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Original Article

Locomotive syndrome affects the acquisition of long-term care insurance system certification

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ABSTRACT

Background: Locomotive syndrome is closely related to the state of long-term care. This study aimed to longitudinally evaluate long-term care certification occurrence in locomotive syndrome using data from the Miyagawa study.
Methods: The study included 470 individuals (168 males, 302 females; mean age, 70.7 years) with no long-term care certification at the time of participation in the study. Locomotive syndrome was classified into three stages (stages 1–3) according to the 25-question Geriatric Locomotive Function Scale. Analysis was performed with long-term care certification occurrence as the endpoint and locomotive syndrome stage as the explanatory variable.
Results: The median observation period was 6.3 years, and long-term care certification occurred in 69 (34.2%) and 30 (11.2%) of the participants in the locomotive syndrome and no-locomotive syndrome groups, respectively. Independent risk factors of long-term care certification occurrence were locomotive syndrome stage-3 (hazard ratio: 2.27) in the total number of studies, and locomotive syndrome stages 2 (hazard ratio: 2.49) and 3 (hazard ratio: 2.79) in females. Locomotive syndrome stage-3 was an independent risk factor in long-term care certification occurrence due to musculoskeletal disorders (hazard ratio: 3.89).
Conclusions: The higher the locomotive syndrome stage, especially in females, the higher the risk of long-term care certification occurrence.

1. Introduction

The super-aged society of Japan is rapidly advancing. In 2019, the aging rate reached 28.4%, and by 2065, it is expected to reach 38.4% [1]. As the elderly population increases, the demand for long-term care increases. In 2000, the Japanese government established a long-term care insurance system [2]. This system allows people aged ≥65 years to receive services when they need long-term care or assistance in activities of daily living. The number of people receiving certification has been increasing, reaching 6.69 million in 2019. The long-term care certification (LTCC) rate accounts for 18.3% of the elderly population aged ≥65 years. According to a 2019 Ministry of Health, Labour and Welfare survey, musculoskeletal disorders (MD) such as joint disorder, bone fracture/fall, and spinal cord injury accounted for 24.8% of all indications for long-term care [3]. In the Research on Osteoarthritis/osteoporosis Against Disability (ROAD) study, Akune et al. reported that the risk factors for LTCC were region, age, body mass index <18.5 or ≥27.5 kg/m^2, grip strength, knee extension torque, usual gait speed, chair stand time, and muscle dysfunction [4]. Measures developed to address MD are expected to reduce the number of people requiring long-term care and to extend healthy life expectancy.

In 2007, the Japanese Orthopaedic Association defined locomotive syndrome (LS) as a condition that increases the risk of long-term care due to progressive decline in mobility [5]. LS is classified into stages 1–3 according to degree of severity; the higher the number, the more severe the mobility impairment [6]. Although it has been suggested that LS is closely associated with the need for long-term care, few reports have examined the association between LS stage and LTCC occurrence [7,8]. In addition, previous reports have not examined the specific causes that led to LTCC

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occurrence [7,8]. The purpose of this study was to longitudinally evaluate the impact of LS on LTCC occurrence based on previous cohort studies. In addition, we investigated LS as an independent risk factor in LTCC occurrence due to MD.

2. Materials and methods

2.1. LTCC

The individuals who wish to receive services under the long-term care insurance system are required to submit an application to the municipality. A home-visit survey of 74 items related to activities of daily living was conducted by city staff. The survey data was processed on a computer based on the uniform standards set by the government to determine the eligibility of the applicant to receive LTCC. If certified, the committee classified the applicants into one of the seven levels while considering the written opinion of the attending physician. The degree of care required was greater as the support and care levels increased.

2.2. Causes of the need for long-term care

In Japan, comprehensive survey of living conditions by the Ministry of Health, Labour and Welfare surveys all households once every three years to determine the status of persons requiring long-term care [9]. The survey is conducted using a method in which the surveyor distributes questionnaires on the status of caregivers which is filled by the household members, and the surveyor collects the completed questionnaires at a later date. The questionnaire asks respondents to select the main cause of their need for long-term care from the following: cerebrovascular disease (stroke), cardiac disease (heart disease), malignant neoplasm (cancer), respiratory disease, joint disorder, dementia, Parkinson's disease, diabetes, sight/hearing impairment, bone fracture/fall, spinal cord injury, infirmity due to aging, others, and I do not know [10]. Based on the tabulated results, the Ministry of Health, Labour and Welfare publishes the causes of the need for long-term care.

2.3. The 25-question Geriatric Locomotive Function Scale (GLFS-25)

The GLFS-25 is a self-administered questionnaire that comprises 4 items for pain, 16 items for activities of daily living, 3 items related to social functioning, and 2 items on mental health status, and subjectively assesses mobility decline. Each item is graded on a 5-point scale from no impairment (0 points) to severe impairment (4 points). The total score ranged from 0 (best) to 100 (worst). Seichi et al. reported that a score of $\geq$7 on the GLFS-25 is defined as LS [11]. In addition, a score of 7–15 on the GLFS-25 is defined as LS stage-1, 16–23 as LS stage-2, and $\geq$24 as LS stage-3 [6]. LS stage-1 is a state in which the decline in mobility function has begun, and LS stage-2 is a state in which the decline in mobility function has progressed. LS stage-3 is a condition in which social participation is limited due to decreased mobility and is likely to require treatment for some MD.

2.4. Participants

Every two years since 1997, we have conducted a musculoskeletal cohort study of residents of $\geq$50 years of age in Miyagawa village area. The region is mountainous, and its main industry is forestry. In 1997, the total population was 4196, of which 1463 were $\geq$65 years of age, for an aging rate of 34.8%. In 2019, the total population was 2856, of which 1420 were $\geq$65 years of age, for an aging rate of 49.7%. This cohort study was initiated to investigate the natural history of osteoporosis and osteoarthritis of the knee. A total of 12 medical examinations were conducted between 1997 and 2019. All residents $\geq$50 years of age were invited by mail to participate in the examination, and those residents who were willing to participate were asked to return the invitation. The inclusion criterion was the ability to walk to the hospital where the survey was performed and to understand the purpose of this study. The participants understood and signed an informed consent form for participation in the study. The Ethics Committee for Human Research at our institution approved this study (U2018-022).

Since the LS study began with the eighth examination in 2011, participants from the 2011 (8th), 2013 (9th), 2015 (10th), and 2017 (11th) examinations were included in this study. Participation rates among all residents were 9.8% (221 of 2247, 8th), 10.2% (223 of 2184, 9th), 9.7% (204 of 2101, 10th), and 8.7% (176 of 2027, 11th). Data of the first evaluation of each participant was used. For example, if the participant participated in both 2011 and 2015 examinations, the data of 2011 was used in this study. Data were collected retrospectively in this study.

A total of 824 people participated in the 8th through 11th examinations, and 314 people participated more than once, making a total of 510 participants. Of these, 3 persons with missing data were excluded. Of the 507 participants, 37 were certified by long-term care insurance and were excluded; 470 participants (168 males and 302 females) were included in the analysis. Three deaths were included in the analysis. At the time of examination, each participant's height and weight were measured by a nurse and physician at the hospital where the study was conducted, and the body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). LS was evaluated using the GLFS-25 [8]. At the time of examination, a self-administered questionnaire containing the GLFS-25 was distributed to the participants, and the results were tabulated. We defined a GLFS-25 score of $\geq$7 as LS, according to Seichi's report [11]. The participant group with LS was defined as LS group, and the participant group that did not fall into the LS category was defined as no-LS group. Furthermore, LS stage-1 was defined as a GLFS-25 score of 7–15 points, LS stage-2 as 16–23 points, and LS stage-3 as $\geq$24 points [6].

In April 2020, we went to the municipalities to collect information on the occurrence of LTCC, date of first certification, level of care, death, and change of residence from the time of medical examination to March 31, 2020. LTCC was defined as an individual being certified as either requiring support levels 1–2 or care levels 1–5 in the long-term care insurance system. Participants with LTCC were defined as the LTCC group and those without LTCC as the no-LTCC group.

For participants who received LTCC, the primary cause of the need for care was also investigated. Since we could not find any reports that investigated the reasons why people were certified as requiring long-term care in the past, we referred to the method used by the Ministry of Health, Labour and Welfare to tabulate the causes in the certification of requiring long-term care, which is published based on comprehensive survey of living conditions [3]. In April 2021, questionnaires with the same options as those to be included in the survey form that used comprehensive survey of living conditions were mailed to homes, to be filled out and returned by household members. As for the cause of the need for care, cerebrovascular disease (stroke), cardiac disease (heart disease), malignant neoplasm (cancer), respiratory disease, joint disorder, dementia, Parkinson's disease, diabetes, sight/hearing impairment, bone fracture/fall, spinal cord injury, infirmity due to aging, others, and I do not know were listed as options [10]. For those participants who had not returned the form by one month later, we went directly to the municipal authorities and compiled information on the causative disease from the attending physician's written opinion at the time of initial LTCC application. Participants

Table 1
Student's t-test for age, BMI, and height; Mann-Whitney's *U* test for observation period; and Fisher's exact test for LS stage and LTCC occurrence were used to compare the results in males and females.

Factor	Total (n = 470)	Male (n = 168)	Female (n = 302)	p value
Age (year)	70.7 ± 9.1	71.1 ± 9.3	70.5 ± 9.0	0.498
BMI (kg/m2)	22.9 ± 3.1	23.2 ± 2.9	22.8 ± 3.3	0.133
Height (cm)	154.6 ± 8.7	162.1 ± 7.3	150.4 ± 6.3	<0.001
Observation period (year)	6.3 [range: 0.2–8.3]	5.5 [range: 0.2–8.3]	6.3 [range: 0.4–8.3]	0.297
LS Stage 1	118 (25.1%)	38 (22.6%)	80 (26.5%)	0.006
LS Stage 2	42 (8.9%)	12 (7.1%)	30 (9.9%)	
LS Stage 3	42 (8.9%)	7 (4.2%)	35 (11.6%)	
LTCC occurrence	99 (21.1%)	30 (17.9%)	69 (22.8%)	0.238

BMI, body mass index; BW, body weight; LS, locomotive syndrome; LTCC, long-term care certification.

Table 2
Main reasons for the acquisition of long-term care by level of care required.

	Total (n = 99)	Male (n = 30)	Female (n = 69)	Persons requiring support (n = 42)	Persons requiring care (n = 57)
Dementia	41 (41.4%)	11 (36.7%)	30 (43.5%)	11 (26.2%)	30 (52.6%)
Joint disorder	17 (17.2%)	5 (16.7%)	12 (17.4%)	13 (31.0%)	4 (7.0%)
Bone fracture/fall	10 (10.1%)	2 (6.7%)	8 (11.6%)	5 (11.9%)	5 (8.8%)
Cerebrovascular disease (stroke)	10 (10.1%)	4 (13.3%)	6 (8.7%)	4 (9.5%)	6 (10.5%)
Infirmty due to aging	7 (7.1%)	4 (13.3%)	3 (4.3%)	3 (7.1%)	4 (7.0%)
Cardiac diseases (heart diseases)	4 (4.0%)	1 (3.3%)	3 (4.3%)	2 (4.8%)	2 (3.5%)
Others	3 (3.0%)	–	3 (4.3%)	–	3 (5.3%)
Malignant neoplasm (cancer)	3 (3.0%)	1 (3.3%)	2 (2.9%)	1 (2.4%)	2 (3.5%)
Parkinson's disease	2 (2.0%)	1 (3.3%)	1 (1.4%)	2 (4.8%)	–
Sight/hearing impairments	1 (1.0%)	–	1 (1.4%)	1 (2.4%)	–
Respiratory diseases	1 (1.0%)	1 (3.3%)	–	–	1 (1.8%)
Diabetes	–	–	–	–	–
Spinal cord injury	–	–	–	–	–
I do not know	–	–	–	–	–

with LTCC due to MD such as joint disorder, bone fracture/fall, and spinal cord injury were defined as LTCC-due-to-MD group, and those with LTCC due to other factors were defined as LTCC-due-to-non-MD group.

2.5. Statistical analysis

Participants were compared based on gender using *t*-test for age, BMI, and height; Mann-Whitney's *U* test for observation period; and Fisher's exact test for LS stage and LTCC occurrence. Causes for receiving LTCC were compared between the LS and no-LS groups using Fisher's exact test. Univariate analysis was performed in the LTCC and no-LTCC groups using Cox proportional hazards model with age, BMI, height, and LS stage as explanatory variables. Survival curves with LTCC occurrence as endpoint by LS stage were created and tested by log-rank test and Bonferroni correction. Survival curves were also generated and tested by gender. Multivariate analysis was performed using Cox proportional hazards model with LTCC as the objective variable and the factors that were significant on univariate analysis as explanatory variables. The same multivariate analysis was performed separately for male and female participants. In addition, univariate analysis was performed in two groups, LTCC-due-to-MD group and other participants, using Cox proportional hazards model with age, BMI, height, and LS stage as explanatory variables. Multivariate analysis was performed with LTCC occurrence due to MD as the objective variable and the factors that were significant on univariate analysis as explanatory variables.

Statistical significance was set at $P<0.05$. All statistical analyses were performed using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria) [12].

3. Results

The mean age of the 470 participants (168 males and 302 females) was 70.7 years, and the median observation period was 6.3 years. There was no change of residence, and three deaths (two males and one female) occurred prior to the acquisition of LTCC. Table 1 shows participant background. The prevalence of LS was 43.0% (LS stage-1, 25.1%; LS stage-2, 8.9%; and LS stage-3, 8.9%). During the observation period, 99 patients received LTCC (30 males and 69 females). The overall LTCC incidence rate was 3.8/100 person-years, and LTCC incidence rate for male and female participants was 3.3/100 person-years and 4.1/100 person-years, respectively. Care level-1 (31 individuals) was the most common care level, followed by support level-1 (26 individuals). Sixteen participants were in support level-2, 14 in care level-2, seven in care level-3, two in care level-4, and three in care level-5. Table 2 shows the causes of LTCC acquisition. Table 3 shows the results of

Table 3
Univariate analysis using Cox proportional hazards model of LTCC and no-LTCC groups.

Factor	No-LTCC group (n = 371)	LTCC group (n = 99)	p.value
Age (year)	68.4 ± 8.4	79.5 ± 5.9	<0.001
Gender	M, 138; F,233	M, 30; F, 69	0.390
BMI (kg/m2)	22.9 ± 3.2	22.9 ± 3.1	0.936
Height (cm)	156.0 ± 8.5	149.3 ± 7.3	<0.001
LS (%)	Stage 1: 88 (23.7)	Stage 1: 30 (30.3)	<0.001
	Stage 2: 26 (7.0)	Stage 2: 16 (16.2)	
	Stage 3: 19 (5.1)	Stage 3: 23 (23.2)	

BMI: body mass index; F: female; LS: locomotive syndrome; LTCC: long-term care certification; M: male.

Table 4
Main reasons for the acquisition of long-term care by LS stages.

	No-LS group (n = 30)	LS group (n = 69)	LS stage 1 (n = 30)	LS stage 2 (n = 16)	LS stage 3 (n = 23)
Dementia	12 (40.0%)	29 (42.0%)	11 (36.7%)	9 (56.3%)	9 (39.1%)
Joint disorder	1 (3.3%)	16 (23.2%)	8 (26.7%)	3 (18.8%)	5 (21.7%)
Bone fracture/fall	3 (10.0%)	7 (10.1%)	6 (20.0%)	–	1 (4.3%)
Cerebrovascular disease (stroke)	5 (16.7%)	5 (7.2%)	1 (3.3%)	1 (6.3%)	3 (13.0%)
Infirmty due to aging	2 (6.7%)	5 (7.2%)	1 (3.3%)	1 (6.3%)	3 (13.0%)
Cardiac diseases (heart diseases)	2 (6.7%)	2 (2.9%)	1 (3.3%)	–	1 (4.3%)
Others	2 (6.7%)	1 (1.4%)	–	–	1 (4.3%)
Malignant neoplasm (cancer)	1 (3.3%)	2 (2.9%)	1 (3.3%)	1 (6.3%)	–
Parkinson's disease	1 (3.3%)	1 (1.4%)	–	1 (6.3%)	–
Sight/hearing impairments	–	1 (1.4%)	1 (3.3%)	–	–
Respiratory diseases	1 (3.3%)	–	–	–	–
Diabetes	–	–	–	–	–
Spinal cord injury	–	–	–	–	–
I do not know	–	–	–	–	–

LS: locomotive syndrome.

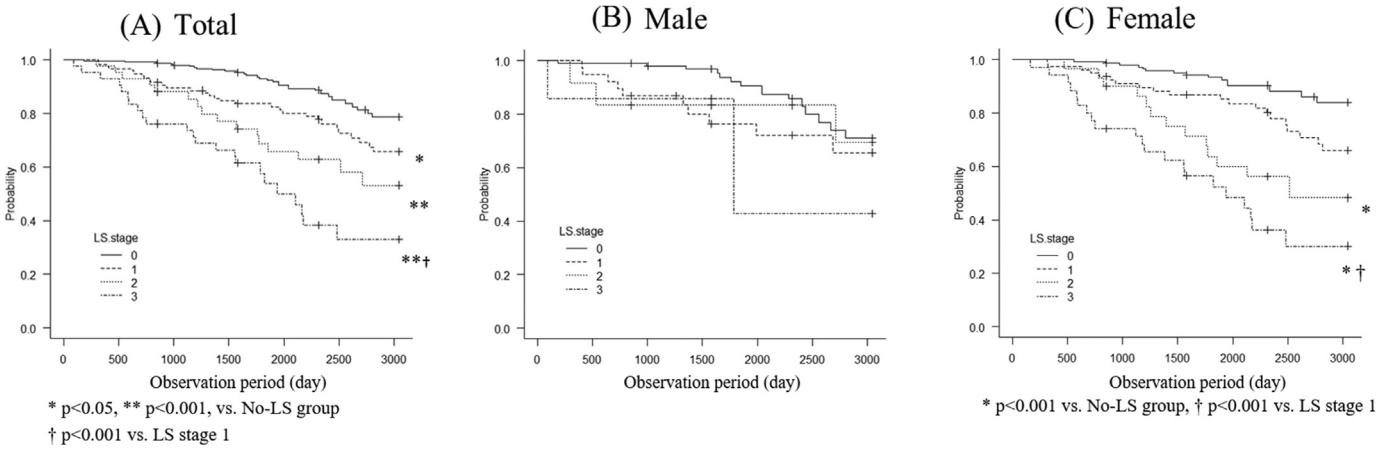

Fig. 1. Survival curves with long-term care certification occurrence as endpoint by locomotive syndrome (LS) stage. Four groups (no-LS, LS stage-1, LS stage-2, and LS stage-3 groups) were compared by log-rank test and Bonferroni correction. A: Total, B: Male, C: Female.

Table 5A
Cox proportional hazards model with LTCC as outcome and age, height, and LS stage as explanatory variables.

Factor	No-LTCC group (n = 371)	LTCC group (n = 99)	HR	95% CI	p value
Age (year)	68.4 ± 8.4	79.5 ± 5.9***	1.15	1.10–1.19	<0.001
Height (cm)	160.0 ± 8.54	149.3 ± 7.26**	0.93	0.89–0.97	0.001
LS stage 1	88 (23.7%)	30 (30.3%)	1.68	1.00–2.84	0.091
LS stage 2	26 (7.0%)	16 (16.2%)	1.83	0.978–3.04	0.061
LS stage 3	19 (5.1%)	23 (23.2%)*	2.27	1.23–4.18	0.022

*p<0.05, **p<0.01, ***p<0.001.
BMI, body mass index; CI, confidence interval; F, female; HR, hazard ratio; LS, locomotive syndrome; LTCC, long-term care certification; M, male.

univariate analysis that is performed using the Cox proportional hazards model separately for the LTCC and no-LTCC groups.

During the observation period, 69 (34.2%) and 30 (11.2%) patients in the LS and no-LS groups, respectively, received LTCC. The LTCC incidence rates were 6.4/100 person-years in the LS group and 2.0/100 person-years in the no-LS group. Table 4 shows the causes of LTCC in the LS and no-LS groups.

3.1. Survival curves by LS stage with LTCC occurrence as endpoint are shown in Fig. 1

In the total study, a comparison of the four groups at initial screening (no-LS, LS stage-1, LS stage-2, and LS stage-3 groups) showed that more patients in the LS group at the initial screening

Table 5B
Cox proportional hazards model with LTCC as outcome, age, height and LS stage as explanatory variables in males.

Factor	No-LTCC group (n = 138)	LTCC group (n = 30)	HR	95% CI	p value
Age (year)	69.1 ± 8.7	80.6 ± 5.2***	1.15	1.08–1.23	<0.001
Height (cm)	163.3 ± 7.1	156.2 ± 5.3*	0.93	0.86–0.99	0.034
LS stage 1	28 (20.3%)	10 (33.3%)	1.45	0.62–3.40	0.578
LS stage 2	9 (6.5%)	3 (10.0%)	1.14	0.30–4.31	0.843
LS stage 3	5 (3.6%)	2 (6.7%)	1.25	0.25–6.26	0.790

*p<0.05, **p<0.01, ***p<0.001.
BMI, body mass index; CI, confidence interval; F, female; HR, hazard ratio; LS, locomotive syndrome; LTCC, long-term care certification; M, male.

Table 5C
Cox proportional hazards model with LTCC as outcome, age, height and LS stage as explanatory variables in females.

Factor	No-LTCC group (n = 233)	LTCC group (n = 69)	HR	95% CI	p value
Age (year)	68.0 ± 8.2	79.0 ± 6.1***	1.15	1.09–1.20	<0.001
Height (cm)	151.6 ± 5.9	146.3 ± 5.8	0.95	0.90–1.00	0.050
LS stage 1	60 (25.8%)	20 (29.0%)	1.87	0.94–3.72	0.074
LS stage 2	17 (7.3%)	13 (18.8%)*	2.49	1.15–5.40	0.021
LS stage 3	14 (6.0%)	21 (30.4%)**	2.79	1.37–5.70	0.005

*p<0.05, **p<0.01, ***p<0.001.
BMI, body mass index; CI, confidence interval; F, female; HR, hazard ratio; LS, locomotive syndrome; LTCC, long-term care certification; M, male.

Table 6
Univariate analysis using Cox proportional hazards model of LTCC-due-to-MD group and other participants.

Factor	No-LTCC/LTCC due to non-MD group (n = 443)	LTCC due to MD group (n = 27)	p. value
Age (year)	70.3 ± 9.1	78.7 ± 4.9	<0.001
Gender	M, 161; F,282	M, 7; F, 20	0.346
BMI (kg/m2)	22.9 ± 3.1	22.9 ± 3.4	0.928
Height (cm)	154.9 ± 8.6	148.8 ± 7.4	<0.001
LS stage (%)	Stage 1: 104 (23.5)	Stage 1: 14 (51.9)	<0.001
	Stage 2: 39 (8.8)	Stage 2: 3 (11.1)	
	Stage 3: 36 (8.1)	Stage 3: 6 (22.2)	

BMI: body mass index; CI: confidence interval; F: female; HR: hazard ratio; LS: locomotive syndrome; LTCC: long-term care certification; M: male; MD: musculoskeletal disorders.

and with a higher LS stage received LTCC compared to that observed in the no-LS group (p<0.001; Fig. 1A). No significant differences were found in the male study (Fig. 1B). In the study of females, significant differences were found between the no-LS and LS stage-2 groups, no-LS and LS stage-3 groups, and LS stage-1 and LS stage-3 groups (Fig. 1C). Cox proportional hazards regression analysis showed that LS stage-3 had an independent and significant effect on receiving LTCC, with a hazard ratio of 2.27 (Table 5A). Age and height were also significant factors. LS stage was not a significant factor for males (Table 5B), while LS stages 2 and 3 were significant factors for females (Table 5C).

Table 6 shows a comparison of participant backgrounds in the two groups of LTCC-due-to-MD group and other participants. In the Cox proportional hazards model with LTCC occurrence due to MD as the objective variable, age, gender, LS stage-1, and LS stage-3 were significant factors (Table 7).

4. Discussion

In this study, we examined LS as a risk factor of LTCC occurrence longitudinally. LS was an independent risk factor of LTCC occurrence; especially in females, the higher the LS stage, the higher the risk for LTCC occurrence. Furthermore, LS stage-3 was an independent risk factor in LTCC occurrence due to MD.

To our knowledge, only two reports have examined the association between LS and LTCC occurrence [7,8]. Niwa et al. also used the GLFS-25 to evaluate LS and classified the participants into groups 1 (scores 7–15) and 2 (scores ≥16 points) [7]. In their report, the cumulative incidence rates of either LTCC or death in group 1 or 2 were 11%, 18%, and 39%, respectively, during an average 4.9-year observation period. The Japanese Orthopaedic Association proposed the concept of LS stage-3 in 2020; thus, we added LS stage-3 in this study. The cumulative incidence rates of LTCC in this study were 12% in the no-LS group, 26% in the LS stage-1 group, 38% in LS stage-2, and 55% in LS stage-3 for 6.3 years of observation period [7]. Our rates were similar to those reported in Niwa et al.'s study. They also found that LS stage-2 was associated with LTCC acquisition, which is consistent with the results of our study. Moreover, Yoshimura et al. reported that LS stage-3 is significantly associated with disability [8]. This result is consistent with that of our study. Previous reports have not investigated the causes of LTCC. Therefore, we investigated these causes and examined the influence of LS on LTCC occurrence due to MD.

In this study, the risk of LTCC occurrence was higher in females with higher LS stage, but in males, there was no significant difference in LTCC occurrence between LS stages in male. Life expectancy in this study was 89.1 years for female and 82.7 years in male, and healthy life expectancy was 82.9 years in female and 79.8 years in male [13]. A man with mild motor disability is unlikely to apply for LTCC because his female spouse is still alive and able to support him. In this study, most reported dementia as the reason for applying for LTCC. The dementia may have resulted in the need for long-term care before MD became apparent. The prevalence of knee osteoarthritis, a frequent degenerative disease of the musculoskeletal system, is significantly lower in male than in female, which may explain the findings in this study [14].

In a cohort study of adults aged ≥65 years, Makizako et al. reported that participants with physical frailty were at a higher risk of receiving LTCC [15]. Physical frailty occurs when LS progresses, and the decline in physical ability becomes more pronounced with subjective symptoms. Yoshimura et al. reported that majority (93.3%) of the participants with physical frailty had LS stage-2 [16]. In our study, LS stage-3 had an independent effect on LTCC. These results are consistent with the findings of Makizako et al. [15]. LS was originally a concept in preventive medicine for the prevention of long-term care because of locomotive organ dysfunction; however, LS stage-3 was identified as a stage that requires more active intervention [6]. Many patients who have undergone surgery for lumbar spinal canal stenosis or total hip arthroplasty have been reported to have improved from LS stage-3 to stage-2 or less after the surgery [17–19]. This study identified LS stage-3 as an independent risk factor in LTCC occurrence due to MD. The GLFS-25 can be used to screen for LS not only in medical institutions, but also in municipalities and companies. Based on the results of this study, it

Table 7
Cox proportional hazards model with LTCC due to MD as outcome and age, height and LS stage as explanatory variables.

Factor	No-LTCC/LTCC due to non-MD group (n = 443)	LTCC due to MD group (n = 27)	HR	95% CI	p value
Age (year)	70.3 ± 9.1	78.7 ± 4.9***	1.12	1.05–1.20	<0.001
Height (cm)	154.9 ± 8.6	148.8 ± 7.4*	0.93	0.87–0.99	0.016
LS stage 1 (%)	104 (23.5)	14 (51.9)**	5.87	1.92–18.0	0.002
LS stage 2 (%)	39 (8.8)	3 (11.1)	2.41	0.52–11.2	0.260
LS stage 3 (%)	36 (8.1)	6 (22.2)*	3.89	1.01–15.0	0.046

*p<0.05, **p<0.01, ***p<0.001.
BMI: body mass index; CI: confidence interval; F: female; HR: hazard ratio; LS: locomotive syndrome; LTCC: long-term care certification; M: male; MD: musculoskeletal disorders.

is possible to examine the acquisition of LTCC during routine outpatient consultations. If the LS stage is high, the presence of musculoskeletal disease should be evaluated. With appropriate intervention, improving the LS stage can reduce LTCC occurrence.

This study has some limitations. First, since the participants were limited to those who were able to travel to the examination site and had the ability to understand and respond to the content of the questionnaire, the number of participants who received LTCC may have been underestimated. Second, participants who required assistance in activities of daily living but were in an environment where they received adequate support from those around them may not have applied for LTCC. Third, information on the disease that were indicators for LTCC was extracted by selecting one of the diseases listed on the questionnaire form by the participants in response to the question. Therefore, it is possible that accurate information on participants who needed care due to multiple diseases were not obtained. For participants whose information could not be recorded using the questionnaire, the disease that led to the application for LTCC was extracted from the opinion form of the attending physician. However, because the form includes an objective assessment by the attending physician, there may be errors in the perception of the condition requiring long-term care between the physician and the applicant. Fourth, LS in this study was evaluated using only the GLFS-25 because it is considered the most convenient way to screen for LS and evaluate it over time. Fifth, the confounding factors reported as risk factors of LTCC by Akune et al. such as region, grip strength, knee extension torque, usual gait speed, chair stand time, and muscle dysfunction were not examined in this study [4].

In conclusion, the higher the LS stage at initial screening, the higher the LTCC occurrence. Evaluation of LS stage may predict LTCC occurrence. Improvement in the LS stage may be an effective preventive measure for LTCC occurrence, especially in female. The rate of aging in the target areas in this study was high, and we believe that the future relevance of the results of this study is high for the Japanese, who have an increasing ageing population.

Ethical statement

The Ethics Committee for Human Research at our institution approved this study (U2018-022).

Declaration of competing interest

None.

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