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Assessment of simple reaction time in badminton players

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Introduction. Badminton is considered a sport requiring high levels of all constituent speeds. Few available instances of research in this area maintain that badminton players are characterised by high levels of movement speed, nervous conductivity and agility. Aim of the Study. This work was aimed to determine the times of simple reaction in male and female badminton players by assessing differences between badminton players and controls. Assessment of reaction times also involved a comparison of results obtained during the experiments with standards available in the literature. Material and Methods. Subjects were divided into four groups: two groups of top level junior players (10 boys and 6 girls); 26 non-playing boys and 6 non-playing girls. The measurements were conducted with the use of the MRK-80 reaction meter. Results. Arithmetic means, minimum and maximum values, standard deviation and coefficient of variation were calculated. Student's t-test was conducted to compare the results in the groups. Conclusions. Badminton players display shorter reaction times than non-players, which is probably the consequence of practicing badminton. The difference was found between results of all tests taken by boys and most tests taken by girls. The comparison of the obtained reaction times displayed by badminton players with the available standards proved that their values were mostly average, which might be the consequence of the fact that in badminton, like in many other sports, more complex factors, e.g. choice reactions, anticipation, etc., are of far greater significance.

KEY WORDS: simple reaction time, badminton, sport.

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What is already known on this topic?
Researchers examining reaction time and its significance in sport indicate that it may be improved, albeit to a limited degree. Reaction time depends mostly on individual properties of the nervous and muscle systems. Research shows that more experienced athletes react faster than their less advanced counterparts. According to many authors, the time of simple reaction plays a pivotal role in badminton and should be developed to the greatest possible extent. Many authors emphasize a number of differences in reaction time between badminton players and non-players, but it is difficult to find studies that examine the reaction time of badminton players against any set standards.

Introduction

Badminton is a popular sport which can be practised by anyone regardless of age or experience. The game involves most of the body (the majority of muscle groups), while energy is acquired from both aerobic and anaerobic processes. Regular badminton training enhances physical fitness, especially, movement coordination, speed, strength and stamina. Badminton also requires a constant analysis of the continuously changing situation on the court, forcing the player to react precisely and quickly, improving his or her assessment and anticipation skills [1]. With its long history spanning more than three thousand years badminton is one of the fastest games. According to the Badminton World Federation (BWF), the fastest measured smash shot was executed by a Chinese doubles player Fu Heifeng, who hit the shuttlecock with the speed of 332 km/h during the Sudirman Cup in 2005, although according to other sources, he executed the record-breaking shot during the World Team Championships in Glasgow in 2007 [2, 3, 4]. The current Guinness World Record in shuttlecock speed is 421 km/h [5].

The most advanced and experienced badminton players display the ability of quick analysis of the situation during the match and anticipation of the opponent's movements as well as the faculty for making instant decisions concerning the type of the opponent's move, its aiming position, the applied force, etc. Research shows that a player in the defensive position has 0.1 s to react to the opponent's attack [1]. Due to badminton's swift pace, continuous changeability of the situation on the court as well as complexity and precision of players' movements, the decisive factor in the game is speed and all its constituents, i.e.:

- reaction time (simple and complex – choice and differential),
- speed of an individual movement,
- frequency of movements [6, 7, 8].

Reaction time is defined as the period of time that elapses between the occurrence of a stimulus and initiation of movement, consisting of the following five segments:

1. Stimulation of the receptor, which depends on the level of concentration and the precision of peripheral vision, among others, which to a certain extent can be trained.
2. Transmission of stimulation to the central nervous system, which depends on the constant conduction speed in nervous tracts.
3. Transmission of stimulation through nervous centres and formation of an executory signal, both of which depend on the motility of nervous processes – it is the longest and quantitatively most diversified parameter determining the general time of reaction.
4. Transmission of the signal from the central nervous system to the muscle, whose speed remains constant and can not be improved by training.
5. Stimulation of the muscle – a change in its tension, i.e. an initiation of movement [6, 9].

Researchers have frequently taken up the issue of reaction time and its significance in sport, arguing that it depends on the type of stimulus – a reaction to a visual stimulus requires a little more time than a reaction to an auditory one: 150-200 ms for the former and 120-160 ms for the latter [9]. It also depends on individual properties of the player's nervous and muscular systems, his or her initial alertness of the opponent and current condition (e.g. hunger, drowsiness, tiredness, motivation, attitude to the performed activities, body temperature). The time span between the occurrence of the stimulus and initiation of movement also depends on such factors as age, sex, type of personality, medical condition or the extent of functional asymmetry [6, 9, 10]. Numerous research results quoted in the literature show that reaction time substantially affects the acquired results – analyses of correlations between reaction time and effectiveness of effort prove that more experienced players react more quickly than their less advanced counterparts [11]. Borysiuk in his study of fencers' reaction time did not find any substantial differences in fencers' reaction time values, concluding that they were all characterised by quick reactions (simple and complex) possibly due to their prior selection [12]. However, other researchers' conclusions are less categorical. Fontani et al. established that experienced karate practitioners reacted more quickly to visual stimuli than beginners, while it was found that less experienced volleyball players displayed shorter reaction times than experienced players [13]. Similar conclusions were drawn in the case of sprinters, where research showed that less experienced athletes (students) acquired results similar to those attained by advanced sprinters [14]. After several years of research of female sprinters participating in the World Athletics Championships, Pilianidis and Mantzouranis concluded that a shorter reaction time was not necessarily tantamount to a better result at the finishing line [15]. The research of reaction time values also included comparisons of competitors representing various disciplines. Carrying out his research of 192 female athletes practising different disciplines, Bhupinder concluded that, among others, they displayed different reaction times [16]. The shortest reaction times (to auditory and visual stimuli) were displayed by basketball players, while the longest – by gymnasts and athletes. He also argues that female athletes practising individual sports displayed longer reaction times than female team ball players.

It would thus be interesting to try to determine whether experienced badminton players display short reaction times, considering the fact that badminton is regarded as a discipline requiring high levels of all constituent speeds. Few available studies in this area maintain that badminton players are characterised by a great movement speed and a high level of nervous conductivity and agility [17]. Some researchers claim that badminton players display a correlation between the reaction times of upper and lower limbs, while differences between men and women as well as between players with various degrees of experience are significant [18]. Yuan et al. concluded that in terms of precision of reaction at the highest speeds badminton players are characterised by a shorter reaction time and a lower number of committed errors than a control group of students [19]. Research results confirm that elite badminton players react more quickly and more precisely than non-training controls, especially in situations typical of badminton, while they do not display better results in terms of movement speeds [20].

Aim of Study

The present work aimed to determine the times of simple reaction in male and female badminton players by assessing differences between badminton players and controls. Assessment of reaction times also involved a comparison of results obtained during the experiments with standards available in the literature. The working hypothesis assumed that male and female badminton players were characterised by a high level of this component speed, while their test results prove that it is higher than in the people who do not practise badminton.

Material and Methods

The subjects were divided into four groups. The first group included 10 boys – top junior players representing the Province of Lower Silesia in Poland in national championships, who trained regularly (4 times a week on average). The second group consisted of 6 girls with similar sports achievements. The third group was made up of 26 teenage boys from the 18th Lower Secondary School in Wrocław, who did not practise badminton. The fourth group included girls at the same age from the same school, who did not practise badminton either. Table 1 presents the characteristics of the sample groups. The groups of players comprised boys and girls who had trained for the period of 1 to 11 years (Table 2).

The experiments were carried out at the same time of the day, i.e. in the morning, to prevent tiredness caused by daily duties from affecting the results, in a well-lit, soundproof room, only in the presence of the researchers. Each subject took part in a test involving his or her both limbs, always starting with his or her dominating hand.

The tests were carried out with the use of the MRK-80 reaction meter, manufactured by the Śląskie Zakłady Sprzętu Medycznego (Silesian Medical Equipment Works) in Zabrze (Poland), designed to measure the time of reaction to visual and auditory stimuli in physiology, neurology and ergonomics laboratories. The MRK-80 is made up of the following parts:

- a panel for the experimenter with buttons for initiating the stimuli, a counter displaying the number of transmitted stimuli, a counter of errors made by the subject, a display of the acquired score with the accuracy of one hundredth of a second, an in-built speaker for emitting auditory stimuli (bass and treble – Fig. 3),
- a set of two pairs of buttons, operated by hands and feet, of simple and reliable construction (Fig. 1, Fig. 2),
- a screen emitting visual stimuli in three colors: yellow, green and red (Fig. 1, Fig. 2).

Table 1. Subjects' age, arithmetic means, standard deviation, minimum and maximum values

	Mean	Standard deviation	Minimum	Maximum
Badminton players – boys (n = 10)	15.9	0.94	15	18
Badminton players – girls (n = 6)	16.8	2.11	14	20
Control group – boys (n = 26)	15.0	0.98	14	16
Control group – girls (n = 6)	16.0	0	16	16

Table 2. Characteristics of badminton players in terms of their training experience

Training experience	Mean	Minimum	Maximum	Standard deviation	Coefficient of variation [%]
Boys	4.5	1	7	1.63	36.3
Girls	5.8	4	11	2.64	45.2

Figure 1. The screen for emission of visual stimuli with the manual reaction button

Figure 2. The screen emitting a visual stimulus

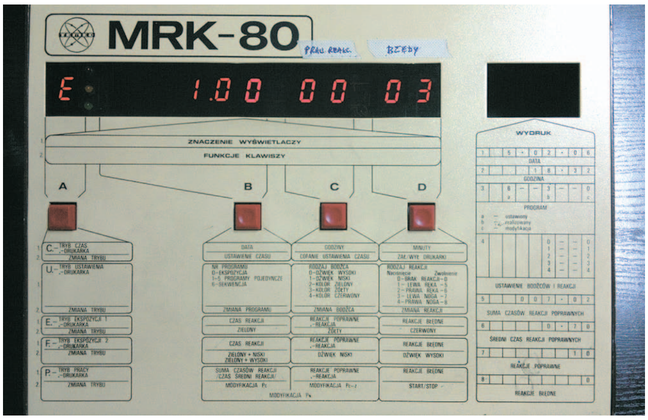

Figure 3. The experimenter's panel of the MRK-80

The two stations of the apparatus were arranged along a line at a distance of 2 meters from each other in such a way that the operator could see the light signal, but the operator's panel was beyond the subject's range of vision (Fig. 4). The measurement of the time of reaction to one stimulus involved one button operated by the hand and a visual stimulus of green colour. The experimenter greeted each subject with the following words:
"Good morning. Please sit down in front of the screen and place your both hands on the table. Place the thumb of your dominant hand on the red button on the device. In a moment you will see a green light on the screen in front of you and your task will be to press the button as soon as possible after seeing the light. The test will involve

Figure 4. The experiment station with the MRK-80 set

24 light stimuli, 12 for each hand, starting with your dominant hand. I will tell you when to switch hands. Have you got any questions? Let's start the test".

The results were recorded in tables to the nearest 0.01 s. Henceforth, the test described above will be referred to as "Test I".

Descriptive statistics were applied to process the results. To establish the significance level of differences between the groups the t-test was conducted. The results were calculated with the use of StatSoft's *STATISTICA* software package (ver. 10.0).

Results

The obtained results were subjected to statistical analysis. Arithmetic means, minimum and maximum values, standard deviation and coefficient of variation were calculated. Student's t-test was conducted to compare the groups. The arithmetic mean of the results in the test for the group of boys-players was 0.27 s, both for the left and the right hand (Table 3). A slightly greater standard deviation was found for the non-dominant limb – 0.04 s, while the standard deviation for the dominant limb was 0.02 s, which testifies to a slightly smaller dispersion. This also validates a smaller coefficient of variation calculated for the dominant limb. The analysis of the group of the boys who did not practise badminton showed greater differences between the results of tests for both limbs. The group reacted more quickly in the tests for the dominant limb – the mean was 0.3 s. The considerable dispersion of minimum and maximum values (Table 3) points to a diversification of individuals in the group, i.e. there were boys with outstanding results and those with mediocre ones. Standard deviation SD amounted to 0.04 s and the coefficient of variation V was 12.8%. In the test conducted for the non-dominant limb the average result was 0.32 s, while the difference between the maximum and minimum results was greater (SD 0.06 s and the coefficient of variation V = 17.5%). A comparison of Test I results for both groups with the standards calculated for this age shows that the badminton players' results were "below average", while those for the non-players were "weak" [21].

In the group of girls badminton players the arithmetic mean of the results in the test was 0.26 s for both limbs. Small differences were observed in the values of standard deviation, while the values of the coefficient of variation for the non-dominant limb were higher in both groups (Table 4), which proves a greater diversification of the results acquired for the non-dominant limb. Very similar results for both hands are substantiated by the value of the coefficient of variation, where the difference is 4%. In Test I the girls who did not play badminton

Table 3. Results of Test I in groups of boys – players and non-players

			Mean [s]	Minimum [s]	Maximum [s]	Standard deviation	Coefficient of variation [%]
Test I	Badminton players – boys	Dominant limb	0.27	0.24	0.30	0.02	7.50
		Non-dominant limb	0.27	0.23	0.33	0.04	12.93
	Control group – boys	Dominant limb	0.30	0.22	0.38	0.04	12.8
		Non-dominant limb	0.32	0.21	0.49	0.06	17.5

Table 4. Results of Test I in groups of girls – players and non-players

			Mean [s]	Minimum [s]	Maximum [s]	Standard deviation	Coefficient of variation [%]
Test I	Badminton players – girls	Dominant limb	0.26	0.23	0.28	0.02	7.34
		Non-dominant limb	0.26	0.21	0.33	0.04	16.47
	Control group – girls	Dominant limb	0.30	0.29	0.32	0.01	3.4
		Non-dominant limb	0.30	0.28	0.37	0.03	10.7

acquired the same mean results for the right and the left limbs – 0.30 s. (Table 4), while diversification of results was small – SD for the dominating limb was 0.01 s and the difference between the maximum and minimum results was only 0.03 s with a very small coefficient of variation V = 3.4% (Table 4). Similar results, however more dispersed (SD – 0.03, coefficient of variation V – 10.7%), were found for the non-dominant limb in this group (Table 4). A comparison of results acquired in Test I by both groups of girls with the standards calculated for this age shows that the results acquired by badminton players were "average", while those for the non-players were "weak" [21].

The test of significance of differences between the groups of boys players and non-players proved their statistical significance in the test for both limbs (Table 5).

Table 5. Significance of differences between badminton players and the control group ($p \leq 0.05$)

Group	Variable	p
Boys	Test I – Dominant limb	**0.007**
	Test I – Non-dominant limb	**0.0145**
Girls	Test I – Dominant limb	**0.0002**
	Test I – Non-dominant limb	0.051

The test of significance of differences between the groups of girls players and non-players proved their statistical significance in Test I involving the dominant limb. In the case of the non-dominant limb in Test I, p was found to be 0.051, which proved the lack of statistical significance of differences (Table 5).

What this study adds?

This study helps to prove that badminton players display shorter reaction times than non-players, which is probably the consequence of practicing badminton. On the other hand, research shows that more complex factors, e.g. choice reactions, anticipation, etc., might be of greater significance to badminton than simple reaction time.

Discussion

The present study aimed at determining the times of simple reaction for boys and girls practising badminton, and comparing them with the results in control groups as well as with available standards. The data was obtained in laboratory experiments (electronic measurement of reaction time). The analysis of test results produced a few conclusions. The first, concerned with the assessment of differences in reaction time between practising badminton players and non-players, indicates that the former display shorter simple reaction times than the latter. However, individual results obtained in the control group, such as minimum values, prove that some of the participants obtained results similar to those of the practising players. Thus, the control group of boys was more diversified and more numerous. The differences in reaction time values were statistically significant, which justifies the thesis of better (shorter) simple reaction times in the examined badminton players than in the control group. This may prove the significance of this speed constituent in badminton and that it may result from regular training and its effect on the players' bodies, or possibly from other factors, such as the effectiveness of the selection process. Many researchers, focusing on the issue of reaction time and its significance in sport, indicate that it may be improved, however, to a limited degree, as it largely depends on individual properties of the nervous and muscle systems [9]. Yet, as it was mentioned above, opinions to the contrary can be also found. For instance, Ando et al. maintain that reaction time improves. After three weeks the subjects of their research considerably improved their times of reaction to visual stimuli [22]. Such a considerable difference was not found in the case of the girls badminton players and girls from the control group, even though the differences concerned the dominant limb in Test I. Further research carried out on a larger sample might reveal the differences more clearly. Other authors emphasize the differences between practising badminton players and non-players [18]. Shuming Wang et al. tested the precision of movement as well as the reaction time and proved that badminton players displayed quicker and more precise reactions than their peers [19]. According to many authors, speed and its components, e.g. simple reaction time, play a pivotal role in badminton and should be developed to the greatest extent possible [1, 2]. This results from constant developments in badminton and changes in its rules – increased speed of the game, greater diversity and new solutions optimising training. Literature provides suggestions of tests assessing reaction times, which should be implemented as the basis for selection of prospective badminton players [23]. Developments resulting in reducing reaction times can be also noted in other sports disciplines. Pilianidis et al. examined, among others, reaction times of sprinters participating in the Olympic

Games of 2000, 2004 and 2008 and found that reaction time in athletics is constantly improving: the times from 2008 were shorter than in 2000 and 2004 [24].

The average reaction time values for individual subjects in the present study were compared with standards in literature with the use of a scale: very good, good, average, below average, weak [21]. The average results of boys badminton players were found to be "below average" ("weak" in the case of non-players), while the badminton playing girls' results were "average" ("weak" for non-players). The analysis of reaction times displayed by the boys and girls playing badminton prompts the conclusion that even though it is an important factor differentiating the players from non-players, it does not seem to be the most important parameter decisively affecting sport results. Some sport practitioners and theoreticians claim that the difference between advanced and less advanced athletes does not necessarily consist in the values of simple reaction times, but in more complex factors such as complex reaction times, the ability to anticipate and to concentrate, the faculty for quick analysis of situation, etc. [12, 25, 26]. Interestingly, research shows a distinct difference between the players and non-players in the values of attained reaction times concerning both upper limbs. Sports where only one limb is the "playing" one often result in a decisive dominance of the so-called active limb in various parameters, including reaction time, especially in the case of elite athletes [27]. Sports involving a greater participation of the non-dominant limb results in less diversified values of reaction times for both limbs and distinctly better ones for the non-dominant limb in comparison with non-players. After examining reaction times of martial arts practitioners (Qwan Ki Do) and controls, Cojocariu established that reaction times concerning the dominant limbs were similar, but for the non-dominant limb they were much shorter in athletes, which possibly suggests that the difference may result from systematic training and thus a frequent use of the non-dominant limb in the studied martial art [28]. Practising badminton may involve a comprehensive development of the player. It is also possible that the examined players – boys and girls – were frequently subjected to symmetrical training aiming at a greater training efficiency by symmetrisation of exercises.

The authors would like to stress that this study constitutes only an introduction to further, more extensive research on the importance of reaction time in badminton, i.e. a game where the significance of speed is obvious.

Conclusions

1. Badminton players display shorter reaction times than non-players, which is probably the consequence of practising badminton. The difference was found in the results of all tests taken by boys and in the majority of tests by girls.
2. A comparison o of the badminton players' reaction times with available standards showed that the players' scores were mostly average, which may result from the fact that in badminton, like in many other sports, more complex factors are of greater significance, e.g. choice reactions, anticipation, etc.

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