

Acute Effects of Square-Stepping Exercise on Cardiorespiratory Fitness and Cognitive Function in Older Adults

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The Square-Stepping Exercise (SSE), a multi-task exercise, is now done by older people worldwide. However, it lacks basic data. This study investigated its intensity and acute effects on cardiorespiratory fitness and cognitive functions in older adults. Nineteen senior residents in Ibaraki were involved in this study. It followed a crossover design, and included the control (CTR) and SSE experiments. The participants' gas exchange and heart rate (HR) were measured during interventions and two cognitive tests were conducted before and after the interventions. The SSE was classified as a low-intensity exercise (2.1-2.7 METs, 14.3-17.3 %HR_{reserve}). The results from a cognitive test showed that reaction time improved in the SSE experiments. This showed that the SSE may have helped improve information processing speed. SSE's intensity was low and it could bring some acute effects on cognitive function. This intensity may be beneficial for high-risk older people to perform, and for healthy people to enjoy the exercise while communicating with others.

【Introduction】

Many studies have demonstrated that daily exercise can be a way for individuals to prevent unhealthy aging, lead an independent life, and reduce the risks of being bedridden and requiring nursing care. Walking is the most popular exercise amongst senior citizens in Japan, and it has a variety of health benefits. Studies have revealed that the Metabolic Equivalent (MET) value of walking at 4km/h is 5.1 METs for older people, and that daily walking is related to better cognitive function. Given this strong evidence, communities and local governments in Japan have started implementing systems and exercise classes that encourage senior citizens to leave their homes and become physically active. In addition to recommending daily exercise such as walking, the local government in Kasama City, Ibaraki, Japan, introduced Square-Stepping Exercise (SSE) to their exercise classes. Previous studies have shown that 3- and 4-month SSE programs improved or maintained balance ability, lower-limb functions, and cognitive functions in older adults. SSE also had a significant effect on fall prevention. This was first introduced in 2008, and there are more than 16,000 people do it within the city. The exercise is

also done in many countries. Nevertheless, this growing exercise lacks basic data such as its intensity and acute effects.

In order to provide new indexes of SSE, the main purpose of this study was to investigate its intensity in METs and its acute effects on cardiorespiratory fitness in older adults, using cardiopulmonary tests. A second aim was to investigate acute effects of SSE on cognitive functions.

【Methods】

The participants were 19 people aged 65 years and older who had been practicing SSE for at least 1 year in Tsukuba City, Ibaraki, Japan.

This study followed a crossover design, and included two experiments: the control (CTR) and SSE. All the participants underwent both experiments in random order two days in a row. Each experiment's main components were pre-intervention cognitive tests, intervention (SSE: rest-SSE-rest, CTR: 40-minute rest), post-intervention cognitive tests. The cognitive tests were the Stroop Test and the Trail Making Test part A (TMT-A). During the interventions, the participants' gas exchange and heart rate (HR) were measured using a MetaMax® 3B-R2 (CORTEX). For the cognitive tests, two-way repeated measures analysis of variance (ANOVA) with experiment (SSE/CTR) and session (pre/post) was used to investigate the existence of a significant difference ($p < 0.05$). Post hoc tests with a Bonferroni correction were conducted to determine where and how the differences occurred. Effect size (Cohen's d) was also estimated.

【Results and Discussion】

The MET value of SSE was between 2.1 and 2.7, and the $\%HR_{\text{reserve}}$ was between 14.3 and 17.3. The energy expenditure during the SSE-intervention was 64.1 to 67.2 kcal. Therefore, SSE was categorized as a low-intensity activity (1.5–3 METs, $<40\%HR_{\text{reserve}}$). Although this intensity and energy expenditure might not be high enough for healthy individuals, this study has proved that this exercise can be recommended for high-risk populations such as frail older adults to start with as daily exercise. However, given SSE's social features, this level of intensity may be the best for older adults to have active conversations with friends while performing SSE together.

In the TMT-A test, there was not significant difference at pre- and post-interventions between the CTR and SSE experiment. However, the effect size was medium for only the CTR experiment. In the Stroop Test, significant improvement was seen in reaction time in the SSE experiment (Figure 1). The effect size was large or medium for only the SSE experiment. Although acute effects on cognitive function were not consistent in the two tests, it can be concluded that the SSE session may have helped information processing speed.

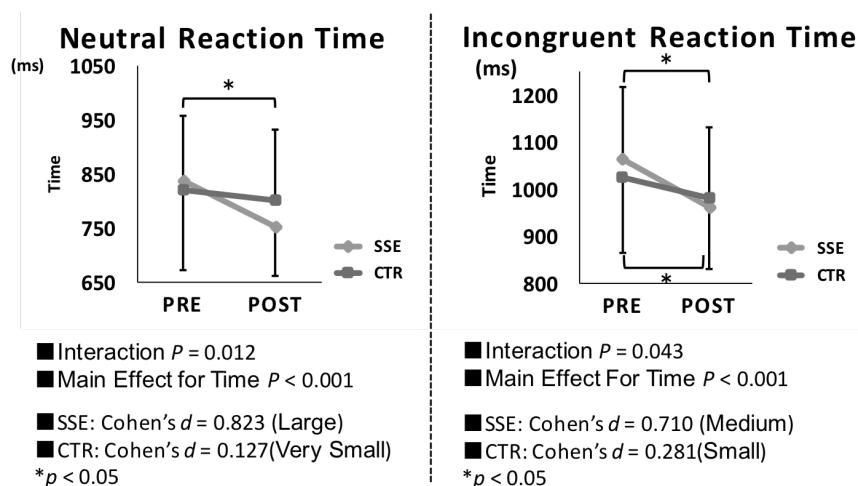


Figure 1: Results of the Stroop Test

【Conclusions】

The strengths of this study were that the detail of study protocol was shown, and that the variables were investigated in detail. From the outcomes of the gas exchange analysis, this study found that SSE is a low-intensity form of exercise. Its MET value was 2.1 to 2.7 METs, and $\%HR_{\text{reserve}}$ was 14.3% to 17.3%. Although its intensity was lower than that of many other popular exercises, these findings showed that SSE is an exercise that can be introduced to high-risk older people, such as those who are frail and inactive, as an introduction to a new exercise habit.

Regarding effects on cognitive function, this study showed it was possible that SSE could improve cognitive function, especially information processing speed. Even though the improvement was small, if older people kept performing SSE repeatedly, the improvement could become more visible. This could be a reason why previous longitudinal studies have found improvements in cognitive function in older persons after SSE programs.

【Significance of the Study】

These basic data and findings of acute effects obtained in this study can be utilized as an index of SSE by fitness professionals working with older adults, as well as workers at nursing homes, when choosing appropriate exercises. The findings could also be useful for local governments and communities with an interest in introducing SSE but who are yet to make a decision, helping them to be sure about this relatively new exercise. As the exercise intensity of SSE is low, this study has proved that it can be used with older people with a wide range of health status, from high-risk older individuals to those who are healthy. In addition, the basic indexes such as MET value and energy expenditure can be referred to when comparing the aptitude of SSE with that of other exercises. Furthermore, these findings will assist with better understanding of the mechanisms underlying the long-term results acquired in previous studies.

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