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Original Article

Physical function and health-related quality of life of community-dwelling older adults with locomotive syndrome and pre-frailty

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Abstract. [Purpose] To consider the effective rehabilitation approaches for locomotive syndrome (LS) and pre-frailty, we examined the characteristics of physical function and health-related quality of life (HRQoL) in community-dwelling older adults. [Participants and Methods] Eighty-three individuals (age 71.8 ± 5.5 years, 29 males and 54 females) were divided into robust (R), LS, and locomotive syndrome with pre-frailty (LSP) groups. We compared the subscale and summary scores of the 36-Item Short-Form Health Survey (SF-36) as HRQoL indices. The grip strength, five-chair stand up test (SS-5), and normal walking speed were the physical function indices. [Results] The LS group had lower two-step scores and normal walking speed but there was no significant difference in the SF-36. The two-step score and 25-question geriatric locomotive function scale, SS-5, seven SF-36 subscales, and mental component summary (MCS) scores were lower in the LSP group. Compared to that of the LS group, the LSP group did not show significant difference in physical function but showed lower values in overall health, vitality, mental health, and MCS in the SF-36 subscales. [Conclusion] The subjective evaluation of one's health was lower than that of the deterioration of physical function as a characteristic of the LSP.
Key words: Locomotive syndrome, Pre-frailty, HRQoL

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INTRODUCTION

In 2007, the Japanese Orthopaedic Association (JOA) proposed locomotive syndrome (LS) in Japan, a super-aged society[1)]. LS refers to a condition in which the risk of needing nursing care increases due to a decline in mobility caused by a locomotor disability that interferes with daily life[2)]. On the other hand, physical frailty is a condition that cannot be ignored because it increases the risk of decline in daily living activities, falls, and hospitalization, and may increase mortality[3)]. In older adults, the presence of chronic pain which is the common symptoms in LS was associated with an increased risk of frailty[4)]. With ageing, the prevalence of pain and frailty increase, and chronic pain and frailty they are associated with functional decline and have negative impacts on older adults' quality of life (QOL)[5)]. There is a category called pre-frailty in frailty as a preliminary step. Although less vulnerable than frail state, pre-frailty people are at higher risk than robust adults of greater frailty, hospitalization, falls, worsening disability and mortality[6, 7)]. The early detection and prevention of frailty are recommended for community-dwelling older adults with a pre-frailty status, as they are more likely to return to a robust state than frailty people[8)]. The systematic review showed that the prevalence of frailty, pre-frailty and robustness was 7.4%, 48.1%, 44.4% in Japanese[9)]. In the preventive point of view, it would be necessary to intervene or support to older people pre-frailty as much as or more than frailty.

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Since both LS and physical frailty are based on the decline of physical function due to aging, it is expected that a considerable number of older people suffer from both. Yoshimura et al. reported that the frequency of LS alone was much higher than frailty in a large-scale cohort study of Japanese individuals aged 60 or older[10]. In other words, it can be inferred that LS and frailty develop sequentially with LS occurring first and physical pre-frailty falls into the frailty state. It has been shown that frailty can be reversibly returned to a healthy state by appropriate treatment such as exercise[11]. From this, it is considered that the adverse effects on health can be minimized by detecting the functional deterioration of the locomotor and the physical pre-frailty that is likely to be complicated after that at an early stage and performing appropriate intervention.

Frailty is a concept that includes physical vulnerability and mental, psychological, and social aspects, which have an influence on each other[12]. Thus, it is necessary to consider individuals from a physical perspective and also from multiple perspectives. In a systematic review, it was shown that the quality of life (QOL) among community-dwelling older people with physical frailty was lower than those without physical frailty[13]. Health-related QoL (HRQoL), which is directly related to health, has been used as an important outcome in the medical and health care fields. Regarding this concept, the Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) is one of the most used HRQoL scales in the world[14]. The SF-36 is consistent with the physical, psychological, and social aspects of frailty and is a useful scale for understanding the characteristics of community-dwelling older people from multiple perspectives.

It has been reported that the SF-36 score of LS individuals is lower than non-LS individuals[15], but these studies were conducted on LS participants judged only by the 25-question geriatric locomotive function scale (GLFS) and not LS including physical function assessment. In addition, it has been reported that HRQoL declines with physical function in both LS and physical pre-frailty[13, 16], but we have not found a report that clarifies HRQoL in community-dwelling older people with LS and physical pre-frailty. Furthermore, the characteristics of physical function and HRQoL of community-dwelling older adults with pre-frailty, which is the preliminary stage of physical frailty, has not been clarified. In this study, we examined the characteristics of physical function and HRQoL of community-dwelling older adults with LS and physical pre-frailty individuals to help devise a rehabilitation approach to prevent older adults from requiring support or to improve their support status.

PARTICIPANTS AND METHODS

Among 97 older people living in the community who requested to attend the salon, 92 were selected who met the following six conditions: age 60 or older, independent in daily life, not applicable to frailty, no motor symptoms that interfere with daily life, a dementia screening test (MMSE) score of 28 points or higher, and complete measurement data. The purpose of this study was explained to these 92 participants in writing and orally, and their written consent was obtained. The Research Ethics Review Committee of Osaka University of Health and Sport Sciences (Approval No. 20-2) and the Research Ethics Review Committee of Kinjo University (Notification No. 2020-01) approved this study.

To determine the degree of LS, the 2-step test, the standing test, and the GLFS[17] proposed by the JOA were performed. Those who corresponded to locomotive syndrome stage 1 or 2 or 3 were defined as LS participants. The revised Japanese version of the Cardiovascular Health Study criteria (revised J-CHS criteria)[18] that determine muscle weakness and decreased walking speed, decreased physical activity, fatigue, and weight loss were used. If 1–2 items of muscle weakness, walking speed decrease, physical activity decrease, fatigue, and weight loss are applicable, it is judged as pre-frailty[19, 20]. Those who were categorized into neither LS and pre-frailty were classified in the robust (R) group. Those who fell into LS only in the LS group. Those who fell into both LS and pre-frailty into the LSP group. Based on the results of locomotive syndrome risk test and J-CHS criteria, 37, 27 and 19 participants were classified into R, LS and LSP. The R group (69.1 ± 5.3 years, 9 males, 28 females, body mass index (BMI), 22.6 ± 0.9 kg/m^2), the LS group (74.4 ± 4.9 years, 13 males, 14 females, BMI 23.4 ± 1.1 kg/m^2), and LSP (73.3 ± 4.7 years, 7 males, 12 females, BMI 24.2 ± 1.3 kg/m^2) were included in the study. As a result, 83 participants (71.8 ± 5.5 years old, 29 males and 54 females) were analyzed.

Grip strength, the five times chair-rise test (SS-5), and normal walking speed were measured as physical function indexes. Grip strength was measured with a digital dynamometer (Grip-D, Takei Kiki Kogyo Co., Ltd., Niigata, Japan). On the SS-5, the participants crossed their arms in front of their chest, stood and sat down from the chair five times as quickly as possible, and the time was measured until the completion of the fifth sitting once. The walking speed (m/s) was calculated by measuring the time required with a stopwatch on a walking path with a 4-meter section and a 1-meter preliminary path in front and behind. The walking speed (m/s) was calculated by measuring the time required with a stopwatch.

Body composition was measured using a body composition meter (MC-780A, Tanita, Tokyo, Japan) for body fat percentage, fat mass, lean mass, skeletal muscle mass (SMI), and BMI.

The SF-36 was used to assess HRQoL. Eight subscale scores of PF, daily role functioning (physical) (RP), body pain (BP), overall health (GH), vitality (VT), social functioning (SF), daily role functioning (mental) (RE), mental health (MH), and three summary scores of physical component summary (PCS), mental component summary (MCS), and role/social component summary (RCS) were calculated using a web-based scoring system.

As a statistical study, the 2-step score (2-step length normalized by height), the GLFS, grip strength, SS-5 required time, normal walking speed, body composition data, and SF-36 scores (8 subscales and three summary scores) were compared and examined between the three groups. Since the frequency of LS and pre-frailty increases with age, multiple comparisons

were performed with each group after the covariance analysis with age as a covariate to eliminate the effect of age. The significance level was adjusted by the Bonferroni method. For the rise test, the χ^2 test was used to compare the three groups. The statistical software SPSS version 26 was used. Significance was determined at 5%.

RESULTS

Of the 83 participants analyzed, the proportion of females was 75.7% in the R group, 51.9% in the LS group, and 63.2% in the LSP group. The highest was in the R group, but there was no significant difference between the groups.

Of the 83 participants analyzed, 46 (55.4%) had LS; 19 (22.9%) had LS on the 2-step test, 24 (28.9%) on the standing test, and 27 (32.5%) on the GLFS. Of the LS participants, 40 (87.0%) had locomotive syndrome stage 1. According to the results of the J-CHS criteria, the number of patients with physical pre-frailty (corresponding rate) was 19 (22.8%), and the corresponding rate of each item was muscle weakness in 5 (26.3%), walking speed decrease in none, physical activity decrease in 6 (31.6%), fatigue in 13 (68.4%), and weight loss in 4 (21.1%).

The results of physical function of the three groups are shown in Table 1 and the results of the SF-36 in Table 2. In the comparison between the R and the LS group, the LS group showed significantly lower values in the 2-step score ($p<0.01$) and

Table 1. Comparison of 2-step score, GLFS and physical function (Covariate: age)

	R group	LS group	LSP group	Bonferroni
Two Step Score	1.35 ± 0.04	1.32 ± 0.04	1.34 ± 0.05	a**, b**
GLFS (points)	2.58 ± 1.91	6.61 ± 2.19	10.57 ± 2.56	b**
Grip Strength (kg)	29.38 ± 2.84	27.92 ± 3.19	28.32 ± 3.70	
SS-5 (s)	7.38 ± 0.58	8.02 ± 0.68	9.12 ± 0.83	b**
Normal walking speed (m/s)	1.54 ± 0.10	1.37 ± 0.06	1.45 ± 0.11	a**

Mean ± Standard Deviation.
a: R group vs. LS group; b: R group vs. LSP group.
*p<0.05 **p<0.01.
GLFS: 25-question geriatric locomotive function scale; SS-5: Sit to Stand-5; R group: robust group; LS group: locomotive syndrome only group; LSP group: locomotive syndrome with pre-frailty group.
Multiple comparisons were performed with each group after the covariance analysis with age as a covariate to eliminate the effect of age. The significance level was adjusted by the Bonferroni method.

Table 2. Comparison of each item of the SF-36 (Covariate: age)

	R group	LS group	LSP group	Bonferroni
PF	94.30 ± 4.00	86.60 ± 4.50	81.60 ± 5.20	b**
RP	91.80 ± 7.00	82.90 ± 8.00	74.20 ± 9.30	b*
BP	79.50 ± 7.40	73.00 ± 8.50	60.90 ± 9.80	b*
GH	70.10 ± 5.30	69.70 ± 6.10	57.50 ± 7.10	b*, c*
VT	76.40 ± 5.30	75.10 ± 6.10	57.20 ± 7.10	b**, c**
SF	92.20 ± 6.80	86.40 ± 7.90	75.30 ± 9.10	b*
RE	93.60 ± 7.20	87.20 ± 8.20	80.30 ± 9.50	
MH	82.20 ± 5.20	81.70 ± 6.00	68.40 ± 7.00	b*, c*
PCS	50.40 ± 3.30	46.70 ± 3.90	45.20 ± 4.30	
MCS	58.60 ± 2.80	59.40 ± 3.30	52.60 ± 3.60	b*, c*
RCS	51.40 ± 4.00	47.30 ± 4.70	47.40 ± 5.20	

Mean ± Standard Deviation.
b: R group vs. LSP group; c: LS group vs. LSP group.
*p<0.05, **p<0.01.
R group: robust group; LS group: locomotive syndrome only group; LSP group: locomotive syndrome with pre-frailty group; PF: physical functioning; RP: role physical; BP: bodily pain; GH: general health; VT: vitality; SF: social functioning; RE: role emotional; MH: mental health; PCS: physical component summary; MCS: mental component summary; RCS: role/social component summary.
Multiple comparisons were performed with each group after the covariance analysis with age as a covariate to eliminate the effect of age. The significance level was adjusted by the Bonferroni method.

normal walking speed ($p<0.05$), but there was no significant difference in the GLFS and SF-36. In the comparison between the R and LSP groups, the LSP group showed significantly lower values for the 2-step score ($p<0.01$), higher values for the GLFS ($p<0.01$) and SS-5 time ($p<0.01$), and higher values for the SF-36 PF ($p<0.01$), RP ($p<0.05$), BP ($p<0.05$), GH ($p<0.05$), VT ($p<0.01$), SF ($p<0.05$), MH ($p<0.05$) and MSC ($p<0.05$). In the comparison between the LS and LSP groups, the LSP group showed significantly lower GH ($p<0.05$), VT ($p<0.01$), MH ($p<0.05$) and MSC ($p<0.05$) in SF-36. There were no significant differences in grip strength and body composition (adiposity, fat mass, lean mass, SMI, BMI) among the three groups.

DISCUSSION

The purpose of this study was to clarify the characteristics of physical function and HRQoL of community-dwelling older people with LS complicated by pre-frailty.

First, it is natural that the 2-step score, one of the criteria for judging LS, is lower in the LS and LSP groups than in the R group because they have LS. In the comparison between the R group and the LSP group, there was a difference in the time required for the SS-5 and a decrease in the 2-step score. It has been reported that SS-5 time is related to many physical and mental factors. Lord et al. reported that knee flexor strength, ankle dorsiflexor strength, intrinsic sensory capacity of the lower extremity, tactile threshold, reaction time, and stability on a foam rubber mat are independent factors of SS-5 time[21]. In standing up, it is necessary to maintain dynamic stability while projecting the center of gravity to the base of the supporting period. Considerable lower limb muscle strength, intrinsic and extrinsic sensation, and balance are required. It is expected that opportunities to stand up will be reduced due to the increased effort required. Therefore, the amount of activity and the range of activity decreased. It is presumed that this corresponds to the decrease in the amount of physical activity in the J-CHS criteria. The normal walking speed was significantly lower in the LS group, but not in the LSP group. However, the walking speed was 1.4 m/s, which did not meet the criterion of 1.0 m/s described in the J-CHS criteria. In addition, since the number of patients in the LSP group who had a decrease in walking speed according to the J-CHS criteria was zero, the walking ability of the LS and LSP groups was considered low enough not to interfere with daily life.

The results of the HRQoL scale showed that there was no difference between the R group and the LS group. On the other hand, there was a difference between the R and LSP groups in 7 of 8 subscales and MCS, indicating that the LSP group had a general decrease in HRQoL. In the comparison of physical functions between the two groups, there was a difference in the time required for SS-5. The SS-5 mainly reflects lower limb muscle strength, and it is suggested that a decrease in lower limb muscle strength causes a decrease in daily living ability and leads to a decrease in QOL in older individuals[22]. In addition, it has been reported that the time required for the SS-5 is affected by the pain, anxiety, and vitality scores of the Short-Form 12 Health Status Questionnaire, which is a shortened version of the SF-36[21]. From these results, it is inferred that HRQoL is decreased due to a decrease in the amount of physical activity and a narrowing of the range of activity, resulting from a decrease in mobility function and mobility opportunities due to a decrease in the ability to stand up.

Compared with the LS group, the LSP group showed differences in the GLFS score, SF-36 subscale score, and MCS. In addition, within the J-CHS items, the rate of fatigue and the decrease in physical activity that the subject subjectively judges is high, and the rate of objective judgment such as muscle weakness and decrease in walking speed is low. From this, it was inferred that the subjective evaluation of one's health was lower than the deterioration of physical function as a characteristic of the LSP group. Differences were observed in the subscale scores and MCS of the three items of HRQoL, especially GH, VT, and MH. It has been reported that the score of SF-36 decreases as the locomotive degree progresses[23]. Although it has been reported that the SF-36 score decreases as the locomotive syndrome risk progresses[13, 16], no specific subscale has been shown to decrease in LS and frailty. In the present study, we could not clarify the reason for the specific decrease in GH, VT, MH, and MCS in the LSP group. In the future, we will increase the number of samples and clarify the characteristics of the HRQoL subscale and summary score of LS and LSP.

One of the limitations of this study is that the research participants were recruited through the recruitment process, and therefore, it is considered that they are relatively interested in research and have high health consciousness. In addition, because the participants were older people who were able to come to the research institute by car or public transportation. Assuming the process from the merger of LS and pre-flail to the merger of LS and frailty, it is necessary to include frailty participants and to clarify the effect of the combination of LS and frailty on HRQoL.

In the present study, HRQoL was maintained but physical function decreased in LS participants, and HRQoL was decreased in LSP participants, although there was no difference in physical function compared with LS participants. In addition, it was found that HRQoL decreased in the pre-frailty stage, which is the stage before frailty, suggesting that a rehabilitation approach that improves not only physical function but also HRQoL is necessary from the LS stage.

Conflicts of interest

The principal investigator and co-investigators have no conflicts of interest to disclose in relation to this research.

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