

Physical Activity During Soccer Games in Elementary School Physical Education : Effects of Ball Differences

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(accepted December 5, 2022)

Abstract : The purpose of this study was to examine the amount of physical activity during soccer games of elementary physical education in relation to differences in balls. Twenty-four fifth-grade students (twelve boys and twelve girls) from elementary school A in Ishikawa Prefecture were asked to play a game with a rubber ball (molten B614J) and a game with a sponge ball (molten STS21). In each game, the court size was 20 m x 10 m, the number of players was 3vs3, and game time was 3 minutes.

Activity time (Light intensity: 0-2.9 METs, Moderate intensity: 3.0-5.9 METs, Vigorous intensity: 6.0-METs) for each exercise intensity during the game was measured using an tri-axial accelerometer (OMRON, HJA-750C). In addition, a questionnaire survey consisting of technical/tactical, physical, and psychological aspects was administered after the game. The main results are as follows:

1. Examining the activity time for each exercise intensity during the game, no significant differences were found between the games played with rubber balls and those with sponge balls (Light intensity rubber: 10.8 ± 20.4 seconds, sponge: 17.5 ± 30.0 seconds; Moderate intensity rubber: 133.8 ± 26.2 seconds, sponge: 130.8 ± 28.7 seconds; Vigorous intensity rubber: 35.4 ± 25.7 seconds; sponge: 31.7 ± 26.5 seconds).
2. The questionnaire survey after the game showed that the percentage of children who responded positively (agree / strongly agree) in the psychological items 12, 13, and 14 "Interest", "Volition", and "Attitude" exceeded 90% in all cases.

These results indicate that children can enjoy playing both games, but the amount of activity during the game does not change depending on the type of ball.

Key words : MVPA (moderate to vigorous physical activity), physical fitness, small sided game, equipment modification

I Introduction

The Ministry of Education, Culture, Sports, Science and Technology (MEXT)'s *Manual of National Curriculum Guidelines for Elementary Schools (Physical Education)* indicates that differences exist between children who exercise and those who do not, and that, while children's physical fitness is improving, it is still low compared to around 1985, when it was highest (MEXT 2017). To combat these issues, the guidelines recommend

making further improvements in physical fitness as a learning outcome both in learning exercises for fitness as well as in other domains (MEXT 2017). The WHO guidelines on physical activity and sedentary behavior (2020) recommend engaging in moderate to vigorous physical activity (MVPA) for an average of 60 minutes or more each day. While the issue of children's declining physical fitness should be dealt with collectively by schools, households, and communities rather than only at school,

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the foundation for the solution is physical education at school in a form that benefits everyone.

One exercise domain in elementary physical education is ball movement, which can be broken down into “goal-type,” “net-type,” and “baseball-type” when the primary focus is on off-the-ball movement. Soccer is the most iconic goal-type game. However, while it is popular among children, it has been found to be difficult for inexperienced teachers to supervise or in situations in which there are differences in ability within a class (Japan Football Association 2017). In developing ball-game lessons for upper elementary, educators need to find ways to make it easier for pupils to participate according to their stage of development by modifying parameters such as the number of players, the size of the field, the height of the net, the distance between bases, the rules of the game (i.e., making them easier or harder), and equipment other than the ball (MEXT 2017). Taking this into account, it becomes important to examine the adjustments that could be made to elementary school physical education classes to increase the amount of physical activity children get.

Previous studies on physical education classes involving ball movements have examined how games can be modified to improve children’s ability (Onizawa 2007, 2008, 2012), but few have focused on the amount of activity in the game itself. One study examined differences in physical activity affected by changes in the size of the field in ball movements in an elementary physical education class (Tsuda et al. 2021). A study by Hill-Haas et al. (2011), which focused on small-sided amateur soccer matches (games with a smaller number of players), found that players’ psychological responses, such as their heart rate and blood lactate concentration, as well as the distances they ran, differed when the size of the field was modified according to the number of players. Tsuda et al. (2021) applied this finding to soccer in an elementary physical education class. However, among the

mentioned parameters, research has not gone beyond examining changes in the size of the field. The Japan Football Association (2017) recommends using a sponge ball to reduce fear of the ball in children with a low skill level and children who are not athletically inclined. While having children use a sponge ball to play games would be expected to increase their level of physical activity, it is yet to be determined whether this is actually the case. Therefore, the purpose of this study was to examine the effects of different types of balls on the amount of physical activity in small sided games.

II Research method

2.1. Subjects and exercise task

The subjects in this study were 24 5th-grade one-class pupils (12 boys, 12 girls; height: 138.9 ± 6.4 cm, weight: 35.5 ± 8.2 kg) attending Japanese public school A. We divided them into 8 groups of 3 to facilitate 3-on-3 games. Consideration was given to the ways in which the subjects were grouped so that there would not be differences in physical fitness and athletic ability across teams.

In this study, we asked the subjects to play two 3vs3 games in total, one with a rubber ball and the other with a sponge ball, on a 20m x 10m field prepared on the floor of the school gym (**Figure 1**). Consideration was given to the order of each group’s turn to prevent ordering effects.

Rubber ball game:

Width of field: 20m x 10m, number of players: 3vs3; duration: 3 minutes; ball: B614J (molten).

Sponge ball game:

Width of field: 20m x 10m, number of players: 3vs3; duration: 3 minutes; ball: STS21 (molten).

Reasons for choosing these parameters include the fact that MEXT recommends the use of simplified games to increase situations in elementary physical education soccer classes in which everyone is involved (MEXT 2017) and the fact that two to three minutes is appropriate for one game (Japan Football Association 2017). The Japan Football Association (2017) indicates a 20m x 15m field

and 4vs4 (plus goalkeepers) as standard parameters for upper elementary. We tried to set up a 20m x 15m field on the school gym floor but could only establish one of the dimensions; since this was practical research focused on an actual physical education class, we decided to use two 20m x 10m fields, one for each game, as a pedagogical consideration. We chose the 3vs3 format so that it was easy for the subjects to be aware of passing and support triangles.

For both games, we used cone goals that were 70cm high and spaced 3m apart. The rules were as follows: (1) kickoff only occurred at the beginning of the game; (2) after a goal was scored, the game was restarted with a goal

kick; (3) when a ball left the field from the side, the game was restarted with a kick-in; (4) direct free kicks were made for all fouls; (5) no offsides instances were allowed; and (6) no penalty kicks were allowed.

To begin the exercise task, we obtained consent to participate from the school principal, the teachers in charge (the head teacher of grade and homeroom teacher), and all subjects and their guardians upon providing them with a sufficient explanation of the objective, method, and safety of this study. This study was approved by the XX University Research Ethics Committee.

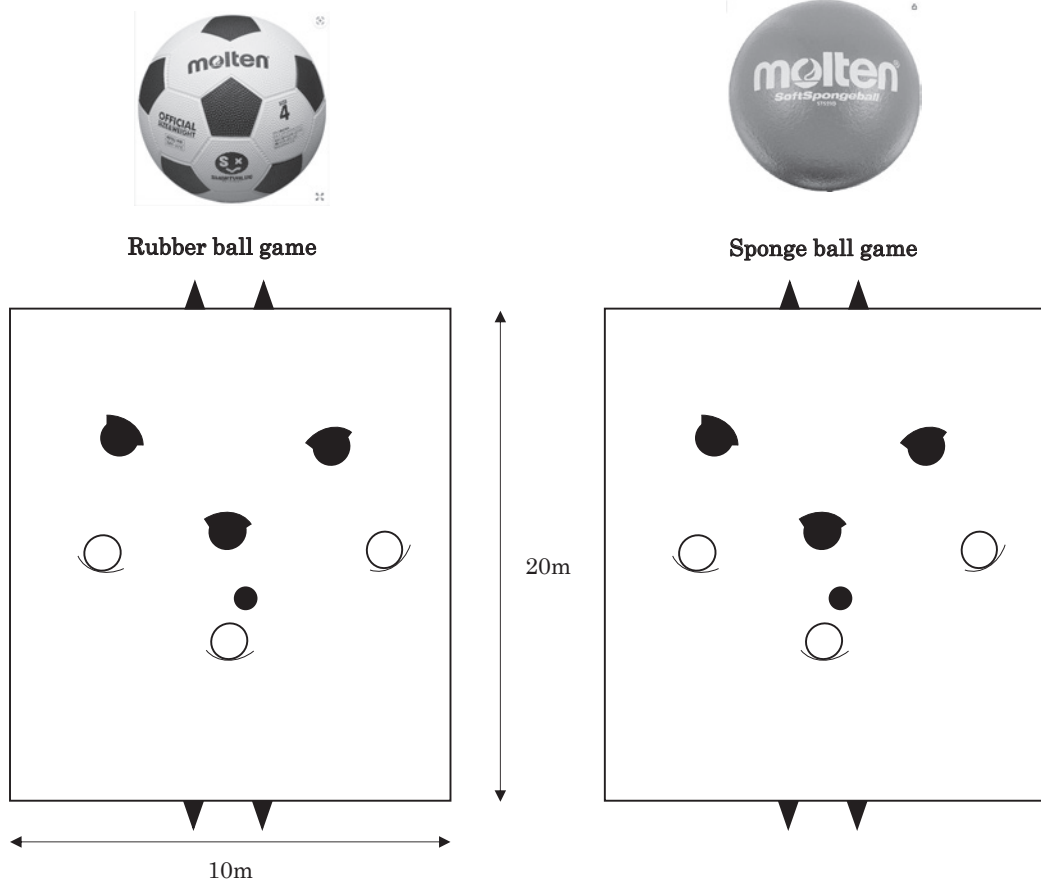


Figure 1 Two types of game settings

2.2 Measurement items and process

2.2.1 Activity level during the games

Each child was fitted with an tri-axial accelerometer (OMRON HJA-750C) around their waist before the beginning of the physical education class to examine their activity levels during the games. The tri-axial accelerometer were used to calculate the duration of activity in the games at each level of intensity (0–2.9 METs, 3.0–5.9 METs, and 6.0+ METs) based on the average level of intensity every 10 seconds. Since the values calculated with these tri-axial accelerometer are adult MET values, we replaced them with child MET values using the formula in Hikihara et al. 2021. Based on the WHO guidelines on physical activity and sedentary behavior (2020), we defined 0–2.9 METs as light intensity, 3.0–5.9 METs as moderate intensity, and 6.0+ METs as vigorous intensity in this study.

2.2.2. Post-game questionnaire survey

To understand how the children interpreted the games, we conducted a questionnaire survey after the games were finished regarding the technical and strategic dimension, fitness dimension, and psychological dimension (Tsuda et al. 2021). We asked them to evaluate the games in terms of off-the-ball movement and ball handling (technical and strategic dimension); power and endurance (fitness dimension); and interest, volition, and attitude (psychological dimension) (**Table 2**). They were

asked to give their responses to the statements on a 5-point scale (1: Strongly disagree, 2: Disagree, 3: Neither, 4: Agree, 5: Strongly agree).

2.3. Statistical processing

We performed paired *t*-tests on the physical activity levels for the rubber ball games and the sponge ball games for each level of intensity. A significance level of <5% was used for the statistical processing.

For the questionnaire surveys, we calculated the proportion of each response (1: Strongly disagree —5: Strongly agree) to each statement. IBM SPSS statistics ver. 25 was used to process the data.

III Results

Table 1 shows the duration of activity at each level of exercise intensity during the games. No significant difference was found between the games at any level of exercise intensity (light intensity: rubber 10.8±20.4s, sponge 17.5±30.3s; moderate intensity: rubber 133.8±26.2s, sponge 130.8±28.7s; vigorous intensity: rubber 35.4±25.7s, sponge 31.7±26.5s).

Table 2 shows the results of the post-game questionnaire survey. Over 90% of the children responded affirmatively to the statement regarding their “interest” (statement 12) among the statements relating to the psychological dimension.

Table 1 Activity time per intensity in two types of game

	Activity time (sec)	
	Rubber ball game (n = 24)	Sponge ball game (n = 24)
< 3.0 METs	10.8±20.4	17.5±30.0
3.0-5.9 METs	133.8±26.2	130.8±28.7
≥ 6 METs	35.4±25.7	31.7±26.5

Values are means±SD.

Table 2 Results of post questionnaire survey after two types of game

	Rubber ball game					Sponge ball game					
	1	2	3	4	5	1	2	3	4	5	
Technique (Coordination)											
1. Could you play game according to the task of the game ?	0	0	1	8	15	0	0	0	3	4	17
2. Could you do what you have been unable do during the game until now ?	0	1	5	6	12	0	0	6	5	13	
3. Could you contact the ball frequently ?	0	1	1	3	19	0	1	1	7	15	
4. Could you kick the ball (pass, shoot) frequently ?	2	1	3	1	17	1	1	2	6	14	
5. Could you control the ball frequently ?	3	1	2	5	13	1	2	7	4	10	
6. Could you dribble frequently ?	3	2	6	5	8	2	2	5	4	11	
7. Could you get the ball frequently ?	2	2	3	6	11	2	3	3	7	9	
8. Could you perform helpful movements for team when you were away from the ball ?	1	1	7	5	10	1	3	4	10	6	
Physical fitness											
9. Could you perform speedy play for a few seconds during game very frequently ?	2	2	4	5	11	2	2	6	7	7	
10. Could you perform hard play lasting from 10 to 30 seconds during game sometimes ?	3	1	3	4	13	2	0	8	5	9	
11. Could you move continuously during the game ?	1	3	1	6	13	1	1	3	5	14	
Psychology											
12. Could you enjoy playing the game ?	0	0	1	1	22	0	0	1	3	20	
13. Could you play game with maximal effort ?	1	0	0	4	19	0	0	1	4	19	
14. Could you play the game in a friendly way and in cooperation with friends ?	0	0	1	4	19	0	0	0	4	20	

Values indicate those who responded. 1. Strongly disagree, 2. disagree, 3. Neither, 4. Agree, 5. Strongly agree

IV Discussion

The WHO guidelines on physical activity and sedentary behavior (2020) recommend engaging in moderate to vigorous physical activity (MVPA) for an average of 60 minutes or more a day. This is why we examined the amount of movement children engaged in during games. If we calculate the proportion of MVPA in the games based on the mean values shown in Table 1, the levels of MVPA in the rubber ball game and sponge ball game were 94.0% and 90.2%, respectively, exceeding 90%. In addition, for both games, approximately 80% of the children responded affirmatively to statement 11 (aerobic capacity) on the questionnaire survey asking, “Could you move continuously during the game?” (Table 2). This may be due to the fact that in soccer, the players perform intermittent exercise (Bangsbo 1994). That is, since players repeatedly alternate between sprinting and jogging during a game, their activity level increases to some extent under both conditions.

It is also important to understand whether the children felt positively about the game afterwards. This is because in the past, Japanese physical education curricula were regarded as problematic for involving classes based on gym-type exercises, which caused students to dislike exercise and physical education (Takahashi 1997). In addition, Takashi (1994) points out that even if teaching materials for physical education are made from and introduce learning content of educational value, that content must arouse the desire to learn in actual students or it will fail to adequately serve its intended function. However, looking at statement 12 regarding “interest” in the psychological dimension, we can see that over 90% of the children responded affirmatively to the statement “Could you enjoy playing the game?” (Table 2). This indicates that a majority of the children were able to enjoy themselves during the game. In the study by Tsuda et al. (2021), 80% of children gave affirmative responses to a similar statement, indicating that the result in our study is quite

high, even in comparison to this.

The current Japanese physical education curriculum guidelines clearly specify that educators incorporate games that have been simplified with regard to parameters such as the number of players, size of the field, equipment, and rules in order to teach ball movement (MEXT 2017). While this was mainly written from the perspective of teaching children to think strategically, it can arguably also apply to activity levels. In other words, increasing students’ activity levels given a limited number of class hours necessitates thinking about how to modify these conditions. This study focused on 3vs3 games to examine how the type of ball used affects in-game activity levels and found that children were able to enjoy themselves playing both games (that is, regardless of the type of ball), but their in-game activity levels did not change based on differences in the type of ball used. Tsuda et al. (2021) report that changing the size of the field resulted in changes in the level of physical activity. Considering these results, it is possible that differences in the type of ball used have less of an effect on the level of physical activity when compared to the size of the field.

The limitations of this study and tasks for future research are as follows. Since this study only involved playing a game under certain specific conditions, future studies should examine what happens when the size of the field, number of players, time, and/or other parameters are changed. Further, this was also a cross-sectional study that examined the characteristics of a single exercise session rather than a longitudinal study that would verify the teaching effect across teaching units. In future studies, it would therefore be helpful to prepare a teaching program in which modified games are incorporated throughout all of the teaching units and investigate its teaching effect. While this study has left those tasks for future research, its significance lies in the fact that it identifies how in-game activity levels vary according to the type of ball used in 3vs3 games in particular.

V Conclusion

These results indicate that children can enjoy playing both games, but the amount of activity during the game does not change depending on the type of ball.

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