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The Effect of Footwork Trainer on Agility and Vo2max in Badminton Athletes

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ABSTRACT

This research aims to determine: (1) the effect of footwork trainers on the agility of badminton athletes in the 10-12 year age group at PB Jati Wetan Kudus. (2) the effect of footwork trainer on VO2max of badminton athletes in the 10-12 year age group at PB Jati Wetan Kudus. The research uses an experimental method with a "One Groups Pretest-Posttest Design" design. The population of this study was male badminton athletes aged 10-12 years from PB Jati Wetan Kudus. The agility instrument uses a shuttle run with a validity of 0.87 and a reliability of 0.93. Meanwhile, to measure VO2max, the multistage fitness test (MFT) is used. The population in this study were 10 PB Jati Wetan badminton players. Data collection techniques in this research used documentation and action tests to measure agility and VO2max. The results of this research using SPSS 24 are correlation and paired samples T-test results for agility (r-count = 0.963 and T-test = 8.481) and VO2max (r-count = 0.877 and T-test = -12.667). Training using a footwork trainer has more influence on agility than VO2max. Thus it can be concluded that the footwork trainer can increase the agility and VO2max of badminton players, especially PB Jati Wetan Kudus athletes.

Keywords: Footwork trainer; Agility; VO2max

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INTRODUCTION

Badminton is a sport played by two people (singles) or two pairs (doubles) who play against each other. This game uses a racket as a bat and a shuttlecock as the object to be hit (Kusnadi, 2020). The sport of badminton in Indonesia has been known for a long time, so this sport is one of the sports that is popular with many groups, because apart from being popular, this sport is quite easy to play for anyone, both parents and children.

The sport of badminton has now returned after the pandemic 2 years ago, now many competitions have started to be held, one of which is Kudus Regency which is currently holding major competitions such as the kretek cup. By holding competitions such as the kretek cup, it can revive the enthusiasm of badminton clubs in Kudus Regency to compete.

Various efforts have been made to improve the abilities of badminton athletes, including support through training camps by the Branch Management of the Indonesian Badminton Association (PBSI) in every city and district. The club is a place

to develop athletes in the early age group whose existence is important to create young players who have basic abilities in the sport of badminton. One of them is the PB Jati Wetan badminton coaching club, Kudus Regency.

Based on observations made by researchers, PB Jati Wetan athletes in Kudus District experienced deficiencies in agility and vo2max several times. It can be seen from his footsteps which are not fast enough to reach the shuttle backwards or forwards suddenly, when he is in the middle of the field.

Researchers also conducted an interview with a PB Jati Wetan coach in Kudus District named Teguh in 2023. The results of the interview showed that there were several deficiencies in the athletes' control of the field so that the shuttelcook returns were less than optimal. According to the coach of PB Jati Wetan, Kudus District, the influencing factor is the lack of agility in the athletes' footwork.

Agility is the ability to change body position or direction of body movement quickly when moving quickly, without losing balance or awareness of orientation towards body position (if from a stationary position, then moving quickly, regarding the vo2max component, (Fardiansyah et al., 2019). In this case, athletes need agility components, good coordination and balance components.

Vo2max is the ability of the heart, lungs and blood vessels to function optimally during rest and exercise to take in oxygen and distribute it to active tissues for body metabolism (Nugraha, 2017). Maximum oxygen volume (vo2max) is a level of body capacity expressed in liters per minute or milliliters/minute/kg body weight.

Footwork is the basis for producing quality strokes, that is, if done in a good position, an athlete must have the ability to move quickly (Astrawan & Jaya, 2019). It can be concluded that footwork speed cannot be achieved if the footwork is irregular. Based on the problems that have been described, researchers are interested in conducting research on "the influence of footwork trainers on agility and vo2max in badminton athletes in the 10 - 12 year age group at PB Jati Wetan, Kudus Regency".

In this article there are research questions, which include: 1) What is the influence of footwork trainers on agility in badminton athletes in the 10-12 year age group, PB Jati Wetan, Kudus District?, 2) What is the influence of footwork trainers with vo2max on badminton athletes in the 10-12 age group? year of PB Jati Wetan Kudus District?, and 3) How does agility with vo2max affect badminton athletes in the 10-12 year age group of PB Jati Wetan Kudus District?

LITERATURE REVIEW

Badminton

Badminton is a type of game that requires good speed and dexterity to hit the shuttlecock, where correct footwork and hitting technique will produce a perfect shot (Hamid & Aminuddin, 2019). The aim of this game is to send the shuttlecock over the net so that it enters the opponent's area or court. Being a great badminton player is not an easy job, because it requires understanding and mastering physical, technical, tactical and psychological skills simultaneously in order to produce an effective and efficient game (A. K. Putra et al., 2017) Seen when observing a badminton match , athletes usually need a good amount of strength, speed, agility, endurance and coordination (Jaworski & Zak, 2015).

The official badminton court is that the lines on the badminton court have a thickness/width of 3.8cm. These court lines can be drawn using paint or by attaching tape to the floor. The field is made of cotton or nylon. The pole height is 155 cm and

the net is 152 cm. The net posts are installed right in the middle of the end of the side line of the court. The net is made of fine rope in a dark color. The net width is 0.75 m and the net length is 6.10 m. The top of the net is given a white border 7.5 cm wide.

Shuttlecocks are made from synthetic materials, namely cork and goose feathers. The number of feathers embedded in the cork is 16 feathers. Feather length is 62-70 mm. weighs 4.74-5.50 grams. Rackets are made from materials that are hard but still flexible (not stiff), for example iron or fiber. The racket consists of five parts, namely the handle, the area where the strings are attached, the head of the shaft and the neck of the racket. The length of the racket must not exceed 68 cm and the width of 23 cm. The surface on which the strings are attached must not exceed 28 cm in length and 22 cm in width.

Basic Badminton Techniques

The game of badminton really requires skills to master the basic techniques of the game such as how to hold the racket (grip), hitting techniques (strokes), and footwork, and techniques for mastering game patterns. The technique of holding a racket (grip) is the basis for performing various strokes in badminton. Accuracy in holding the racket affects the result of the shot. There are several types of grip, namely: American grip, forehand grip, backhand grip, and combination grip (G. I. Putra & Sugiyanto, 2016). The basic hitting techniques that need to be mastered in badminton include: serve, lob, drop, smash, net, underhand and attack (G. I. Putra & Sugiyanto, 2016). All types of punches must use good grip and footwork. One of the basic techniques that players or athletes must master is footwork techniques. Footwork is the regulation of foot work, because wherever the foot moves, the body will follow the movement of the foot (Islamiah & Sepdanius, 2019). If the legs are slow then the body movement will be slow, if the legs jump then the body will jump, so the body movement depends on the position of the feet. Therefore, if a player has good footwork, it will be easy for the player to catch the ball.

Footwork

Footwork is foot movements that regulate the body to place the shuttlecock hitting movement according to its position. This aspect of physical condition is very important because in playing badminton you have to make complex movements, such as jumping, moving quickly to chase the shuttlecock, turning your body, taking wide steps to maintain body balance (Eka, N., Dewi, S., & Respaty, 2018) . To master good footwork, athletes must be coached and trained specifically and systematically, so that they can perform footwork well and correctly. Footwork aims to train foot movements to explore and control the field. With good control of the field and movement speed, the athlete will get the right hitting position.

There are three ways to practice footwork for badminton players, namely: 1) From the center of the court, step towards the right corner, then return to the center, continue to the front left and return to the center. Do repeated movements, 2) From the middle position step sideways to the right, back to the center then to the right side and back to the center. Repeat, and 3) From the middle position, step back to the back right, then back to the center and step back to the back left and back to the center. Do it over and over again. Badminton Skills Diagnostic Model (BSDM) instrument that was compiled had included four main components: 1) footwork, 2) execution position, 3) shuttlecock running, and 4) stroke which w as effectively used to see and assess

badminton skills as a whole (Yudi et al., 2020). The results of the research product are in the form of a valid and reliable footwork test instrument as a measure of the footwork skills of junior badminton players. Based on the opinions of expert practitioners, academics, and badminton coaches who assess the validity of the instrument, a "very good" score is produced (Williyanto et al., 2023).

Footwork Trainer

Footwork trainer is an application that provides badminton footwork training using random shadow footwork drills to increase speed. Improve badminton footwork skills in a short time. Using Steps, movement across the court will become second nature, allowing time to play the desired shot. As you practice more, footwork will no longer hinder you in improving your badminton game. Footwork is a foot movement that brings the body to get the proper position so that it is easy to anticipate the blow and placement of the cock into the opponent's field. In its implementation, athletes are required to be able to move agile, agile and fast without losing balance and good coordination of movements to return the cock with good technique. The better the quality of footwork, the better the athlete's performance in the field (Arnando et al., 2023). Athletes in an efficient way where there is the ability to read all the physical performance data, obtain a database of it constantly and have a system that allows practicing the slide that is often used as footwork (Vasquez et al., 2023).

Agility

Agility is the ability to change body position or direction of body movement quickly and simultaneously with other movements. Agility must consider not only speed but the ability to reduce speed, change direction, and renew it again in response to stimuli, (Achmad Rifai et al., 2020). In this agility component, good coordination and balance components are needed, for an athlete to have agility, namely having the ability to circle objects quickly with good agility biomotor components in order to reach the shuttlecock from one point to another quickly. Agility is also influenced by several factors, namely: muscle strength, speed, muscle explosive power, reaction time, balance and coordination (Yuliawan & Sugiyanto, 2014).

Agility refers to the technical skills and abilities required by athletes to quickly react and adjust direction, speed, or movement patterns when faced with stimuli (P. Wang et al., 2024). Body composition and maximal oxygen consumption as well as muscle power, speed, agility, and anaerobic power variables were assessed before and after the intervention (Rezaei et al., 2024). Body composition data included total and regional fat mass, lean mass, and body fat percentage, whereas athletic performance measures included the vertical jump, 10-yard dash, and pro-agility (5-10-5) shuttle run (Summer et al., 2024). High-intensity interval training employing the Tuja-Shuttle Run exercise model significantly increased speed, agility, and anaerobic capacity (Jatmiko et al., 2024).

The ability to maintain focus, coordinate eye movements effectively, and exhibit agility are crucial components in achieving success in the sport of badminton. The research involves an analysis of how these factors interrelate and contribute to the overall proficiency of players in executing various badminton techniques (Shapie et al., 2023). Conclusion High-intensity functional training effectively improves athletes' muscle strength, power, flexibility, and sport-specific performance has significant impact on endurance and agility (X. Wang et al., 2023). A short-term structured

training program consisting of balance, agility, and speed exercises significantly improves an athlete's aptitude, agility, and speed compared to physical education class activities (Sehgal et al., 2023).

Volume Oksigen Maksimal (Vo2max)

VO2 max is the maximum volume of oxygen that can be used per minute. According to Guyton and Hall (2008) in Giri Wiarto (2013) VO2 max is the maximum speed of oxygen use in aerobic metabolism. According to Thoden in the Suranto (2008) module, VO2max is the maximum aerobic capacity, describing the maximum amount of oxygen consumed per unit time by a person during exercise or tests, with increasingly heavy exercise until fatigue, the measurement is called VO2max. This O2 max volume is a level of body capability expressed in liters per minute or milliliters/minute/kg body weight. Every cell in the human body needs oxygen to convert food into ATP (adenosine triphosphate) which is ready to be used for work. Each cell that consumes the least oxygen is muscle in a resting state. Contracting muscle cells require a lot of ATP. As a result, the muscles used in exercise require more oxygen and produce CO2.

Maximal oxygen uptake (VO2max) is a physiological indicator of an individual's cardiorespiratory ftness and represents the maximum rate of the cardiovascular and respiratory systems in delivering oxygen to the working muscles (Väisänen et al., 2024). Small Side Game (SSG) is a form of exercise using a small arena with a smaller number of people. This exercise aims to support Vo2Max ability in Football (Pratama et al., 2024). Maximum oxygen uptake (VO2max), maximum pulmonary ventilation, time to exhaustion and total time of nasal respiration were recorded during a submaximal treadmill test. Dyspnea intensity and fatigue perception were evaluated using a labeled visual analog scale (Valsamidis et al., 2024). Because of its relationship to the cardiovascular system, VO2max, which is widely used as an indicator of cardiorespiratory fitness, is also discussed (Štursová et al., 2023). It was only possible to perform a meta-analysis on direct methods to maximum oxygen consumption (VO2max) (Muñoz-Vásquez et al., 2023)

METHOD

The research design used is experimental research using "One Groups Pre-test and Post-test Design" as the research design. In this way, it can be known more accurately, because it can be compared with what was done before the treatment was given. According to Maksum (2009) Research design is a plan for how research will be carried out.

This research aims to determine whether there is an influence of footwork trainers on increasing the agility of badminton athletes aged 10 - 12 years in PB. Jati Wetan District. Kudus and the influence of footwork trainers on increasing heart lung endurance (vo2max) of badminton athletes in the 10 - 12 year age group at PB Jati Wetan, Kudus Regency.

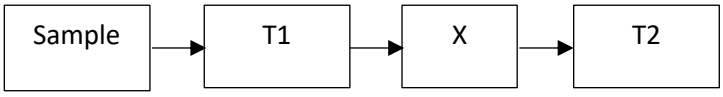

Figure 1. Research procedure

The instrument used to collect pretest and posttest data in this research was an agility test which was measured using the shuttle run method and for vo2max used the multistage fitness test (MFT). Hypothesis testing in this research uses the t-test using SPSS 24. The t-test is used to compare whether two variables are significant or not. After the test requirements are met, a hypothesis test is carried out. In this research, hypothesis testing is used to determine whether or not there is a difference between the pretest and posttest.

RESULTS

Paired Samples Test Agility

Table 1. T-test Agility Result

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pre-test agilty-post-test agility	1.3400	.50073	.15835	.98480	1.70120	8.481	9	.000

If probability > 0.05, Ho is accepted, but if probability < 0.05, Ho is rejected and Ha is accepted. From the data above, it can be seen that the Sig value (2-tailed) = 0.000, so (p) = 0.000 < 0.05, which means Ho is rejected and Ha is accepted. So there is a difference in agility between before and after treatment.

Paired Sample Corelation Endurance Test (vo2max)

Table 2. T-test VO2max result

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Pre-test vo2max & post-test vo2max	10	.877	.001

- Ho: there is no increase in agility results with footwork trainer training
- Ha: there is an increase in agility results with footwork trainer training

If probability > 0.05, Ho is accepted, but if probability < 0.05, Ho is rejected and Ha is accepted. From the data above, it can be seen that the correlation value is 0.877 and Sig (2-tailed) = 0.001, so (p) = 0.001 < 0.05, which means Ho is rejected and Ha is accepted. So there is a difference in agility between before and after treatment.

DISCUSSION

The effect of footwork training on agility

Exercises with the help of a footwork trainer can be done at any time and can be done alone. So athletes can practice agility well when training together on the PB field or in the field around the house. Judging from the results of the research analysis above, there is an influence of training using a footwork trainer on players' agility. From the results of the analysis, the average before treatment (pre-test) was 16.9040

and after treatment (post-test) 15.5610, so the average value increased by 1.343. while the t-test obtained a figure of = 8.481 and sig (p) = 0.000 < 0.05 which indicates that there is a difference in agility between before and after treatment, in other words training treatment using a footwork trainer is able to increase the agility of badminton players at PB Jati Wetan, Kudus regency.

Effect of footwork trainer training on vo2max

From the results of the analysis, the average (mean) before being given treatment (pre-test) was 22.7600 and after being given treatment (post-test) 25.8000, thus the average value increased. while the paired sample correlation test obtained an r-count of 0.877 and sig (p) = 0.001 < 0.05, which means there is a very strong correlation between before and after training treatment using a footwork trainer on vo2max. Meanwhile, the T-test results showed a figure of = -12.667 and sig (p) = 0.000 < 0.05, which indicated that there was a difference in vo2max between before and after training treatment using a footwork trainer was able to increase the vo2max of PB Jati Wetan badminton players, Kudus regency. From this research, it can be seen that the results of the sample studied between agility and vo2max before and after being treated have the same effect but tend to be higher on the vo2max variable seen from the average (mean) of these two variables. This increase was caused by providing training using a footwork trainer during 16 meetings.

This research has several limitations, including the following: 1) the researcher experienced difficulty in controlling discipline and seriousness in practicing in the research sample, 2) some sample individuals still did not understand the footwork techniques given, and 3) because the sample was actually a beginner, the sample had less commitment to this research

CONCLUSION

Based on the results of research data analysis and discussion, the following conclusions can be obtained: 1) The footwork trainer training method has a significant effect on increasing agility in athletes at PB Jati Wetan, Kudus regency; 2) Footwork trainer training has a significant effect on increasing vo2max in athletes at PB Jati Wetan, Kudus regency.

CONFLICT OF INTEREST

The autors declare no conflifct of interest

REFERENCES

Achmad Rifai, Domi Bustomi, & Sumbara Hambali. (2020). Perbandingan Latihan Footwork Dan Shadow Terhadap Kelincahan Atlet Tim Bulutangkis Pb. Setia Putra. *Jurnal Kejaora (Kesehatan Jasmani Dan Olah Raga)*, *5*(1), 25–31. https://doi.org/10.36526/kejaora.v5i1.848

Arnando, M., Ihsan, N., & Sasmitha, W. (2023). Sensor-based badminton footwork test instrument: A design and validity. *Journal of Physical Education and Sport*, *23*(12), 3212–3219. https://doi.org/10.7752/jpes.2023.12367

Astrawan, I. P., & Jaya, I. P. P. (2019). Pelatihan Footwork Bulutangkis 4 Repetisi 5

Set Lebih Baik Dibandingkan Bermain Bulutangkis Untuk Meningkatkan Daya Ledak Otot Tungkai. *Bali Health Journal*, *3*(2), 18–29.

Eka, N., Dewi, S., & Respaty, M. (2018). (2018). Pengembangan Model Latihan Footwork Cabang Olahraga Bulutangkis. *Ilmiah Sport Coaching And Education*, *2*(2), 9.

Fardiansyah, M., Swadesi, I. K. I., & Arsani, N. L. K. A. (2019). Pengaruh Pelatihan Kombinasi Footwork terhadap Peningkatan Kelincahan dan Volume Oksigen Maksimal (VO2 Maks). *Jurnal Ilmu Keolahragaan Undiksha*, *7*(1). https://doi.org/10.23887/jiku.v7i1.14909

Jatmiko, T., Kusnanik, N. W., Nurhasan, N., Muhammad, H. N., & Noordia, A. (2024). Enhancing Speed, Agility, and Anaerobic Capacity via a Tuja-Shuttle Run Exercise Model. *Middle East Journal of Rehabilitation and Health Studies*, *11*(1). https://doi.org/10.5812/mejrh-134693

Jaworski, J., & Zak, M. (2015). The Structure of Morpho-Functional Conditions Determining the Level of Sports Performance of Young Badminton Players. *Journal of Human Kinetics*, *47*(1), 215–223. https://doi.org/10.1515/hukin-2015-0077

Kusnadi, N. (2020). Pengembangan Model Latihan Pukulan Dropshot Bulutangkis Untuk Usia 12 – 14 Tahun. *Journal of SPORT (Sport, Physical Education, Organization, Recreation, and Training)*, *4*(1), 1–11. https://doi.org/10.37058/sport.v4i1.1561

Muñoz-Vásquez, C., Hernandez-Martinez, J., Ramos-Espinoza, F., Herrera-Valenzuela, T., Magnani Branco, B. H., Guzman-Muñoz, E., Floriano Landim, S., Mondaca-Urrutia, J., & Valdés-Badilla, P. (2023). Effects of Olympic Combat Sports on Cardiorespiratory Fitness in Non-Athlete Population: A Systematic Review of Randomized Controlled Trials. *Journal of Clinical Medicine*, *12*(23). https://doi.org/10.3390/jcm12237223

Nugraha, B. F. (2017). Standarisasi Vo2Max Atlet Bulutangkis Kategori Tunggal Remaja Putra Di Jawa Barat. *Jurnal Kepelatihan Olahraga*, *10*(VO2 Max), 43–56.

Pratama, R. R., Fikri, A., & Lubis, J. (2024). The Effectiveness of Small Side Games in Increasing the Vo2Max Ability of Football Athletes. *International Journal of Human Movement and Sports Sciences*, *12*(1), 1–8. https://doi.org/10.13189/saj.2024.120101

Putra, A. K., Ramadi, Putu, N., & Wijayanti, N. (2017). Pengaruh Latihan Footwork Terhadap Kelincahan Pada Atlet Putra Persatuan Bulutangkis Mandiri Pekanbaru U-15. *Jurnal Online Mahasiswa*, *4*(1), 1–8.

Putra, G. I., & Sugiyanto, F. (2016). Pengembangan pembelajaran teknik dasar bulu tangkis berbasis multimedia pada atlet usia 11 dan 12 tahun. *Jurnal Keolahragaan*, *4*(2), 175. https://doi.org/10.21831/jk.v4i2.10893

Rezaei, M., Parnow, A., & Mohr, M. (2024). Additional high intensity intermittent training improves aerobic and anaerobic performance in elite karate athletes. *Sport Sciences for Health*. https://doi.org/10.1007/s11332-023-01156-7

Sehgal, S., Chahal, A., Esht, V., Alshehri, M. M., Beg, R. A., Shaphe, M. A., Alajam, R. A., Kashoo, F. Z., Alghadir, A. H., & Khan, M. (2023). Unleashing potential and

optimizing adolescent roller skating performance through a structured exercise program – a randomized controlled trial. *BMC Sports Science, Medicine and Rehabilitation*, *15*(1). https://doi.org/10.1186/s13102-023-00728-x

Shapie, M. N. M., Okilanda, A., Edmizal, E., Suryadi, D., & Suganda, M. A. (2023). Concentration, eye coordination and agility: How they influence badminton playing skills. *Journal of Physical Education and Sport*, *23*(12), 3309–3317. https://doi.org/10.7752/jpes.2023.12378

Štursová, P., Budinská, X., Nováková, Z., Dobšák, P., & Babula, P. (2023). Sports activities and cardiovascular system change. *Physiological Research*, *72*(S5), S429–S444. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85181769093&partnerID=40&md5=5ebf017d8d4462cf47dca6611e6118aa

Summer, L. C., Cheng, R., Moran, J. T., Lee, M., Belanger, A. J., Taylor, W. L., & Gardner, E. C. (2024). Changes in Body Composition and Athletic Performance in National Collegiate Athletic Association Division I Female Field Hockey Athletes Throughout a Competitive Season. *Journal of Strength and Conditioning Research*, *38*(1), 146–152. https://doi.org/10.1519/JSC.0000000000004591

Väisänen, D., Ekblom, B., Wallin, P., Andersson, G., & Ekblom-Bak, E. (2024). Reference values for estimated VO2max by two submaximal cycle tests: the Åstrand-test and the Ekblom-Bak test. *European Journal of Applied Physiology*. https://doi.org/10.1007/s00421-023-05398-8

Valsamidis, K., Printza, A., Valsamidis, N., Constantinidis, J., & Triaridis, S. (2024). Improvement of the aerobic performance in endurance athletes presenting nasal valve compromise with the application of an internal nasal dilator. *American Journal of Otolaryngology - Head and Neck Medicine and Surgery*, *45*(1). https://doi.org/10.1016/j.amjoto.2023.104059

Vasquez, S., Turpo, J., Vinces, L., & Vargas, D. (2023). A training system for taekwondo players with impact and linear displacement data collection. *2023 9th International Conference on Innovation and Trends in Engineering, CONIITI 2023 - Proceedings*. https://doi.org/10.1109/CONIITI61170.2023.10324148

Wang, P., Shi, C., Chen, J., Gao, X., Wang, Z., Fan, Y., & Mao, Y. (2024). Training methods and evaluation of basketball players' agility quality: A systematic review. *Heliyon*, *10*(1). https://doi.org/10.1016/j.heliyon.2024.e24296

Wang, X., Soh, K. G., Samsudin, S., Deng, N., Liu, X., Zhao, Y., & Akbar, S. (2023). Effects of high-intensity functional training on physical fitness and sport-specific performance among the athletes: A systematic review with meta-analysis. *PLoS ONE*, *18*(12 December). https://doi.org/10.1371/journal.pone.0295531

Williyanto, S., Nugraha, R., Nugroho, W. A., Subarjah, H., Paramitha, S. T., Hamidi, A., Candra, A. R. D., Raharjo, H. P., Kusuma, D. W. Y., Wicahyani, S., & Wiyanto, A. (2023). Development of Footwork Skill Test Instrument for Junior Badminton Players. *International Journal of Human Movement and Sports Sciences*, *11*(3), 612–620. https://doi.org/10.13189/saj.2023.110314

Yudi, A. A., Kiram, Y., & Edmizal, E. (2020). Wbadminton skills diagnostic model (BSDM). *International Journal of Scientific and Technology Research*, *9*(3), 6295–6299. https://www.scopus.com/inward/record.uri?eid=2-s2.0-

85082875221&partnerID=40&md5=0cc78e7196e94b1030d3b065f7f2ce56

Yuliawan, D., & Sugiyanto, F. (2014). Pengaruh Metode Latihan Pukulan Dan Kelincahan Terhadap Keterampilan Bermain Bulutangkis Atlet Tingkat Pemula. *Jurnal Keolahragaan*, *2*(2), 145–154. https://doi.org/10.21831/jk.v2i2.2610