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Determining Reaction Time and Strength in Indonesian Male Badminton Athletes: Regional, National and Olympic Levels

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Abstract

Objectives. The study aimed to analyse the difference in whole-body reaction (WBR) times and the expanding strength of badminton athletes at regional, national, and Olympic levels.

Materials and methods. The study subjects consisted of 24 male athletes. Audio and visual whole-body reaction measurements were carried out, and each athlete's pull and push strength was expanded to analyse the existing differences. The data was analysed using One-Way ANOVA to determine the differences between the three sample groups.

Results. The results showed a significant difference ($p < 0.05$) in visual whole-body reaction and shoulder arm thrust force. Although, the audio whole body reaction variable and shoulder arm tensile strength did not significantly differ ($p > 0.05$).

Conclusions. The study indicated that badminton athletes' visual whole-body reaction speed was found to be better compared to their audio whole-body reaction speed ability. Additionally, Olympic athletes demonstrated enhanced strength conditions than regional and national-level athletes. The findings of this study are anticipated to help coaches in developing and implementing training programmes appropriate to the specific needs and conditions of athletes at the level of competition in which they are engaged.

Keywords: physical fitness, reaction speed, racket sport, elite athlete, junior athlete, young athlete.

Introduction

To succeed as a badminton athlete, one must consider physical condition. Elite athletes usually have better physical (Riccardo Izzo et al., 2018; Demirkan et al., 2015) and emotional (Mitić et al., 2021) conditions than non-elite athletes. Other factors that can influence an athlete's success include technique, tactics, psychology (Almagro et al., 2020), personality (Shuai et al., 2023), lifestyle, and mindset (Gontijo et al., 2023). Among all these aspects, one of the most determining and essential things to consider is physical condition, which can determine the competitive ability of athletes (R. Liu et al., 2022). Research states that physical fitness can also affect the technical abilities of athletes (Farley et al., 2020). Examples of parameters that can be used to measure the level of an athlete's physical condition are the reaction speed and strength of the athlete.

The reaction speed and strength of athletes play a crucial role in athlete performance (Lempke et al., 2020; Suchomel et al., 2021). Athletes are required to have good reaction speed and strength to compete well. It is because the physical condition of athletes can be an indicator of their performance (Prasetyo, 2023). Training players' technical, tactical, and motivational abilities are essential to improve their performance to reach a higher level of play (Özgür et al., 2020). The need for strength and reaction speed varies according to the level of competition in which they participate.

As the level of competition increases, their abilities must also be improved. Other components that affect a person's physical condition are endurance, flexibility, and coordination. With good physical condition, a person's physical fitness will automatically increase. Good physical condition will make the athlete more likely to advance towards the final (Drid et al., 2015). Research also shows that athletes who compete at a higher level will have a better physical condition category (Drid et al., 2015).

However, many coaches and athletes only carry out and run training programs if they know whether the program can improve the athlete's abilities and whether these abilities are sufficient to compete with their opponents in the

competition later. Most coaches do not conduct physical tests on their athletes before and after running a training program, so the coach needs to know how to improve their athletes' abilities. In addition, they will need to find out whether the training program they have given athletes so far has been running effectively, which can help athletes achieve their best performance.

Most physical tests are only carried out when they are about to start competing by the organisation that oversees them. In addition, the general condition of the athlete can be seen through several studies that have been conducted. Several studies have been conducted on badminton athletes that can be used to determine the general condition of badminton athletes. Test items used to measure the fitness or ability of athletes can be developed by considering similar movements during the match (Ando et al., 2024). A study examining the physical development of young elite athletes revealed that within a 15-month gap in physical development in height, weight, left shoulder flexion, and grip strength in male athletes, meanwhile height, medicine ball throws, and countermovement jumps in female athletes (Henn, 2021). Another study on Indonesian badminton athletes with intellectual disabilities stated that athletes' endurance, strength, speed, flexibility, and coordination abilities were in the poor category (Tyas et al., 2021). A study comparing the physical condition of young elite athletes in Indonesia and Turkey stated that the strength abilities of Turkish athletes were much better when compared to Indonesian athletes (Özgür et al., 2020).

Based on several studies on the physical condition of badminton athletes that have been conducted previously. However, studies have yet to compare the physical condition of badminton athletes at several different levels of competition. Therefore, the novelty of this study is using badminton athlete samples from 3 different levels of competition, namely regional, national, and Olympic, to obtain data. This study aims to analyse the differences in physical conditions possessed by athletes from three different levels of competition. This study will focus on analysing differences in physical conditions regarding reaction speed and strength possessed by athletes from the three existing groups. This study is expected to help coaches know the physical condition of athletes on the field and help coaches compile training programs that follow the needs and conditions of their athletes so that the results of training and athlete performance can be achieved optimally.

Materials and Methods

Study Participants

The sample population is male badminton athletes in Indonesia, starting at regional, national, and Olympic levels. The sampling technique used is stratified random sampling with a sample size of 24 male athletes with details of 11 regional, eight national, and five Olympic athletes. The athletes used as samples in the study have won a championship and qualified for the next level of competition, both competitions at the regional, national, and Olympic levels.

Study Organization

Each athlete will take a test to measure their audio and visual reaction speed as well as their expanding strength in pulling and pushing. The tool used in whole-body reaction test is TKK1264P model. The test used will use the sense of hearing as a stimulus receptor with a stimulus in the form of sound and the sense of sight as a stimulus receptor with light as the stimulus used. An expanding dynamometer measures the expanding strength of pulling and pushing. This research complies with the seven WHO 2011 Standards and has been declared ethically acceptable by ethics committee of Universitas Negeri Surabaya No.006/UN38. III.1/DL.01.02./2024.

Statistical Analysis

This research uses IBM SPSS Statistics version 25 to help with the data analysis. The Shapiro-Wilk test was used to determine data normality, and One-Way ANOVA was used to test for significant differences between the three sample groups.

Results

Table 1. Sample Profil

No.	Characteristic	N	Min	Max	Mean	SD
1.	Age	24	14	31	21.2917	5.63745
2.	Height	24	154.50	183.00	174.3875	6.50420
3.	Weight	24	46.00	88.30	70.2125	9.57398
4.	IMT	24	19.00	28.00	21.2917	5.63745

Table 1 shows the characteristics of the samples used. The athletes analysed ranged from teenagers to adults. There is also a relatively significant difference in the variables of weight and height, considering the relatively significant age difference. Based on the analysis carried out, after the data was declared normal, the analysis process was continued to the next stage to determine the significance of the existing data.

From the results of the significance test in Table 2, it is known that 3 test variables have results where there are significant differences between the test results owned by

Table 2. Data Significance Test

No	Variabel Test	ANOVA					
		Sum of Squares	df	Mean Square	F	Sig.	Annotation
1.	Audio WBR	0.001	2	0.001	1.099	0.352	sig. > 0.05 (No Significance)
2.	Visual WBR	0.018	2	0.009	13.559	0.000	
3.	Expanding Strength (Pull)	528.243	2	264.122	3.432	0.051	sig. < 0,05 (Significance)
4.	Expanding Strength (Push)	2165.249	2	1082.625	17.698	0.000	

athletes from three different competition levels. The test variables are audio WBR and push expanding strength. Other results obtained from Table 2 are that other test variables show no significant differences in athletes competing in the three competition groups. The variables are audio WBR and pull expanding strength.

Based on Table 2, it is known that there are significant differences ($p = 0.000$) in the visual WBR variable. While in the audio WBR variable, no significant differences were found ($p = 0.352$). It proves that the three groups have prominent differences in visual reaction speed abilities, but there are no significant differences in audio reaction speed abilities. The data obtained from the test results show that in the visual WBR variable, athletes at the Olympic level have the lowest abilities. Meanwhile, in the WBR audio variable, the athlete's ability at a higher level of competition will decrease.

The data in Table 2 show that the push expanding strength variable has significant results ($p = 0.000$), which means there is a significant difference in the push expanding strength in athletes from the three competition groups. Meanwhile, the pull expanding strength variable shows no significant difference ($p = 0.051$). Although it has different results, something interesting about the expanding strength variable is that the test results data show that the athlete's expanding strength ability increases with the increase in the competition level, both for the pulling and pushing categories.

Discussion

The findings obtained in this study stated significant differences ($p < 0.05$) owned by regional, national, and Olympic athletes in the variables of visual WBR and push expanding strength. There were no significant differences in the variables of audio WBR and pull expanding strength ($p > 0.05$).

Whole Body Reaction

Coordination is a crucial factor in achieving success in badminton (Donie et al., 2023; Jaworski et al., 2021). Research shows that amateur badminton players do not have good balance, agility, and eye-hand coordination even though they perform better sports (Wong et al., 2019). The research has proven that playing experience significantly affects the coordination abilities of badminton athletes (Jaworski et al., 2017).

One aspect included in athlete coordination is reaction speed. An athlete's body reaction time has a very crucial impact on an athlete's performance on the field (Lempke et al., 2020; Yildiz et al., 2020). One of the factors that influences reaction time is the athlete's physical condition. The better an athlete's physical condition, the better their reaction speed will be (Hamidur Rahman et al., 2021). Reaction speed is the time between a given stimulus and a series of movements carried out due to that stimulus (Bańkosz et al., 2020; Ervilha et al., 2020).

Research reveals that reaction speed plays a vital role in achieving success in badminton, along with the techniques and tactics possessed in the game (Yüksel et al., 2018). Research on reaction time speed between athletes and non-athletes states that their audio reaction speed is faster when compared to their visual reaction speed (Hamidur Rahman et al., 2021). Similar research on hockey players also showed that their reaction speed abilities were better when compared to visual reaction speed (Avci et al., 2023). It has findings that are contrary to the research conducted, that badminton athletes from regional, national, and Olympic levels have better visual reaction speed results when compared to their audio reaction speed. Several factors can affect visual reaction speed, including the dominant hand, colour, stimulus possibilities, and arrangement models (M. Liu et al., 2021). Meanwhile, factors that can affect audio reaction speed are age, gender, dominant hand, central versus peripheral vision, fatigue, respiratory cycle, fasting, personality, sports activity, and a person's intelligence (Jain et al., 2015).

The results found on WBR show that athletes at the regional, national, and Olympic levels have better visual WBR abilities than audio WBR. The results state that athletes at the Olympic level have the lowest reaction speed compared to athletes from regional and national levels. This could be due to their more mature age, which decreases their reaction speed.

In addition, the audio WBR results found that athletes in the regions had the best audio WBR abilities of the three groups of athletes and audio WBR abilities were lower at higher competition levels. It indicates that athletes' ability to respond via audio will decrease as they age. This condition can occur because their hearing and movement abilities are decreasing.

Another interesting result from the visual WBR and audio WBR of the three groups of athletes is that their visual reaction speed has better results when compared to their audio reaction speed. It proves that badminton athletes from all three levels of competition respond faster through sight than hearing. In badminton, athletes rely more on their sight to respond to the opponent's shuttlecock hit.

With this reality, existing coaches can create training programs that focus more on the speed of athletes' visual reactions because, in matches, visual reaction speed is very crucial and is more reliable to be able to respond to an opponent's hits than audio reaction speed for both regional and Olympic athletes. In addition, training programs that focus on reaction speed must be further improved for athletes with increasingly mature ages, considering that as age increases, athletes' reaction speed abilities will decrease. Several factors affect reaction speed, including the magnitude of the stimulus, age, gender, and level of fatigue (Pavelka et al., 2020). One way to increase the reaction speed of athletes is by doing motor imagery (Fekih et al., 2020) and plyometric training (Deng et al., 2024).

Expanding Strength

In addition to reaction speed, an athlete's strength ability also plays a vital role in an athlete's performance on the field. Good strength ability will minimise injuries when playing (Cuthbert et al., 2021; Lauersen et al., 2018; Talpey et al., 2017). The strength can also affect the athlete's skill ability (Suchomel et al., 2016). Warming up before doing activities can be a factor that can affect an athlete's strength ability (Resende et al., 2020).

Research on strength reveals that elite athletes have better strength abilities when compared to sub-elite athletes (Beddows et al., 2020). These findings align with research findings, that the athlete's strength and ability increase with

the competition level. Similar results are also found in other studies, which state that elite athletes have better strength than sub-elite and amateur players (Guðmundsdóttir et al., 2017). Research on leading and substitute athletes shows that main players have better strength abilities (Kim et al., 2019). The differences between athletes at different levels are likely due to the process of maturity and body mass.

In contrast, as competition increases, the chronological age and age of the athlete also increase. Research has shown that older players have better strength abilities (Peeters et al., 2023). The higher the level of competition, the greater the athlete's training load will be. The increase and high training load will increase muscle mass (Lopez et al., 2021), which will affect their strength abilities.

The results obtained on expanding strength state that the athlete's strength ability improves as the competition level increases. This proves that better strength abilities are needed at a higher level of competition. In addition, it shows that athletes with better-expanding strength abilities will have more potential to reach a higher level of competition.

Expanding strength is related to hitting ability in badminton athletes. It means that the hitting ability of Olympic athletes is better and more robust than that of regional and national athletes. Coaches can design training programs to improve athletes' strength and performance, enhancing their chances of advancing to the next level of competition. Some ways to increase athlete strength are resistance training (Krzysztofik et al., 2019), weight training (Nasrulloh et al., 2022), and velocity-based training (VBT) (Włodarczyk et al., 2021).

In badminton, players must display optimal performance, be able to move quickly (Phomsoupha et al., 2015), and have good power (Deng et al., 2024). Coordination is also a crucial factor in success in badminton (Donie et al., 2023; Jaworski et al., 2021). Research shows that amateur badminton players do not have good balance, agility, and eye-hand coordination performance even though they show better sports performance (Wong et al., 2019). Based on this, it is essential for badminton athlete coaches to continue to monitor the condition of their athletes in various factors to improve their abilities and achieve their peak performance. This research is expected to help coaches understand the condition of their athletes among athletes at various levels of competition. In addition, it is expected that after understanding the physical condition of athletes, coaches will also compile and develop training programs that are appropriate to the conditions of each individual. Many coaches still equate training programs for their athletes on the field. It was discovered that each athlete has a different physical condition, so they require different treatments.

With the rapid development of badminton and science and technology, of course, further research is needed to improve the quality of the game and utilise the development of technology and existing science to improve the quality of players. The large number of badminton players who have emerged from various circles, both children and adults and men and women, is a limitation in this study. The sample used in the study was still limited to male athletes, teenagers and adults. In further research to be conducted, it is hoped that the sample scope will be increased and expanded, both in terms of age and gender, so that the research results can be used to present all existing groups.

Conclusions

This study concludes that there are significant differences among male badminton athletes at the regional, national, and international levels in visual WBR and push-expanding strength. The strength ability of groups with higher levels of competition will have better results. In the WBR variable, the results were found that badminton athletes' visual WBR abilities were faster than audio WBR abilities. It occurs because the training load and age are different among the three groups of athletes. In the audio WBR and pull expanding strength variable, no significant differences were found between the three groups of athletes.

After conducting the study, it is hoped that coaches can adjust the training program according to the conditions and needs of each athlete due to differences in physical condition between one athlete and another. With a training program that follows the needs and portions of each athlete, the final results and objectives can be achieved optimally, and athletes will be able to achieve their best performance.

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Conflict of interest

All authors declare no conflicts of interest.

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Визначення часу реакції та силових показників індонезійських спортсменів-бадмінтоністів чоловічої статі: Регіональний, національний та олімпійський рівні

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 2 табл., 45 джерел.

Мета дослідження. Мета дослідження полягала в проведенні аналізу відмінностей у часі реакції всього організму (ЧРО) та збільшенні рівня силових показників спортсменів-бадмінтоністів на регіональному, національному та олімпійському рівнях.

Матеріали та методи. У дослідженні взяли участь 24 спортсмени чоловічої статі. Задля аналізу існуючих відмінностей проведено вимірювання слухової та зорової реакції всього організму, а також збільшено рівень сили тяги та поштовху кожного спортсмена. Отримані дані проаналізовано за допомогою однофакторного дисперсійного аналізу (ANOVA) з метою визначення відмінностей між трьома вибірковими групами.

Результати. За результатами дослідження було виявлено достовірну різницю ($p < 0,05$) у показниках зорової реакції всього організму та сили поштовху плечового поясу та рук. Однак істотних відмінностей у показниках змінної слухової реакції всього організму та сили розтягування плечового поясу та рук не спостерігалося ($p > 0,05$).

Висновки. Дослідження показало, що швидкість зорової реакції всього організму спортсменів-бадмінтоністів мала кращі показники порівняно зі здатністю до швидкості слухової реакції всього організму. Крім того, олімпійські спортсмени продемонстрували більш високі силові показники, ніж спортсмени регіонального та національного рівней. Отримані результати дослідження допоможуть тренерам у розробці та впровадженні тренувальних програм, що відповідають специфічним потребам і умовам спортсменів на рівні змагань, в яких вони беруть участь.

Ключові слова: фізична підготовленість, швидкість реакції, ракетковий вид спорту, спортсмен високого класу, спортсмен-юніор, спортсмен молодого віку.

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