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学位論文内容の要旨

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学位論文題名

Effect of seasonal variation on physical activity and frailty among community dwelling elderly living in snowy cold regions

（積雪寒冷地に居住する高齢者における身体活動量とフレイルに対する季節変動の影響）

Background:

Although the benefits of physical activity are well-known, levels of physical inactivity are increasing in many countries. Physical activity, particularly for preventive care of the elderly, must be encouraged. The level of physical activity undertaken by people is influenced by season; however, little is known about seasonal fluctuations of physical activity and its relation to muscle strength. Generally, physical activity declines in winter in snowy-cold regions. Physical activity is a diagnostic criterion for frailty, hence it is possible to assume that the status of frailty fluctuates depending on the season.

Objectives:

The current study had three aims: 1) to clarify the association between physical activity levels and muscle strength/skeletal muscle mass during non-snowy and snowy seasons in northern Japan, 2) to investigate the effect of lower limb muscle strength training programme for elderly individuals on the physical activity during the snowy season, assuming physical strength benefits promoting physical activity, and 3) to clarify the phenomenon of seasonal frailty and its association with health-related quality of life (QOL).

Methods:

Participants were community-dwelling elderly people aged 65 years or older living in Tobetsu, northern Japan. People who had a certificate needed long-term care insurance which is run by municipal governments to provide long-term care services were excluded.

In Chapter Ⅰ, a 30-s chair-stand test (CS-30) and body composition measurements using bioelectrical impedance analysis were conducted prior to physical activity measurement using a three-dimensional acceleration sensor in both non-snowy and snowy seasons. Daily steps for the non-snowy and snowy seasons were compared using Welch's t test. The association between the CS-30/skeletal muscle index and daily steps in both seasons was estimated by fitting multiple linear regression models, with age and sex as covariates.

In Chapter Ⅱ, daily step counts were measured during the snowy season in 2018 (with no exercise intervention) and 2019 (after the exercise intervention). Physical function

was measured before and after the intervention, including body mass index, CS-30, grip strength, normal gait speed, short-test battery for locomotive syndrome, Kihon checklist (KCL), and 25-question geriatric locomotive function scale. The 12-week supervised exercise programme included a 1-hour exercise routine, performed twice per week was conducted. The exercise programme consisted of 10-15 min warm-up, low-intensity resistance training for the lower limbs and trunk (20-30 min), ergometer cycling as moderate aerobic exercise (10-15 min), and a cool-down.

In Chapter Ⅲ, a questionnaire was administered twice: in the snowy season and non-snowy season. Frailty was judged using KCL. Self-rated health, life satisfaction, exercise satisfaction, and QOL scores for both seasons were obtained. Depending on the status of frailty in both seasons, four classifications were established (robustness, non-snowy frailty, snowy frailty, and year-long frailty). Frailty was judged by $4 \leq$ of KCL score.

Results:

Average daily step counts were significantly lower during the snowy season, compared to the non-snowy season ($P < .01$). The CS-30 in the snowy season alone was significantly associated with daily step counts. Multiple linear regression analyses results revealed that, for the same muscle strength in both seasons, the daily step counts during the snowy season were fewer than those during the non-snowy season (Chapter Ⅰ).

To examine the effect of muscle strength training programme on the physical activity during the snowy season, 11 women and 3 men (78.6±5.2 years old) were participated the programme. The exercise intervention improved physical function, with a significant increase in step count among individuals with lower baseline strength. Improved lower limb strength positively correlated with an increase in step count (Chapter Ⅱ).

Regarding the investigation of seasonal frailty by questionnaire research, 144 valid responses were obtained. In today, 45% participants exhibited frailty throughout the year, 31% were robust throughout the year, and 10% exhibited frailty during either the snowy or non-snowy season. A multiple regression equation to predict the status of year-long frailty revealed cognitive decline, mood of depression, self-rated health, low physical strength and social frailty in the non-snowy season as the predictive factors. In addition, KCL score in the non-snowy season was the strongest predictor of QOL score (Chapter Ⅲ).

Conclusions:

The muscle strength required to perform adequate physical activity depended on season. Lower limb muscle strengthening is an effective intervention to improve physical activity during the snowy season among community-dwelling elderly. The status of frailty fluctuates seasonally in an individual, whose status vacillates between the conditions of advanced frailty and robustness. Frailty in the non-snowy season is considered a step in the progression of physical dysfunction.