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Badminton as a Recreational Sport: Comparison of Physiological Intensity, Rating of Perceived Exertion, and Duration of a Doubles Game Using Various Scoring Systems

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1 Introduction

The intensity of exercise and the energy expenditure during various sport activities have been evaluated for both children[9] and adults,[2-8,10,13,14] and this information has been used as a guideline for physical training and exercise prescription. Although sports should always be played with good sportsmanship based on the rules of the respective sport, in recreational sports, the original rules of the sport are often changed in proportion to the age and skill of the participants and for the maintenance and improvement of health. This may be a desirable way to more safely enjoy sports.

In order to maintain and improve our health, we established a badminton club for school personnel, and regularly play badminton during lunch breaks and after work. After work, we usually practice the basics of badminton and play doubles games for approximately two hours. During lunch breaks, however, we usually play doubles game immediately after basic practice due to the limited time. According to the formal rules of badminton, one doubles game is played using a 15-point system. Since there is only one court for badminton at our school and the time for the lunch break is limited, not all of the club members would be able to participate in a doubles game if we use this formal rule, which prolongs the time that other non-playing members must wait. This prevents the club members from engaging in sufficient physical activity. In addition, not being able to play for a sufficient time is stressful. Therefore, we examined a system that enables all of the members of our badminton club to participate in at least one doubles game within the limited lunch break. This system allows a larger number of club members to participate in club activities.

In this study, we considered the scoring system of badminton, which affects game duration, and evaluated various scoring systems for doubles game of badminton that would allow sufficient participation in order to maintain and improve health, based on a comparison of physiological intensity, rating of perceived exertion, and duration of games.

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2 Methods

2.1 Subjects

The subjects were five healthy male members of our college staff who belonged to the badminton club (mean age: 43.8 ± 10.2 years; mean height: 169.9 ± 10.2 cm; mean weight: 67.7 ± 6.0 kg). All of the subjects were beginners at badminton, with less than one year of experience.

2.2 Scoring systems

All of the subjects played doubles games of badminton using 15-, 10-, and 5-point systems, following a sufficient warm-up period of basic practice. Each doubles game was played by different pairs of players.

2.3 Physiological intensity and rating of perceived exertion during a doubles game

In this study, we measured the physiological intensity and rating of perceived exertion (RPE) during a doubles game of badminton. Heart rates (HR) during the exercise were continuously measured at one-minute intervals using a 64-Kbyte heartbeat memory device (TAKEI, Niigata, Japan). In addition, %HRmax · reserve was obtained using the following equation:

$$\%HRmax \cdot reserve = (HRexercise - HRrest)/(HRmax - HRrest) \times 100$$

HRexercise is the heart rate during exercise, and HRrest is the heart rate at rest. HRmax was predicted using the following formula: $HRmax = 210 - 0.8 \cdot Age$.

The number of steps and the energy expenditure during the games were measured using a MY CALORY EC-510 (YAMASA, Tokyo, Japan). The RPE[11] during a game was determined by direct interview with each player at the end of the game.

2.4 Statistical analysis

All values are expressed as mean ± standard devia-

tion (SD). The physiological intensity during each game was compared by a one-way ANOVA. In addition, multiple comparison (a Fisher's LSD test) was used to test significant differences among the respective groups revealed by the ANOVA. P values below 0.05 were considered to be significant.

3 Results and Discussion

The intensity of exercise and the energy expenditure during various sport activities have been evaluated for both children[9] and adults,[2-8,10,13,14] and the resulting information has been used to predict the effect of exercise. In addition, the intensity of exercise or physical training varies depending on the objective, for example, "improvement of competitive ability," "maintenance and improvement of health and stress reduction," or "rehabilitation." The badminton club at our college was established in order to maintain and improve health, and doubles games are played regularly during lunch breaks and after work. The frequency of club activities by subjects during lunch breaks was higher than that after work, and this tendency may be observed for numerous workplaces. Currently, five to six members of our club usually play badminton for approximately 30-40 minutes during lunch breaks. However, if the formal rules of badminton are used, not all of our club members can participate in doubles games during the limited time designated for the lunch break. Therefore, in this study, we compared the physiological intensity, RPE, and duration of doubles games among the three groups using three different scoring systems (15-, 10-, and 5-point systems). Subsequently, based on the information about these issues, we clarified a set of rules for doubles badminton that allows several members to participate in order to sufficiently maintain and improve their health.

Table 1 lists the physiological intensity, RPE, and the duration of doubles games of badminton according to the three scoring systems. Although the dynamics of each game vary depending on the players, the games examined in this study were relatively well balanced. The mean heart rate for each doubles team ranged from 124 beats/min to 127 beats/min, and there were no significant differences among the three groups. In addition, %HRmax · reserve did not differ significantly among the three groups (15-point system, 58%; 10-point system, 56%; and 5-point system, 54%). RPE values were significantly higher for the 15-point system group than for the other two groups. However, the number of steps and the energy expenditure, both of which were affected by the duration of exercise, were highest in the 15-point system group, followed by the 10- and 5-point system groups in that order (Table 1).

Table 2 shows a comparison between the findings of this study and previous studies. When the physiological intensity was compared between singles and doubles games of badminton, the physiological intensity of singles games was only slightly higher than that of doubles games. In this study, the physiological intensity was

Table 1 Comparison of physiological intensity, rating of perceived exertion, and duration of a doubles game in each scoring system

	15 point system	10 point system	5 point system
Duration (min)	12.5 ± 1.3	9.2 ± 0.5*	3.9 ± 1.2*
Heart rate (bpm)	127 ± 13.7	124 ± 14.4	122 ± 17.1
%HRmax · reserve	58 ± 11.4	56 ± 12.2	54 ± 14.9
Pedometer (steps)	750 ± 109	524 ± 165*	269 ± 98*
Energy expenditure (Kcal)	30.9 ± 3.4	24.6 ± 3.0*	16.0 ± 1.4*
RPE	12 ± 0.4	11 ± 0.4*	10 ± 0.9*

Values are mean ± SD.

*Significant difference for 15 point system ($p<0.05$).

Table 2 Comparison between this study and previous studies

Authors	Subjects	Type of game	HR (bpm)	Exercise intensity	RPE
This study	middle aged men	doubles game	124#	55.8b#	11
Asami et al.[2]	middle aged women	doubles game	121	53.7a	9
		singles game	146	71.4a	11
Hoshikawa et al.[4]	middle aged men	singles game	114	58a, 64b	12
Kagaya et al.[6]	students	practice game	170-190	—	—
Kozar AJ and Hunsicker P[7]	young adult men	singles game	150	—	—
Takami et al.[13]	young adult men	singles game (trained)	145	—	—
		singles game (untrained)	113	51.7a	—

#The mean value of each scoring system.

a%$\dot{V}O_2$max.

b%HRmax · reserve.

similar among the three groups using the three different scoring systems. This finding is similar to that reported by Asami et al.[2]

The American College of Sports Medicine (ACSM)[1] recommends HRmax values of 55 (65)-90% as an exercise intensity that can contribute to the maintenance and improvement of cardiopulmonary function. Generally, exercise involving accurately maintaining an intensity of 70-85%HRmax for a duration of 20-30 minutes and a frequency of 3-5 days/week may improve cardiopulmonary function.[1] In subjects performing lower levels of physical activity, it has been reported that even exercise at an intensity of 55-64%HRmax may be sufficient for improving cardiopulmonary function.[1] In the present study, since the intensity of doubles games ranged between 54 and 58%HRmax · reserve for the three different scoring systems, all of these doubles games were found to contribute to the maintenance and improvement of cardiopulmonary function, regardless of the scoring system used. However, the effectiveness may vary depending on the duration and frequency of exercise. Our club usually plays badminton 3-5 days a week, which meets the ACSM recommendation for the frequency of exercise.[1] Although lunch break usually lasts about 50 minutes, we have only 20-30 minutes for playing badminton during lunch breaks, excluding the time for warm-up and basic practice. Therefore, we sought to examine a system for efficiently exercising within a limited lunch break. In this study, we measured the time required for each doubles game of badminton. The 15-, 10- and 5-point groups required approximately 13, 9 and 4 minutes, respectively. Based on the duration of these doubles games, we predicted the frequency and energy expenditure of doubles games assuming 30 minutes of exercise, and the 5-point group showed the highest values (Table 3).

In addition, we predicted that a maximum of seven doubles games can be played in 30 minutes if the 5-point system is used (Table 3). However, since more than four members of our club usually participate, each member can participate in less than seven doubles games. Therefore, we also investigated the mean frequency of participation in doubles games per player when games were played using the 5-point system during a 30-minute lunch break. We found that one player could participate in an average of five doubles games, and the average energy expenditure per player was estimated to be approximately 80 Kcal (Table 3), which is not so high. Asami et al.[2] and Kagaya et al.[6] reported that the intensity of basic practice such as a rally is higher than that of actual games. Therefore, basic practice before games may increase energy expenditure. Moreover, additional exercise after work may increase the daily energy expenditure to approximately 300 Kcal, resulting in the achievement of the targeted daily physical activity of 300-400 Kcal.[1]

It has been suggested that recreational sports contribute little to the improvement of cardiopulmonary function,[4] probably because, compared to training, pleasure is considered to be more important than physical activity level in recreational sports. However, since the intensity of recreational sports is limited, they can be played for a prolonged period of time, and it has been reported that recreational sports may contribute to increased energy expenditure and improvement of metabolism.[12]

In the present study, the use of 5-point system allowed a larger number of club members to participate in recreational doubles games of badminton within the limited time allowed for the lunch break. Moreover, the 5-point system allows an increase in energy expenditure in participating members. Thus, adjusting the scoring system according to the time available for participating in recreational sports resulted in more effective maintenance and improvement of health for our club members. In the future, we are planning to evaluate the effect of continuous play in badminton on the maintenance and improvement of health by introducing a novel method of practicing the basics of badminton.

Table 3 Predicted the frequency and the energy expenditure of doubles games by supposing 30 minutes of exercise

	15 point system	10 point system	5 point system
Duration (min)	12.5 ± 1.3	9.2 ± 0.5	3.9 ± 1.2
Frequency of doubles game[a]	2	3	7
Frequency of doubles game[b]	—	—	5.0 ± 0.3
Energy expenditure (Kcal)[c]	61.8 ± 6.8	73.9 ± 9.0	112.1 ± 9.7*
Energy expenditure (Kcal)[d]	—	—	80.1 ± 7.7

Values are mean ± SD.

[a] Frequency of doubles game for 30 minutes predicted based on the duration of a doubles game by each scoring system.

[b] Frequency of doubles game when played for 30 minutes by 5 point system.

[c] Energy expenditure predicted from each game frequency: energy expenditure by each scoring system shown in Table 1 × game frequency.

[d] Energy expenditure when played for 30 minutes by 5 point system.

* Significant difference for 15 point system ($p<0.05$).

4 Conclusions

In this study, we compared the physiological intensity and RPE of doubles games of badminton using three different scoring (15-, 10-, and 5-point) systems. Major findings of this study were as follows:

(1) Mean values of heart rate and %HRmax · reserve did not significantly differ among the three groups of different scoring systems;
(2) RPE values were significantly higher in the 15-point system group than in the 5-point system group;
(3) The frequency of doubles games within 30 minutes was highest in the 5-point system group; and
(4) The exercise intensity of doubles games using the 5-point system was 54%HRmax · reserve, which corresponds to the minimum exercise intensity contributing to the improvement of cardiopulmonary function.

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