	0.41
MMSE‡	0.24 (0.07–0.83)	0.02
MNA‡	0.53 (0.17–1.69)	0.29
GDS‡	2.21 (0.86–5.65)	0.09
LSA†	0.38 (0.14–1.02)	0.05
SF-8 Physical component summary	0.92 (0.86–0.99)	0.03
SF-8 Mental component summary	0.92 (0.84–1.00)	0.06
SF-8 General Health	0.85 (0.78–0.94)	0.001
SF-8 Physical functioning	0.98 (0.93–1.03)	0.55
SF-8 Role-physical	0.96 (0.89–1.02)	0.23
SF-8 Bodily pain	0.91 (0.85–0.97)	0.01
SF-8 Vitality	0.81 (0.73–0.90)	<0.001
SF-8 Social functioning	0.95 (0.89–1.00)	0.09
SF-8 Mental health	0.91 (0.83–1.00)	0.05
SF-8 Role-emotional	0.95 (0.87–1.03)	0.28

†Analyzed values were categorized as above or below the median. ‡Analyzed values were categorized according to respective cut-offs. Variables were analyzed one by one together with sex and sleep duration in a multivariate logistic regression model. CI, confidence interval; OR, odds ratio; SF-8, Short-Form 8.

Table 5 Stepwise logistic regression considering quality of sleep as a dependent variable and comorbidities, Mini-Mental State Examination, Geriatric Depression Scale, Life-Space Assessment, Short-Form 8 Physical and Mental component summaries, Short-Form 8 General health, Short-Form 8 Bodily pain, Short-Form 8 Vitality, Short-Form 8 Social functioning and Short-Form 8 Mental health as covariates (with sex and self-reported sleep duration inserted as adjusted covariates)

Variables	OR (95% CI)	*P*
MMSE	0.13 (0.03–0.55)	0.006
SF-8 Bodily pain	0.91 (0.84–1.00)	0.05
SF-8 Vitality	0.82 (0.73–0.92)	0.001

CI, confidence interval; MMSE, Mini-Mental State Examination; OR, odds ratio; SF-8, Short-Form 8.

on sleep; and (iii) in middle-aged to elderly subjects, a reduced likelihood of having a disorder in maintaining sleep and of having a sleep complaint has been associated with regular weekly activity.[26] Alfano *et al.* also suggested that physical activity was consistently related to better physical functioning, and to reduced fatigue and bodily pain in cancer survivors.[27] Furthermore, physical activity appeared to be related to vitality in Japanese individuals.[13]

Several limitations may accompany the present study, and should be considered when interpreting the results: (i) the cross-sectional design; (ii) the predominance of participants in the good QOS group that might indicate some bias as a result of the selection of healthy volunteers; and (iii) the collected sleep information in the present study considered basic sleep patterns with a self-reported approach. More specific questions, such as those regarding a wide range of sleep problems experienced by older persons, should be included. In addition, the use of specific sleep medication was not verified, and such medications might play an important role in QOS.[14] Thus, we were unable to investigate potential confounding factors resulting from sleep medications, other drugs or even caffeine consumption, considering that they would affect sleep. However, such bias might not restrict our general conclusions. In summary, the present study provides evidence that QOS is particularly linked with cognitive status, bodily pain and vitality in Japanese community-dwelling older adults. However, further research that controls for our limitations is warranted.

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Disclosure statement

None of the authors have a conflict of interest or financial disclosures.

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1 Bivariate comparisons according to quality of sleep for the males' health indicators and quality of life.
Table S2 Bivariate comparisons according to quality of sleep for the females' health indicators and quality of life.
Table S3 Bivariate comparisons according to sex for the participants' health indicators and quality of life.
Table S4 Bivariate comparisons according to quality of sleep by sex for the participants' health indicators and quality of life.

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Original article

Factors associated with falls in active older adults in Japan and Brazil

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ABSTRACT

Background/Purpose: Aging populations are a global public health concern. The risk of falls increases with age, so fall prevention is becoming an important health issue. However, few studies have focused on cross-cultural analyses of falls. Therefore, we aimed to compare the incidence of falls and compare anthropometric measures and physical function between active Japanese and Brazilian older adults.
Materials and methods: We measured the incidence of falls (investigated by self-reported questionnaire), body mass index (BMI), waist circumference (WC), grip strength (GS), one-legged stance (BALANCE), frequency of physical activity (PA), medication use (MU), and hospitalization history in 114 physically active community-dwelling adults 65 years of age and older in Japan (73.9 ± 4.0 years, $n = 40$) and Brazil (70.7 ± 4.5 years, $n = 74$).
Results: The Japanese elderly were older ($p < 0.01$), but had a better BALANCE score ($p < 0.05$) than the Brazilian elderly. Nevertheless, Brazilian elderly showed higher engagement in PA and had higher BMI and WC ($p < 0.01$). Despite the lack of a difference in the incidence of falls between the two cohorts, Japanese elderly who fell had decreased GS compared to Japanese elderly who did not fall [odds ratio (OR): 0.83, 95% confidence interval (CI) 0.72–0.97, $p < 0.05$]. In Brazil, those who fell had larger WC than those who did not fall (OR: 1.07, 95% CI 1.01 – 1.13, $p < 0.01$).
Conclusion: Our results indicate that physical function (i.e., grip strength) is a more important predictor of falls in Japanese elderly. However, increasing waist size is a predictor of falls in Brazilian elderly. These findings suggest that risk factors for falls are multifactorial and vary according to setting.

1. Introduction

In 2011, the percentage of Japanese adults ≥65 years was 23%, one of the highest percentages in the world.[1] In Brazil, according to some projections, almost 13% of adults will be classified as elderly in 2020.[2,3] Because of this worldwide trend, falls, which are associated with impairment of physical function and decreased quality of life (QOL) in older individuals,[4] are becoming an increasingly important issue. Therefore, initiatives to identify risk factors for falls are considered important preventive public health measures.

Several studies in Japan[5,6] and Brazil[7–9] have been conducted to ascertain the incidence of falls among community-dwelling older individuals. In Japan, the prevalence of falls ranges from 11% to 27%, varying according to the location.[5] In a national survey of 6616 older adults in Brazil, the average prevalence of falls was 28%, ranging from 19% in the northern region to 30% in the southeast region.[7]

Advanced age,[4,8,10] muscle weakness,[11,12] impaired balance,[11] medications,[8–11] physical inactivity,[8,10,12] and hospitalization[8] were identified as important risk factors for falls in older individuals. To our knowledge, there is only one cross-cultural comparison study focused on falls,[10] and there are no data comparing Japan and Brazil. Comparison of these two countries may be important because of the continuous immigration between the two countries. Therefore, the purpose of this study was to compare the effect of anthropometric measures and physical function on the incidence of falls in active older adults in Japan and Brazil.

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2. Materials and methods

2.1. Participants

A convenience sample of 114 physically active, apparently healthy, community-dwelling women age ≥65 years was recruited from participants in community fitness facilities in Japan and Brazil. In Japan, the participants lived in Kyoto, which is located in the western part of the country; in Brazil, the participants lived in São Caetano do Sul, which is located in São Paulo state (São Paulo metropolitan area) in the southern part of the country. Both cities are characterized as urban and industrialized areas with a high human development index, which makes the comparability procedures more reliable.

All volunteers performed physical activities such as dance or aerobics, and strength, balance, and stretching exercises in regular physical fitness classes, for approximately 50 minutes per session at the time of their measurements. All volunteers provided informed consent in accordance with the procedures of the research ethics committees. A preliminary screening that focused on current health status, medications, cigarette use, and habitual physical activity was followed by a detailed history and physical examination covering past and current health status, symptoms of depression, self-reported ability to perform the basic and instrumental activities of daily living, and an assessment of body composition. Volunteers were excluded due to the following factors: (1) uncontrolled cardiovascular, pulmonary, or metabolic diseases; (2) any orthopedic conditions that could limit exercise or be exacerbated by exercise testing; (3) any type of surgery during the previous 3 months; (4) forced bed rest during the previous 3 months; (5) treatment for or a history of cancer; or (6) adherence of less than 75% to physical fitness classes. One hundred and fourteen participants (Japan, $n = 40$, age 73.9 ± 4.0 years; Brazil, $n = 74$, age 70.7 ± 4.5 years) met the criteria for the study, were cleared for participation, and were willing to carry out the study procedures.

2.2. Demographic and clinical history

Demographic information including age, living situation, educational level, medications, and hospitalization history within the previous six months was collected from a self-reported questionnaire.

The World Health Organization definition of a fall was used, specifically "inadvertently coming to rest on the ground, floor or other lower level, excluding intentional change in position to rest against or on furniture, walls or objects".[13] This definition was used even if the fall did not lead to injury or ill health. The incidence of falls over the past 12 months was analyzed. Additionally, physical activity (PA) was measured with a self-reported questionnaire and included the activities previously mentioned. The frequency of PA was categorized as almost every day (4–7 days per week), two or three times per week, or once a week.

2.3. Body composition

Height and weight were measured with a stadiometer and a digital scale, respectively. For measurements, volunteers took off their shoes and were dressed in lightweight clothing. Body mass index (BMI) was calculated as body mass divided by height squared.[14] The volunteers were assigned to distinct groups according to the BMI cutoffs proposed by World Health Organization classifications (i.e., underweight, BMI < 18.5 kg/m^2; normal weight, BMI 18.5 to 25 kg/m^2; overweight, BMI 25 to 30 kg/m^2; and obese, BMI ≥ 30 kg/m^2).[14] Waist circumference (WC) was measured at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest.[15]

2.4. Physical function

Physical function was evaluated using grip strength (GS) and balance procedures. Maximal isometric grip strength was measured with an adjustable handgrip dynamometer (Smadley's Dynamometer, TTM, Tokyo, Japan). Each participant was asked to stand and hold the dynamometer with arms parallel to the body; GS was measured for both hands once on each side, and the higher value was used as the maximum muscle strength of the participant, as described elsewhere.[16] To measure balance each volunteer stood on one foot with the contralateral knee flexed to 90°; the arms were crossed over the chest with the head facing forward.[17] Three trials with durations of up to 30 seconds were completed on the dominant leg, separated by 1-minute intervals; the longest duration of maintaining the one-legged stance was used as the score.[17]

2.5. Statistical analysis

The Shapiro-Wilk test was used to verify the normality of the data. The data are presented as means ± standard deviation, absolute frequency, or respective percentage or median (interquartile). Chi-square analyses were used to compare the incidence of falls and the differences in sex, living situation, educational level, medications, hospitalization history, and physical activity between the two countries and intragroup. We also used the Student t test to compare age and BMI between countries—age, BMI, WC, and GS according to history of falls in Japan, and age and BMI by history of falls in Brazil. Moreover, the Mann-Whitney U test was used to compare WC, GS, and one-legged stance (BALANCE) between countries— BALANCE according to history of falls in Japan, and WC, GS, and BALANCE by history of falls in Brazil. Logistic regression was carried out to analyze potential risk factors for falls in each country. Statistical significance was set at $p < 0.05$. All analyses were performed using the SSPS version 20.0 (SPSS, IBM Inc., Chicago, IL, USA).

3. Results

Table 1 compares the general characteristics of the participants. The Japanese and Brazilian differed in age, anthropometric measures, and physical function. The Japanese were older ($p < 0.001$) but had better BALANCE scores ($p < 0.05$) than the Brazilian. Brazilian participants were more active but had higher BMI and WC measures (both $p < 0.001$). A larger proportion of Japanese adults had fallen, though the difference between the two groups was not statistically significant.

There was no difference in the prevalence of falls between Japanese and Brazilian older individuals (33% vs. 27%, $p > 0.05$). Japanese elderly who fell had a lower GS than those who did not fall ($p < 0.001$). In Brazil, those who fell were more likely to have larger WC measures than those who did not fall ($p < 0.05$; Table 2).

Logistic regression was carried out to investigate the main risk factors for falls in both countries (Table 3). GS was identified as an important risk factor for falls in Japanese elderly [odds ratio (OR) 0.839; 95% confidence interval (CI) 0.722 – 0.975], whereas WC was a risk factor for falls in Brazilian elderly (OR 1.07; 95% CI 1.018 – 1.13).

4. Discussion

Our study supports the hypothesis that the risk factors for falls differ between older Japanese and Brazilian individuals. Though the prevalence of falls in our Japanese cohort was higher than that of

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Table 1
Bivariate comparison of general characteristics of Japanese and Brazilian participants.

Characteristic	Japan ($n = 40$)	Brazil ($n = 74$)	p
Age (y)	73.9 ± 4.0	70.7 ± 4.5	<0.001
Living situation			
Alone	28	24	0.71
With spouse	40	34	
With spouse and/or child	22	23	
With others of the same generation	5	14	
Other	5	5	
Educational level			
Elementary school	20	19	0.88
Junior high school or above	80	81	
Female	80	80	0.97
BMI (kg·m^2)	22.0 ± 2.1	27.4 ± 3.7	<0.001
Waist circumference (cm [median interquartile])	75.2 (70.9 – 82.3)	87.1 (80.5 – 95.2)	<0.001
Handgrip strength (kgf [median interquartile])	23.7 (20.6 – 28.0)	25 (22 – 31.1)	0.25
Balance (s [median interquartile])	23.6 (7.2 – 30)	13 (6.29 – 24.6)	0.04
Has had a fall	33	27	0.53
On medication	78	89	0.09
Hospitalization history	8	8	0.90
Physical activity	—	—	0.002
Almost every day	28	49	
2 or 3 times a wk	60	51	
Once a wk	13	—	

Data are presented as % or mean ± SD, unless otherwise indicated.
BMI = body mass index; SD = standard deviation.

Japanese national data (26%),[5] it was consistent with data from the same geographical area (35%).[18] The data obtained from our Brazilian cohort are consistent with a nationwide survey of Brazilian community-dwelling older individuals (28%) and older adults from the same geographical area (30%).[7]

Older adults from Brazil had higher BMI and WC measurements than the Japanese elderly. This may be important information because both groups were composed of physically active individuals. Similar results were found in another study of physically active older individuals from Brazil (BMI: 28.1 ± 4.3 kg/m^2; fall prevalence: 25%).[19] WC score is considered a risk factor for cardiopulmonary and metabolic diseases[20]; it is associated with postural balance control.[21] In addition, WC is negatively correlated with QOL and mood.[22] Our results also suggest that increasing WC could be considered an important risk factor for falls in older adults in Brazil but not Japan.

However, Japanese adults who fell had decreased GS, which was confirmed to be a risk factor for falls. GS is a clinical predictor of frailty[23] in older individuals that predicts poor outcomes[24] and increased mortality.[25,26] GS could be used to identify which adults are at risk of falling in epidemiological studies.[27]

We found differences in BMI, but not GS, between Japanese and Brazilian elderly. A study found an interaction between GS and BMI on mobility limitation particularly in men, but no such interaction was observed in women.[28] Because most of the participants were women in our study groups, it might explain our negative study results.

Moreover, balance decreases with age.[29] However, in our study, Japanese participants were older, but showed better BALANCE scores than Brazilian elderly, even though both groups were engaged in similar physical activities at the time of their measurements. One possible explanation for this difference may be intrinsic uncontrolled factors in their usual physical activity routine (e.g., Japanese people could be engaged in more balance-related activities than Brazilian people). Finally, both differences in anthropometric measures and physical function might also be linked with the different lifestyle routine in both countries, though lifestyle factors were not investigated in detail.

We also observed a statistically significant difference in the incidence of falls between Japanese men and women (Table 2). It seems that women have 40–60% more injuries related to falls than men of comparable age.[30]

The findings of this study may be useful in community screening trials for identifying risk factors for falls not previously identified by health care professionals. Therefore, we recommend that grip

Table 2
Bivariate comparison of general characteristics of Japanese and Brazilian participants stratified by history of falls.

Characteristic	Japan ($n = 40$)			Brazil ($n = 74$)		
	Fall ($n = 13$)	No fall ($n = 27$)	p	Fall ($n = 20$)	No fall ($n = 54$)	p
Age (y)	74.3 ± 3.9	73.8 ± 4.2	0.72	70.3 ± 3.7	70.8 ± 4.8	0.67
Living situation	—	—	0.26	—	—	0.24
Alone	46	19		15	28	
With spouse	31	44		35	33	
With spouse and/or child	8	30		15	26	
With others of the same generation	8	4		25	9	
Other	8	4		10	4	
Educational level	—	—	0.08	—	—	0.13
Elementary school	39	11		30	15	
Junior high school or above	61	89		70	85	
Female	100	70	0.02	85	78	0.49
BMI (kg·m^2)	21.9 ± 2.0	22.1 ± 2.1	0.81	29 ± 4.3	27 ± 3.4	0.80
Waist circumference (cm)[a]	74.2 ± 6.5	76.3 ± 6.8	0.25	91.0 (84.5 – 101.4)	83.9 (79.2 – 92.2)	0.01
Handgrip strength (kgf)[a]	20.9 ± 4.3	27.4 ± 8.0	<0.001	24.0 (22.0 – 29.0)	26.5 (21.7 – 32.1)	0.46
Balance (s [median interquartile])	15.2 (6.1 – 29.0)	24.1 (9.2 – 30)	0.56	13.9 (3.9 – 23.3)	12.7 (6.5 – 26.2)	0.54
On medication	92	70	0.12	90	89	0.89
Hospitalization history	15	4	0.18	15	6	0.18
Physical activity	—	—	0.19	—	—	0.23
Almost every day	39	22		60	44	
2 or 3 times a wk	62	59		40	56	
Once a wk	0	19		—	—	—

Data are presented as % or mean ± SD, unless otherwise indicated.
BMI = body mass index; SD = standard deviation.
[a] Median (interquartile) for Brazil.

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Table 3
Odds ratio (95% confidence interval) of falls in Japanese and Brazilian participants.

Risk factors	Japan ($n = 40$)	p	Brazil ($n = 74$)	p
Age	1.03 (0.873 – 1.22)	0.71	0.972 (0.865 – 1.09)	0.62
BMI	0.961 (0.698 – 1.32)	0.81	1.14 (0.987 – 1.31)	0.07
Waist circumference	0.933 (0.827 – 1.05)	0.25	1.07 (1.018 – 1.13)	0.009
Handgrip strength	0.839 (0.722 – 0.975)	0.02	0.966 (0.904 – 1.03)	0.30
Balance	0.959 (0.902 – 1.02)	0.18	0.984 (0.934 – 1.03)	0.55
On medication	5.05 (0.559 – 45.6)	0.14	1.12 (0.208 – 6.09)	0.89
Hospitalization in the past 6 mo	4.72 (0.387 – 57.6)	0.22	3.00 (0.553 – 16.2)	0.20
Physical activity	0.37 (0.113 – 1.22)	0.10	0.533 (0.188 – 1.51)	0.23

Data are presented as Odds ratio (95% confidence interval).
BMI = body mass index.

strength and waist circumference be used as potential screening tools for falls in Japanese and Brazilian older adults, respectively.

In addition, factors such as ethnicity, eating habits, lifestyle, and social behaviors should also be investigated.[5] However, these factors are difficult to control, and there is uncertainty about the influence of these factors on regional differences in the prevalence of falls between these countries. Therefore, the limitations of our study include the following factors: (1) cross-sectional design; (2) potential bias caused by the selection of physically active individuals; (3) small sample size that limits our observations to a community in each country; and (4) a small set of variables used to identify individuals at risk of falls. In this sense, our pilot study provides evidence that falls may be triggered by distinct factors that differ between Japanese and Brazilian older adults. However, further studies should consider a different sample size and spectrum of variables.

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Original Research Article

Cognitive Decline Predicts Long-Term Care Insurance Requirement Certification in Community-Dwelling Older Japanese Adults: A Prospective Cohort Study

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Key Words
Cognitive decline · Long-term care insurance requirement · Older Japanese adults · Prospective cohort study

Abstract
Aim: The purpose of this prospective cohort study is to examine whether cognitive decline is an independent predictor of new long-term care insurance (LTCI) requirement certifications in Japan. ***Methods:*** A total of 5,765 community-dwelling older Japanese adults who, at baseline, were independent in terms of their activities of daily living participated in this study and were followed up for 18 months. The outcome measure was the number of new LTCI requirement certifications during the 18-month period of the study. We collected demographic information through questionnaires and assessed cognitive skills with the Cognitive Performance Scale (CPS). The participants were divided into 3 groups according to CPS scores (0, 1, and 2 or greater). ***Results:*** During the 18-month period, 399 subjects (6.9%) became newly certified for LTCI services. In a multivariate Cox proportional hazards model, older participants with a CPS score of 1 (adjusted HR: 1.39, 95% CI: 1.08–1.77) and 2 or greater (adjusted HR: 2.27, 95% CI: 1.74–2.96) were significantly more likely to receive an LTCI certification compared to those with a CPS score of 0. ***Conclusions:*** Cognitive decline is an independent predictor of new LTCI requirement certifications and the severity of cognitive decline in elderly adults is positively associated with receiving an LTCI requirement certification in Japan.

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Introduction

Frailty in older adults is a serious problem in countries with increasingly aging populations, such as Japan. In general, frailty is defined as a vulnerable state that places older adults at a high risk for adverse health outcomes, such as falls, hospitalization, and mortality [1].

To help manage an extremely rapidly aging population and care for the frail properly, in April 2000 Japan implemented a long-term care insurance (LTCI) system. Before 2000, long-term care services were provided under a tax-based social welfare system for senior citizens with limited economic resources and family support [2]. However, after the LTCI implementation, the services of this program have been provided to older adults who are certified as requiring support or care according to the certification assessment of their care needs [3]. The selection process for classifying dependent older adults involves evaluations of the persons' current mental and physical condition and objective assessments [4]. Thus, those who are certified as requiring LTCI services have variable risk factors associated with frailty.

A survey by the Japanese Ministry of Health, Labour and Welfare revealed that dementia is one of the main reasons for which people require LTCI services. Dementia affects 5–8% of the population over 65 years of age [5] and up to 30% of people aged 85 years and above [6], and its prevalence is currently increasing. It is clear that dementia and Alzheimer's dementia (AD) are associated with mortality [7]. A previous study reported a positive association between physical frailty and cognitive impairment [8]. Furthermore, physical frailty has been associated with a risk for mild cognitive impairment (MCI) and a rapid rate of cognitive decline with age [9]. It has also been shown that cognitive decline is associated with frailty in Japan, and it is one of the predictors of frailty leading to the need for long-term care [10]. However, no studies have determined whether cognitive decline can be an independent predictor of new LTCI requirement certifications.

To fill this gap, the current prospective cohort study examines whether a new LTCI requirement certification can be predicted by using cognitive performance measures. We focused on whether the level of cognitive decline is related to receiving a new LTCI requirement certification among community-dwelling elderly Japanese people.

Materials and Methods

Subjects

We analyzed a portion of the cohort data from a prospective study, the Japan Multicenter Aging Cohort for Care Prevention (J-MACC). This cohort study investigated the factors associated with the need for LTCI services in community-dwelling Japanese adults aged 65 years or older living in Maibara City, Shiga Prefecture. In 2011, the total population was 39,889, the total area 250.46 km^2, and the rate of the aging population 25.3%. We recruited 8,233 community-dwelling older adults who were independent in their activities of daily living (ADL), and the baseline questionnaires were mailed to participants in April 2011 (response rate of 96%). These questionnaires were mainly self-administered. However, if the participants could not answer questions independently, a family member assisted them or answered the questions on their behalf. Older adults who were already ADL-dependent and already receiving benefits from LTCI services were excluded. Furthermore, in the database, we excluded older adults who had missing baseline questionnaire data. Therefore, our analysis was performed with data from 5,765 older adults who were then followed up for 18 months. This study was conducted 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.

Cognitive Performance

We assessed cognitive performance by using the Cognitive Performance Scale (CPS) [11]. The CPS is based on a decision tree algorithm that includes items assessing daily decision-making, short-term memory, ability to make oneself understood, and ability to feed oneself. Cognitive decline is rated on a scale from 0 to 6 (0 = normal, 1 = borderline intact, 2 = mild, 3 = moderate, 4 = moderate-severe, 5 = severe, and 6 = very severe) [11]. The CPS is positively associated with the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment, which are well-known tools for the detection of cognitive impairment and MCI, respectively [12, 13]. In the present study, we divided participants into 3 groups according to their CPS scores (0 = normal, 1 = borderline intact, and 2 or greater = cognitive impairment), which have been shown to be highly correlated with MMSE scores in previous studies, thus indicating high convergent validity [12, 14].

Outcome Measurement

The outcome measure was the receipt of an LTCI requirement certification during the 18-month study period. Dependent older adults are classified according to the following procedure: first, a 74-item questionnaire is administered to evaluate the person's current mental and physical condition, and responses are analyzed using a computerized algorithm [4]. Subsequently, the person receives a home visit and a recommendation from his or her physician. Based on the questionnaire and home visit data, a long-term care approval board makes the final decision. Individuals who become certified as 'dependent older adults' are subdivided into seven levels (support levels 1 and 2, and care levels 1–5) based on their physical condition. Certified adults are provided home services and community-based or institutional services according to their care needs. Individuals who are not eligible for long-term care or support care may utilize preventive care services. In the present study, the city government recorded the date when individuals had been certified as meeting the LTCI requirements, and we updated our database as appropriate.

Covariate Measurement

In the baseline questionnaires, we obtained demographic information on age, gender, body mass index (BMI), the number of medications used (none, 1, 2, 3, or more), family structure (living alone, living in an elderly household, or other), subjective household economic status (very good, good, fair, or bad), and medical history (musculoskeletal disorder, hypertension, lipid disorder, stroke, diabetes, heart disease, respiratory disease, external injury, and cancer).

Statistical Analysis

The baseline characteristics of the participants who were newly certified or not certified as requiring LTCI services were compared using a Student t test or a χ^2 test. In addition, the differences in demographic variables among the 3 groups stratified by CPS score were examined using ANOVA with a post hoc test or a χ^2 test.

Kaplan-Meier survival curves were calculated for the 3 groups of participants newly certified as requiring LTCI services. Using the Cox proportional hazards model, the hazard ratio (HR) and the 95% confidence interval (CI) were estimated to evaluate, in univariate and multivariate analyses, the impact of cognitive decline on the time of receiving an LTCI requirement certification. In the multivariate analysis, the results were adjusted for age, gender, BMI, medication use, family structure, subjective household economy, and medical

Table 1. Baseline demographic differences in the LTCI service requirement certification during the 18-month follow-up

	LTCI requirement certification (n = 399)	No LTCI requirement certification (n = 5,366)	p
Age, years[a]	80.7±6.9	74.2±6.6	<0.001**
Female gender[b]	237 (59.4)	2,829 (52.7)	0.011*
BMI[a]	22.2±3.5	22.7±3.1	0.012*
CPS score[b]			<0.001**
0	232 (58.1)	4,091 (76.2)	
1	89 (22.3)	942 (17.6)	
2 or greater	78 (19.5)	333 (6.2)	
Number of medications taken[b]			<0.001**
0	41 (10.3)	1,021 (19.0)	
1	35 (8.8)	809 (15.1)	
2	59 (14.8)	943 (17.6)	
3 or more	264 (66.2)	2,593 (48.3)	
Family structure[b]			<0.001**
Single	70 (17.5)	491 (9.2)	
Elderly household	73 (18.3)	1,521 (28.3)	
Other	256 (64.2)	3,354 (62.5)	
Subjective household economic status[b]			0.475
Very good	22 (5.5)	218 (4.1)	
Good	141 (35.3)	2,022 (37.7)	
Fair	167 (41.9)	2,228 (41.5)	
Bad	69 (17.3)	898 (16.7)	
Medical history[b]			
Musculoskeletal disorder	88 (22.1)	685 (12.8)	<0.001**
Hypertension	170 (42.6)	2,452 (45.7)	0.252
Lipid disorder	22 (5.5)	429 (8.0)	0.082
Stroke	25 (6.3)	202 (3.8)	0.022*
Diabetes	40 (10.0)	650 (12.1)	0.231
Heart disease	80 (20.1)	702 (13.1)	<0.001**
Respiratory disease	37 (9.3)	251 (4.7)	<0.001**
External injury	18 (4.5)	158 (2.9)	0.095
Cancer	25 (6.3)	207 (3.9)	0.024*

Values are mean ± SD or n (%). * $p < 0.05$; ** $p < 0.01$. [a] Assessed by Student's t test. [b] Assessed by χ^2 test.

history. Survival time was defined as the time between enrollment (the baseline measurements) and either time of receiving an LTCI service requirement certification or the end of the follow-up period (October 2012).

Statistical analyses were carried out using SPSS version 20.0 (SPSS, Chicago, Ill., USA), with a significance threshold of 0.05.

Results

Demographic Data

During the 18 months of the study, 399 subjects (6.9%) became newly certified as requiring LTCI services (table 1). Those who were certified for LTCI requirement were significantly older (80.7 ± 6.9 vs. 74.2 ± 6.6 years, $p < 0.001$) and had a lower BMI (22.2 ± 3.5 vs.

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Table 2. Baseline demographic differences according to CPS scores

	CPS score				
	0 (n = 4,323)	1 (n = 1,031)	2 or greater (n = 411)	p value for trend	post hoc test
Age, years[a]	74.1±6.6	75.3±7.1	77.9±7.3	<0.001**	c–e
Female gender[b]	2,374 (54.9)	501 (48.6)	191 (43.3)	<0.001**	
BMI[a]	22.7±3.1	22.4±3.2	22.2±3.3	0.001**	c, e
Medications[b]				<0.001**	
0	853 (19.7)	154 (14.9)	55 (12.5)		
1	675 (15.6)	141 (13.7)	28 (6.3)		
2	792 (18.3)	156 (15.1)	54 (12.2)		
3 or more	2,003 (46.3)	580 (56.3)	274 (62.1)		
Family structure[b]				0.016*	
Single	401 (9.3)	104 (10.1)	56 (12.7)		
Elderly household	1,216 (28.1)	298 (28.9)	80 (18.1)		
Other	2,706 (62.6)	629 (61.0)	275 (66.9)		
Subjective household economic status[b]				<0.001**	
Very good	664 (15.4)	190 (18.4)	113 (25.6)		
Good	1,765 (40.8)	460 (44.6)	170 (38.5)		
Fair	1,701 (39.3)	341 (33.1)	121 (27.4)		
Bad	193 (4.5)	40 (3.9)	7 (1.6)		
Medical history[b]					
Musculoskeletal disorder	571 (13.2)	140 (13.6)	62 (14.1)	0.557	
Hypertension	1,949 (45.1)	489 (47.4)	184 (41.7)	0.380	
Lipid disorder	358 (8.3)	63 (6.1)	30 (6.8)	0.061	
Stroke	138 (3.2)	43 (4.2)	46 (10.4)	<0.001**	
Diabetes	504 (11.7)	133 (12.9)	53 (12.0)	0.454	
Heart disease	538 (12.4)	169 (16.4)	75 (17.0)	<0.001**	
Respiratory disease	183 (4.2)	63 (6.1)	42 (9.5)	<0.001**	
External injury	109 (2.5)	43 (4.2)	24 (5.4)	<0.001**	
Cancer	151 (3.5)	56 (5.4)	25 (5.7)	0.002**	

Values are mean ± SD or n (%). * $p < 0.05$; ** $p < 0.01$. CPS score: 0 (normal), 1 (borderline intact), 2–6 (cognitive impairment). [a] Assessed by ANOVA. [b] Assessed by χ^2 test. [c] Significant difference between a CPS score of 0 and a CPS score of 1. [d] Significant difference between a CPS score of 1 and a CPS score of 2 or greater. [e] Significant difference between a CPS score of 0 and a CPS score of 2 or greater.

22.7 ± 3.1, p = 0.012) than those who were not certified. More women than men became certified in this cohort (females: 59.4%; males: 52.7%, p = 0.011). In addition, there were significant differences in the rates of high CPS scores, medication use, family structure, and some of the medical history items between the groups (table 1).

The baseline demographic data of the participants stratified into 3 groups according to CPS score are shown in table 2. The number of older adults with a CPS score of 0 was 4,323 (75.0%), with a CPS score of 1 it was 1,031 (17.9%), and with a CPS score of 2 or greater it was 411 (7.1%). ANOVA showed that older adults with a CPS score of 0 were significantly younger (CPS score 0: 74.1 ± 6.6 years vs. CPS score 1: 75.3 ± 7.1 years vs. CPS score 2 or greater: 77.9 ± 7.3 years) and had a higher BMI (CPS score 0: 22.7 ± 3.1 vs. CPS score 1: 22.4 ± 3.2 vs. CPS score 2 or greater: 22.2 ± 3.3) than those with a CPS score of 1 or 2 or greater (p < 0.01). In addition, there were significant differences in gender, medication use, family structure, household economy, and some of the medical history items between the 3 groups (table 2).

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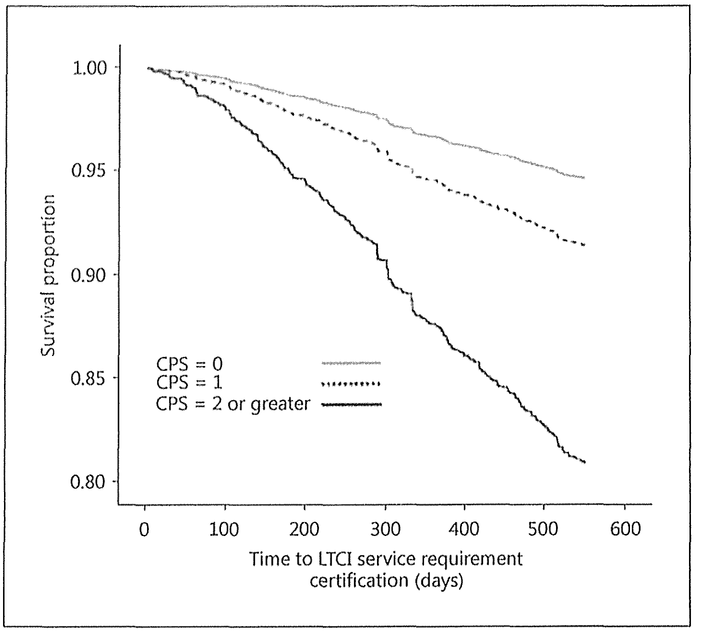

Fig. 1. Kaplan-Meier survival curves illustrating the percentage of subjects who were not certified for LTCI services. During the study period, 232 (5.4%), 89 (8.6%), and 78 (19.0%) subjects with CPS scores of 0, 1, and 2 or greater, respectively, became newly certified for LTCI services.

Table 3. Cox proportional hazards model for the impact of cognitive decline on the time of receiving an LTCI requirement certification

CPS score	Univariate model		Multivariate model	
	HR (95% CI)	p	HR (95% CI)	p
0	1 (ref.)	–	1 (ref.)	–
1	1.64 (1.28–2.09)	<0.001	1.39 (1.08–1.77)	0.009
2–6	3.85 (2.98–4.98)	<0.001	2.27 (1.74–2.96)	<0.001

CPS score: 0 (normal), 1 (borderline intact), 2 – 6 (cognitive impairment). The multivariate model was adjusted for age, gender, BMI, number of medications taken, family structure, subjective household economy, and past medical history.

Cox Proportional Hazards Model

Figure 1 shows the Kaplan-Meier survival curves during the 18-month follow-up according to new LTCI service requirement certifications, with the participants stratified into 3 groups according to their CPS score. During the 18-month period, 232 (5.4%), 89 (8.6%), and 78 (19.0%) subjects with CPS scores of 0, 1, and 2 or greater, respectively, became newly certified as requiring LTCI services.

Older participants with CPS scores of 1 (adjusted HR: 1.64, 95% CI: 1.28–2.09) and 2 or greater (adjusted HR: 3.85, 95% CI: 2.98–4.98) were significantly more likely to be certified as requiring LTCI services according to the univariate analyses using a CPS score of 0 as the reference (table 3). In multivariate analyses, these results remained significant after adjustment for age, gender, BMI, medication use, family structure, subjective household economy, and past medical history [adjusted HR (CPS score 1): 1.39, 95% CI: 1.08–1.77; adjusted HR (CPS score 2 or greater): 2.27, 95% CI: 1.74–2.96] (table 3).

Discussion

In this study, we showed that cognitive decline was an independent predictor of new certifications for LTCI service requirement after adjusting for personal and social information. Cognitive decline is also associated with impairment of instrumental ADL [15] and gait dysfunction [16, 17] from its early stages. Furthermore, cognitive decline is a major risk factor for falls, which are a serious health problem among older adults with or without cognitive impairment [18]. Even MCI has been viewed as a predictor of falls [19]. Thus, cognitive decline is a risk factor for frailty in older adults, both directly and indirectly.

The current study indicates that a higher CPS score was associated with a greater possibility of certification for LTCI services. This finding is important from a clinical or research perspective. The cognitive assessment used in this study (CPS) consists of questions assessing various parts of subjective cognitive decline. According to several previous studies, this measure is closely associated with objective cognitive status evaluations in cross-sectional analysis [20] and predicts the development of dementia [21, 22]. Therefore, subjective cognitive decline based on the CPS is a valid risk factor for frailty in elderly populations. Furthermore, older participants with a CPS score of 1 may manifest MCI or very early dementia, and older participants with MCI may be more likely to be certified as requiring LTCI. Therefore, older adults should be targets of the preventive care system even before the first stages of cognitive impairment.

Recently, numerous research projects have investigated the impact of interventions designed to prevent the progression of cognitive impairment, such as AD [23]. It has been shown that regular exercise is associated with a delay in dementia and AD onset [24]. Furthermore, a multicomponent exercise program concentrating on aerobics was effective for improving cognitive function in older adults with amnestic MCI [25]. Thus, physical exercise can improve cognitive impairment and may be helpful in delaying or preventing the need for LTCI services. In Japan, community-based exercise programs have been found to have beneficial effects on frail older adults [26]. Hence, preventive programs should become widespread and exercise programs should be utilized by older adults.

This study has several limitations. First, we did not include older adults who had missing baseline questionnaire data. In this population, there may be older adults with more severe cognitive impairment or at a higher risk for frailty. Second, the questionnaires in the current study were primarily self-administered. However, if the participants could not answer questions independently, a family member assisted them or answered the questions on their behalf. We did not analyze the difference between those who could answer questionnaires by themselves and those who could not. The latter group may also have more severe cognitive impairment or a higher risk for frailty. Third, although we assessed subjective cognitive performance by using the questionnaire-based CPS, the participants' global objective cognitive function was not assessed by the MMSE or other objective measures.

In conclusion, our results indicate that cognitive decline is an independent predictor of new LTCI requirement certifications, and the severity of cognitive decline in the elderly is positively associated with receiving an LTCI requirement certification in Japan. Intervention studies are needed to explore whether improvement in cognitive impairment may delay or prevent the need for LTCI services among older adults.

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Disclosure Statement

The authors have no conflicts of interest to disclose.

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Chronic kidney disease (CKD) is an independent risk factor for long-term care insurance (LTCI) need certification among older Japanese adults: A two-year prospective cohort study

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ABSTRACT

CKD is associated with impairments in health status, physical function, and frailty. The aim of the current prospective cohort study was to determine whether CKD predicted new LTCI need certification among community-dwelling older Japanese adults. This was a prospective cohort study. We analyzed the cohort data from a prospective study, The Japan Multicenter Aging Cohort for Care Prevention (J-MACC). We followed 8063 elderly adults for 2 years, and we analyzed the relationship between CKD and LTCI need. The outcome studied was new certification for LTCI service need during a 2-year period. We measured serum creatinine (the estimated glomerular filtration rate; eGFR), serum albumin, frailty checklist scores, and body mass index. During the 2-year follow-up, 536 subjects (6.6%) were newly certified as needing LTCI services. We stratified the cohort according to eGFR quartile and performed multivariate analyses using an eGFR value of 71.4–83.6 ml/min/1.73 m^2 as a reference. We found that subjects with eGFR values <60.0 ml/min/1.73 m^2 had a significantly elevated risk of LTCI service need (adjusted hazard ratio: 1.44 [95% CI 1.12–1.86]). Our results indicate that CKD is independently associated with new LTCI service need certification and is an important marker of frailty in older adults.

1. Introduction

Frailty in older adults is a serious problem in countries with aging populations, such as Japan. In general, frailty is defined as a vulnerable state that places older adults at high risk of adverse health outcomes, such as falls, hospitalization, and mortality (Wiswell et al., 2001).

Age is a major risk factor for CKD, which is a growing health problem in Japan. The prevalence of CKD in the adult Japanese population is estimated to be 13% (Imai et al., 2009). In addition, the number of patients with end-stage renal disease (ESRD) has increased by approximately 7% per year in Japan (Akiba et al., 2000). CKD is associated with impairments in health status and physical function, as well as frailty (Brogan, Haber, & Kutner, 2000; Kurella et al., 2004; Kurella, Yaffe, Shlipak, Wenger, & Chertow, 2005). CKD is also associated with oxidative stress, chronic inflammation, insulin resistance, vascular calcification, and osteoporosis (Ensrud et al., 2007; Landau et al., 2011; Shanahan, 2005). Furthermore, a decreased creatinine clearance <60 ml/min/1.73 m^2 has been shown to predict incident falls among community-dwelling older women (Gallagher, Rapuri, & Smith, 2007). Thus, CKD poses a considerable medical and public health challenge, particularly in the older population.

Japan implemented a LTCI system in April 2000 to help manage a rapidly aging population. Prior to 2000, long-term care services were provided under a tax-based social welfare system for seniors with limited economic resources and family support (Campbell & Ikegami, 2000). However, since the implementation of LTCI, the services of this program have been provided to elderly adults who are certified as requiring support or care according to their care needs and certification assessment (Tsutsui & Muramatsu, 2005).

The aim of the current prospective cohort study, therefore, was to determine whether CKD was a risk factor for LTCI need among community-dwelling older Japanese adults.

2. Methods

2.1. Subjects

We analyzed the cohort data from a prospective study entitled J-MACC. This cohort study investigated the factors associated with LTCI need in community-dwelling Japanese

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adults aged 65 years or older. We recruited community-dwelling older adults who were independent in terms of the activities of daily living (ADL) in 2009. The exclusion criteria were older adults who were already ADL-dependent and were eligible to receive benefits from LTCI services. The subjects were followed prospectively for 2 years. During the follow-up period, 226 subjects died or moved; thus, we analyzed 8063 elderly adults. This study was conducted 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.

2.2. Serum creatinine and albumin

The serum creatinine and albumin levels of the subjects were measured. The estimated glomerular filtration rate (eGFR) was calculated using a formula reported by Matsuo et al. (2009): eGFR $(mL/min/1.73\ m^2) = 194 \times Scr^{-1.094} \times Age^{-0.287} \times 0.739$ (if female). This equation originated from the MDRD study group (Coresh, Astor, Greene, Eknoyan, & Levey, 2003) arranged for Japanese individuals, and it is recommended by the Japanese Society of Nephrology. The study cohort was divided into 4 groups according to serum albumin and eGFR quartiles.

2.3. Frailty checklist

The frailty checklist included simple yes/no questions concerning lifestyle (questions 1–5), motor abilities (questions 6–10), nutrition (questions 11–12), oral functions (questions 13–15), seclusion (questions 16–17), forgetfulness (questions 18–20), and emotions (questions 21–25) (Table 1). The total score on the frailty checklist is useful for predicting the risk of being newly certified as needing LTCI services (Coresh et al., 2003). Furthermore, physical exercise is an effective means of improving the total score on the frailty checklist (Imai et al., 2007).

2.4. Body mass index

The patients' height and weight were measured to calculate their body mass index (BMI).

2.5. Outcome measure

The outcome measure was new LTCI service need certification over a 2-year period. The selection process for classifying dependent older adults first involves a questionnaire that evaluates the person's current mental and physical condition (74 items), which is analyzed using a computerized algorithm. A long-term care approval board reaches a final decision based on the algorithm-aided analysis of the questionnaire, a doctor's recommendation, and a home visit report. Individuals who become certified as dependent older adults are subdivided into seven levels (support levels 1 and 2 and care levels 1–5), depending on their conditions. They are provided home and community-based or institutional services according to their care needs. Individuals who are not eligible for long-term care or support care may utilize preventive care services.

2.6. Statistical analysis

The baseline characteristics of the subjects who were certified or non-certified as needing LTCI services were compared. Differences in the demographic variables between the 2 groups were analyzed using Student's t-test or a chi-square test. In addition, differences in the demographic variables among the 4 groups stratified by eGFR quartile were examined using an analysis of variance (ANOVA) and a post hoc test. Kaplan-Meier survival curves were calculated for the group newly determined to need LTCI services and were stratified by eGFR quartile. Cox proportional hazards models were used to estimate the hazard ratios (HR) and 95% confidence intervals (CI) of the relationships between

Table 1
The frailty checklist used in Japan.

Domain	Question	Items	Yes	No
Lifestyle	1	Do you ride the bus or train alone?	0	1
	2	Do you buy household goods for everyday use?	0	1
	3	Do you withdraw and deposit savings?	0	1
	4	Do you visit your friends' homes?	0	1
	5	Do you give advice to family and friends?	0	1
Motor abilities	6	Can you climb stairs without holding onto a handrail or the wall?	0	1
	7	Can get up from a chair without grabbing something?	0	1
	8	Are you able to keep walking for about 15 min?	0	1
	9	Have you fallen in the past year?	1	0
	10	Are you very worried about falling?	1	0
Nutrition	11	Have you ever lost more than 2–3 kg of weight in a 6-month period?	1	0
	12	BMI is less than 18.5.	1	0
Oral function	13	I cannot eat hard foods as well as 6 months ago.	1	0
	14	Have you ever choked on tea or soups?	1	0
	15	Are you concerned with being thirsty?	1	0
Seclusion	16	Do you leave your home at least once a week?	0	1
	17	Compared to last year, has the number of times you go out decreased?	1	0
Forgetfulness	18	Are you told that you are forgetful or you always tell me the same thing?	1	0
	19	Do you look up phone numbers and make phone calls yourself?	0	1
	20	Do you sometimes forget the date and month?	1	0
Emotions	21	(In the past 2 weeks) I do not feel fulfillment in my daily life.	1	0
	22	(In the past 2 weeks) The activities I used to enjoy are no longer enjoyable.	1	0
	23	(In the past 2 weeks) The activities I used to carry out with ease have become troublesome.	1	0
	24	(In the past 2 weeks) I do not think I am a useful person.	1	0
	25	(In the past 2 weeks) I feel tired for no reason.	1	0

Table 2
Baseline characteristics of the study subjects in both groups.

	Certified for LTCI requirement (n = 536)			Non-certified for LTCI requirement (n = 7527)			
	Mean	SD	Min–max	Mean	SD	Min–max	P-Value
Age (years)	80.8	7.4	66–100	76.7	6.5	65–102	<0.001
Gender (female)	332 (61.9%)	4405 (58.5%)	0.043				
BMI (kg/m^2)	22.4	3.5	13.8–35.8	22.8	3.2	12.7–39.8	0.073
Frailty checklist (points)	6.5	4.9	0–23	4.3	4.0	0–24	<0.001
Serum albumin (g/dl)	4.2	0.3	3.2–5.0	4.3	0.3	2.6–5.4	<0.001
eGFR (ml/min/1.73 m^2)	68.5	20.7	22.2–121.3	71.4	17.2	20.3–123.8	<0.001

eGFR quartile and the time to new LTCI service need certification in univariate and multivariate analyses. Multivariate analyses were performed for each covariate and were adjusted for gender, BMI, frailty checklist score, and serum albumin level, factors that are known to be associated with frailty (Levey et al., 2006; Tomata et al., 2011; Yamada, Arai, Sonoda, & Aoyama, 2012). Survival time was defined as the time between enrollment (the date of the baseline measurements) and either the new LTCI service need certification or the end of the follow-up period (March 31, 2011). The data were analyzed using PASW (Windows version 18.0, SPSS, Inc., Chicago, IL). A P value <0.05 was considered statistically significant for all the analyses.

3. Results

During the 2-year follow-up, 536 subjects (6.6%) became newly certified as needing LTCI services (Table 2). Those who were certified for LTCI need were significantly older (80.8 ± 7.4 vs. 76.7 ± 6.5, $P < 0.001$) and had higher frailty checklist scores (6.5 ± 4.9 vs. 4.3 ± 4.0, $P < 0.001$), lower serum albumin levels (4.2 ± 0.3 vs. 4.3 ± 0.3, $P < 0.001$), and lower eGFR values (68.5 ± 20.7 vs. 71.4 ± 17.2, $P < 0.001$) than those who were not certified. More women than men became certified in this cohort (female: 61.6% vs. 58.5%, $P = 0.043$). However, the BMIs were not different between the two groups ($P = 0.073$) (Table 2). We also examined whether eGFR was associated with BMI, frailty checklist score, or serum albumin level. We found that the subjects with eGFR < 60.0 ml/min/1.73 m^2 were significantly older and had lower BMIs, higher frailty checklist scores, and lower serum albumin levels ($P < 0.05$) (Table 3).

Next, we examined the relationship between each variable and new LTCI need certification. The subjects with BMIs <20.5 exhibited a significantly elevated risk of LTCI service need according to multivariate analyses using a BMI of 22.7–24.7 as the reference (adjusted hazard ratio: 1.41 [95% CI 1.11–1.78]) (Table 4). The mean BMI was 22.7 ± 3.3, with a range from 12.7 to 39.8; 1975 participants (24.5%) had BMIs <20.5. The subjects with frailty checklist scores >6 had a significantly elevated risk of LTCI service need according to multivariate analyses using frailty checklist scores <2 as the reference (adjusted hazard ratio: 2.24 [95% CI 1.73–2.90]) (Table 4). The mean frailty checklist score was 4.5 ± 4.1, with a range from 0 to 24; 2042 participants (25.3%) had frailty checklist scores >6. Participants with serum albumin levels <4.1 g/dl tended to exhibit an elevated risk of LTCI service need according to multivariate analyses using a serum albumin level >4.4 g/dl as the reference (adjusted hazard ratio: 1.25 [95% CI 0.97–1.62]). However, the univariate analysis indicated that subjects with serum albumin levels <4.1 g/dl had an elevated risk of LTCI service need (Table 4). The mean serum albumin level was 4.2 ± 0.3 g/dl, with a range from 2.6 to 5.4; 1722 participants (21.3%) had serum albumin levels <4.1 g/dl.

Fig. 1 shows the Kaplan-Meier survival curves according to new LTCI service need certification, with the subjects stratified into 4 groups according to eGFR quartile. Individuals with eGFR values <60.0 ml/min/1.73 m^2 had a significantly elevated risk of LTCI service need according to multivariate analyses using an eGFR value of 71.4–83.6 ml/min/1.73 m^2 as the reference (adjusted hazard ratio: 1.44 [95% CI 1.12–1.86]) (Table 4). The mean eGFR was 71.2 ± 17.4 ml/min/1.73 m^2, with a range from 20.3 to 123.8 ml/min/1.73 m^2; 1963 participants (24.3%) had eGFR values <60 ml/min/1.73 m^2.

4. Discussion

In this study, we found that approximately 25% of adults aged 65 years or over had eGFR values <60 ml/min/1.73 m^2, which indicates that CKD is common among older Japanese adults. The multivariate analyses demonstrated eGFR values <60.0 ml/min/1.73 m^2 were independently associated with new certifications for LTCI service need. Thus, our data indicate that CKD is a critical marker of frailty in older adults.

According to the multivariate analyses, lower BMIs (less than 20.5), and higher frailty checklist scores (more than 6) were associated with certification for LTCI service need. These results are consistent with those of previous studies (Levey et al., 2006; Tomata et al., 2011; Yamada et al., 2012), which revealed that the subjects with the lowest BMIs had an elevated risk of requiring care and that frailty checklist scores were strongly associated with new LTCI service need certifications (Levey et al., 2006). Thus, it is important to assess nutrition, cognitive function, mood, and ADL for care prevention, and the frailty checklist includes these items.

In terms of nutrition, however, our study failed to demonstrate that serum albumin levels were significantly associated with new LTCI service need certification after adjusting for other frailty-related factors, although the univariate analysis demonstrated that

Table 3
Demographic differences according to eGFR quartile.

	eGFR (ml/min/1.73 m^2)									
	Q1: <60.0		Q2: 60.0–71.3		Q3: 71.4–83.6		Q4: >83.6		P-value	Post hoc
Gender (female)	1122 (57.2%)		1153 (54.2%)		1066 (54.2%)		1429 (71.2%)		<0.001	Q2,3 < Q1 < Q4
BMI (kg/m^2)	23.1	3.3	22.7	3.2	22.9	3.1	22.4	3.4	<0.001	Q1 > Q4 > Q2,3
Frailty checklist (points)	5.2	4.6	4.0	3.9	3.2	3.6	3.9	3.8	<0.001	Q1 > Q2 > Q4 > Q3
Serum albumin (g/dl)	4.11	0.27	4.16	0.26	4.21	0.25	4.21	0.26	<0.001	Q1 < Q2 < Q3,4