Effects of soccer instruction to kindergartener on executive function and agility

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1. Introduction

In recent years, research showing that exercise is effective not only for improving physical fitness but also for improving cognitive function, known as executive function, has been attracting attention. Executive function is the ability to achieve goals through higher-order cognitive control and behavioural control, and consists of three elements: inhibition, switching, and updating (Miyake et al., 2000). It is supported that performing complex exercises with high cognitive demands is more effective in improving executive function than performing simple exercises (Diamond, 2015). Therefore, engaging in open skill sports such as soccer and tennis, which are defined as complex exercises with high cognitive demands and where the sports environment is constantly changing and unpredictable, suggested effective in improving executive function. However, because it is not possible to ascertain the original level of executive function before participating in soccer, it is unclear whether participation in soccer is actually effective in improving executive function, and this remains an issue for the future. Additionally, agility, which involves rapid whole-body movements that change speed and direction in response to external stimuli, is the most demanding physical fitness in open skill sports that require sudden changes in body direction while sprinting (Sheppard and Young, 2006).Therefore, the present study investigated whether teaching soccer, which is included in open skill sports, can effectively improve not only agility but also executive function for kindergarteners whose executive function is rapidly developing.

2. Methods

Participants

In April 2020, 31 5-year-old children enrolled in K kindergarten in H prefecture in Japan were targeted as an intervention group who received 12 weeks of soccer instruction. In addition, as a control group, in April 2020, 39 5-year-old children enrolled in K kindergarten in H prefecture in Japan, the same kindergarten as the intervention group, were targeted.

Procedure

Intervention group: For 12 weeks from May to July 2020, participants received soccer instruction once a week for 30 minutes in the morning on the field next to the kindergarten building where the participants attended. Specifically, as a warm-up, the participants dribbled with a soccer ball for 5 minutes, and then played a soccer game for 20 minutes. The game consisted of 4 teams, each consisting of 7 to 8 people, and played 2 10-minute games. Infants on teams that were not playing were instructed to observe the teams that were playing. Afterwards, as a cool-down, stretching exercises were performed for 5 minutes. Soccer instruction was carried out by a male kindergarten teacher who works at the kindergarten to which the subject belongs and has competitive soccer experience. The decision to participate in soccer instruction was made based on the free will of the infants and their parents by the first-time soccer instruction began.

Executive function and agility were measured in April 2020 (pre), before soccer instruction was implemented. In addition, executive function and agility were measured again in August 2020 (post), when soccer instruction ended.

Control group: While the intervention group received soccer instruction, the control group engaged in voluntary indoor play in a kindergarten classroom.

Similar to the intervention group, executive function and agility were measured in April 2020 (pre). In addition, executive function and agility were measured again in August 2020 (post).

Measures

Executive function

The flanker task (Eriksen and Eriksen, 1974) was used as a task to measure inhibition included in executive function.

The hand movement task (Kaufman and Kaufman, 2004) of Kaufman Assessment Battery for Children-2nd edition (KABC-II) was used as a task to measure working memory included in executive function.

Agility

The single-line repeated horizontal jump task (Goshi et al., 1999) was used as a task to measure agility in physical fitness.

Statistical analyses

Data were analysed with IBM SPSS Statistics for Windows, Version 27 (IBM Corporation, Armonk, New York, USA). The significance level was set to less than 5%. To examine gender differences in the results of the measurement items, we conducted an unpaired t-test on the results of each measurement item for boys and girls. In addition, an analysis of variance (ANOVA) was performed for each measurement item: group (intervention group, control group) x measurement period (pre/post). If the interaction was significant, I decided to test for simple main effects.

3. Results

When gender differences in the results of each measurement item were examined using an unpaired t-test, no significant differences were found in any of the measurement items, and no gender differences were observed.

Therefore, ANOVA was performed for each measurement item: group (intervention group, control group) x measurement period (pre/post). As a result, the interaction was not significant for working memory tasks and agility tasks. On the other hand, the interaction of inhibition task was significant (F (1,68) = 4.86, $p < .05$, $\eta^2 = 0.07$). As the interaction was significant for the inhibition task, we conducted a simple main effect test for each. As a result, the intervention group (M = 0.23, SD = 0.01) performed significantly better than the control group (M = 0.19, SD = 0.01) at post ($p < .01$). Furthermore, in the intervention group, post (M = 0.23, SD = 0.01) performed significantly better than pre (M = 0.18, SD = 0.01) ($p < .001$), and in the control group, post (M = 0.19, SD = 0.01) had significantly higher performance than pre (M = 0.17, SD = 0.01) ($p < .01$).

4. Conclusions

The present study revealed that by providing 12 weeks of continuous soccer instruction to 5-year-old children, inhibition, which is included in executive function, significantly improved compared to the control group.

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