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The Influence of Agility Training on the Badminton Athletes' Ability

Muhammad Arnando[1,*], Syafruddin[1], Ardo Okilanda[1], Weny Sasmitha[1], Mardepi Saputra[1], Sepriadi[1], Zulbahri[1], Frizki Amra[1], Indri Wulandari[1], Mottakin Ahmed[2]

[1]Department of Sport Education, Faculty Sport Science, Universitas Negeri Padang, Indonesia
[2]Department of Physical Education, Faculty Sport Science, Government College Silwani, India

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Abstract Badminton is a high-intensity game that requires agility and good footwork for an athlete. The agility training pattern that was compiled had a good impact on progress of research findings. The exercises used to help increase the agility of badminton footwork are shuttle runs, skipping, sprints, ladder drills and shadows using shuttles and cones. This study aims to determine the effect of agility training on the footwork ability of badminton athletes. This research method is a one group experiment. The research compares one independent variable with one dependent variable. The research was conducted at the Badminton Hall of State University of Padang. Participants in this study were badminton athletes from the student's Sports Activity Unit of State University of Padang, totaling 20 people aged 18 years with the same length of training. A 6-way footwork test using a Shuttle cock was conducted to measure the athlete's footwork ability. Inferential statistics with the dependent sample comparative formula (t test) were used to test the hypothesis in this study. The analysis requirements test resulted in normal and homogeneous data. The results of the research on the data analyzed using statistics, it can be concluded that the results of the analysis of agility exercises have an influence on the ability of badminton footwork by obtaining t_{count} = 16.81 with a degree of confidence (α) = 0.05 so that t_{table} = 2.09 and the average difference -average count 0.97. From the results of this analysis, it can be concluded that there is an effect of agility training on the footwork ability of State University of Padang badminton athletes. Based on these results, the exercise intensity of moderate to submaximal intensity given to athletes and the variety of training variations of the type of agility training given are effective in increasing the footwork ability of badminton athletes. Subsequent studies show that footwork is also supported by the coordination of upper body movements, so it is necessary to carry out research on the carrying capacity of footwork movements.

Keywords Agility Training, Badminton, Footwork, Student Athlete, Coordination

1. Introduction

Badminton is a very popular sport on the public [1]. According to Grice [2] Badminton is a sport that is played using a net, rackets and balls with various hitting techniques ranging from relatively slow to very fast styles accompanied by feint movements[3] and even this game can be played by two or more people. This sport is one of the sports that always contributes to medals in every international event such as the Sea Games, Asian Games and Olympics [4]. To achieve this achievement, of course, there are many things that need to be done by every Badminton Federation administrator[5], coach and athlete.

This is also in accordance with Law No. 11 of 2022 concerning National Sports which states that "National Sports aim to maintain and improve health and fitness, achievement, human quality, instill moral values and noble character, sportsmanship, discipline, strengthen and foster national unity and integrity, strengthening national resilience, as well as increasing the dignity and honor of the nation and maintaining world peace".

Therefore, it needs a lot of things that can be done to achieve an achievement. According to Curry [6] there are 4 (four) components of sports achievement, namely physical ability, technical ability, tactical ability and mental ability [7]. These factors influence and function each in achieving achievement. Analyzing the strengths and weaknesses [8] of athletes in a match is the main task of a coach in his accuracy when analyzing an athlete's competition [9]. So that the coach can detect weaknesses and arrange the right program to be able to improve the ability of the athletes. Of the achievement factors, the main factor that is easy to measure clearly is the physical condition component, because this component is easy to observe compared to other components such as technique, tactics and mentality [10]. Physics is the foundation of sports achievement because techniques, tactics and mentality will be well developed if you have good physical quality [11], [12]. The components of the physical condition include: 1) Speed, 2) strength, 3) Endurance, 4) Flexibility, 5) Accuracy, 6) Power, 7) Coordination, 8) Reaction, 9) Balance, and 10) Agility [13]. There are ten components of physical condition, agility is the motor of the body that directs the body to move quickly and precisely in all directions of the field, because agility is a person's ability to change position in a certain area [14], [15], [16]. Furthermore, Brown [15] stated that agility is the ability to change direction while running fast easily in all directions.

The next factor is the technique of playing badminton. J. Cronin, P. J. McNair, & R. N. Marshall [17] states that technique is an effective and rational movement process to complete tasks as well as possible in a match. Furthermore, according to W. Y. Sheng, A. Ginanjar, & G. T. Wei [18] there are 4 basic techniques for playing badminton, namely standing technique, holding the racket (grip), hitting the ball technique (strokes) and footwork technique. Footwork is the movements of the feet that regulate the body to place the movement of hitting the shuttlecock [19], [20]. Setting footwork techniques in badminton is very important, because where the feet move, that's where the body will be carried. If the feet move slowly, the movement of the body is also slow, if the feet jump up, the body also jumps up. So that the movement of the body along with other limbs depends on the position of the feet. The feet are the most important part of body movement [21]. Performing footwork for an athlete must also be supported by excellent physical condition. Components that affect the ability to move the foot include agility, speed, movement accuracy, coordination, and balance. Balance is the notion of the recorder that in every agility movement the athlete should not fall and not be able to stand up quickly because in a matter of seconds a badminton [22] athlete will lose the ball resulting in a loss point which is lost by the opponent.

Based on its meaning and function, to be able to do good footwork [23], athletes must be able to improve their agility, because good agility is owned by an athlete who can carry the athlete's body to all corners of the field with regular and agile foot movements without experiencing delays when hitting in the field. Circumstances that depend on the situation and conditions in the field will be faced in a relatively short and fast time. And exercises that can help increase agility are shuttle run, skipping, sprint, ladder drill and shadow using shuttle and count [24]. Through this form of exercise, it is hoped that it can improve the footwork ability of badminton athletes [25], [26], [27] so that they can move quickly, the feet are lighter and the steps of the feet are more directed so that when changing the direction of movement, the body will not lose balance and coordination. Therefore, it is necessary to develop an appropriate agility training program needed in developing the footwork ability of badminton athletes [28].

2. Method

The research type is experimental research. Experimental research according to Rabek [29] is research to obtain information which is an estimate for information that can be obtained with actual experiments in actual circumstances that do not allow to control or manipulate all relevant variable. The design of this study is to compare one independent variable with one dependent variables[30]. The population in this study were badminton athletes at Padang State University who were members of the Sports Activity Unit, totaling 28 people. Consists of 20 sons and 8 daughters. In taking the sample, the researcher used a purposive sampling technique, this technique prioritizes the considerations of the researcher who has been practicing badminton for more than 8 years. Because the person who practices it has a series of sequential movements. So that the number of samples in this study amounted to 20 people 18 ages old badminton players athlete university. The design used for this research is one pretest-posttest group as shown below:

Figure 1. Research Design

The first procedure of this study is an initial measurement (Pretest) of badminton footwork ability given treatment and then a final measurement (Posttest) was carried out after the sample was given treatment. After the data are obtained, the hypothesis testing is carried out and processed using descriptive and inferential statistics using the formula for the dependent sample t test.

Prerequisite Test

The data normality test used the Liliefors test.

HO = rejected if Lo (Lobservation) > Lt (Ltable), vice versa

HO = rejected if Lo (Lobservation) < Lt (Ltable)

Table 1. Pre-test and Post-Test Data Normality Test

Group		N	Lo	Ltable	Remark
Agility Exercise	Pre-Test	20	0,112	0,189	Normal
	Post-Test	20	0,101		

The pre-test data in Table 1 show an observed L value (Lo) of 0.112, which is compared to the critical L value (Ltable) of 0.189. Given that Lo is smaller than Ltable, the null hypothesis (HO), which presupposes normalcy, is not rejected. Consequently, the data collected before the test is deemed to follow a normal distribution. Similarly, the post-test data show an observed L value (Lo) of 0.101, which is once again lower than the critical L value (Ltable) of 0.189. Therefore, the null hypothesis (HO) is not rejected for the post-test data, suggesting that it conforms to a normal distribution. After confirming the normality of the data, the next step is to perform a homogeneity test to verify that the variances of the pre-test and post-test data are consistent. This exam is essential for verifying the comparison between the initial and final footwork aptitude scores of the participants. A variance homogeneity test is conducted to assess the homogeneity of the data. The obtained findings are then compared to the critical value from the F-table at a significance threshold of $\alpha = 0.01$.

Table 2. The Results Summary of the Badminton Footwork Homogeneity Variance Test (Pretest and Posttest)

Group	Varian	F_h	F_t	Remark
Pre-Test & Post Test	0,74	1,33	2,15	Homogeneous
	0,56			

Table 2 presents a concise overview of the results obtained from the homogeneity variance test carried out on the pre-test and post-test data about badminton footwork ability. The purpose of this test is to verify that the differences between the two sets of data are uniform, which is a crucial need for specific statistical analyses such as the dependent sample t-test. The variance of the combined pre-test and post-test data are determined to be 0.74. The computed F-value (F_h) is 1.33, and it is being compared to the crucial F-value (F_t) of 2.15. Given that the computed F-value is lower than the crucial F-value, it suggests that the variances of the pre-test and post-test data are homogeneous or consistent. Consequently, there is a substantial disparity in the distribution of results between the initial and final assessments of footwork proficiency. The confirmation of homogeneity in the variances of the pre-test and post-test data verify the comparability of the two datasets and guarantees the reliability of subsequent statistical studies.

3. Result

The implementation of this research was carried out for 3 months at the State University of Padang at badminton court. This research is an experiment by taking initial data (pre-test) on objects followed by providing treatment and final data (post-test). In the following, a description of the footwork ability data for badminton athletes from State University of Padang will be presented.

3.1. The Data Description

Table 3. Pretest data for Badminton Footwork Ability

Interval Class	Fa	Fr (%)	Classification
< 13,90	0	0	Very Good
13,90 - 14,76	5	25	Good
14,76 -15,63	9	45	Satisfying
15,63 - 16,49	5	25	Poor
> 16,49	1	5	Very Poor
Total	**20**	**100**	

Table 3 shows the pre-test data for badminton footwork skill, providing a thorough summary of the score distribution among participants from the State University of Padang. The table classifies footwork ability scores into five distinct intervals, spanning from "very good" to "very poor," with each interval defined by specific score ranges. Upon analysis of the data, it becomes evident that the participants possess a remarkably high degree of skill in footwork, since all scores surpass the minimum requirement for "very good." However, the majority of participants demonstrate footwork skills that may be classified as "satisfying," with 45% of them receiving scores falling within this category. Moreover, a significant majority of participants attain scores that fall into the "good" category, suggesting a strong level of performance. In contrast, a smaller number of participants exhibit footwork abilities that can be categorised as "poor" or "very poor," indicating that most athletes have footwork skills that range from satisfactory to commendable. Furthermore, statistical tools like the highest score (16.53), lowest score (13.43), average count (15.20), average value (15.32), and standard deviation (0.86) give us more details about the average and range of participants' footwork scores,

allowing us to fully understand the pre-test data.

Table 4. Post-Test Data for Badminton Footwork Ability

Interval Class	Fa	Fr (%)	Classification
< 13,10	2	10	Very Good
13,10 - 13,85	3	15	Good
13,85 -14,60	8	40	Satisfying
14,60 - 15,35	7	35	Poor
> 15,35	0	0	Very Poor
Total	**20**	**100**	

Table 4 shows the results of the post-test for badminton footwork ability, providing a comprehensive analysis of the scores achieved by participants from the State University of Padang after the intervention. The table categorises footwork ability scores into several intervals, ranging from "very good" to "very poor," based on specified score ranges allocated to each classification, similar to the pre-test data structure. An analysis of the post-test data reveal significant changes in the distribution of footwork ability scores as compared to the pre-test results. It is worth mentioning that although two people obtained scores categorised as "very good," which is significantly less than the pre-test data, the bulk of participants are classified as "satisfying," with 40% of individuals falling into this category. Nevertheless, there is a little decline in the percentage of participants classified as "good," with only 15% falling into this category in the post-test data. In contrast, a greater number of participants demonstrate footwork abilities that are categorised as "poor" in comparison to the pre-test outcomes, with 35% attaining scores falling within this category. Notably, none of the subjects received a score in the "Very Poor" category in the post-test data, suggesting that there were no really low footwork ability scores after the intervention. The statistical summary measures that accompany the post-test data offer additional insights into the distribution and peculiarities of footed ability scores among the participants after the intervention. The highest recorded score of 15.29 and the lowest score of 12.97 show the range of footwork ability present within the participant group. The average count of 14.23 and the average value of 14.20 serve as a measure of the participants' footwork ability score after the intervention, serving as a standard for evaluating overall performance. In addition, the standard deviation of 0.75 indicates the extent to which footwork ability scores vary or spread out from the average, providing information on the consistency or range of participant performance. The statistical metrics, along with the qualitative classification of footwork ability scores, enhance our understanding of the peculiarities of the post-test data in a complete manner.

3.2. Hypothesis Testing

The hypothesis of this study is "there is an effect of agility training on the footwork ability of badminton athletes at the State University of Padang". The hypothesis was tested using a t-test at a significant level $\alpha = 0.05\%$. Based on the calculation results of the pre-test and post-test data with the t-test of the agility training group, $t_{count}t = 16.81$ and t_{table} ($\alpha = 0.05$) = 2.09 which means $t_{count} > t_{table}$, then Ho is rejected and Ha is accepted, which means training agility has a significant effect on improving the footwork ability of badminton athletes at the State University of Padang (Table 5).

Table 5. Initial data t-test (pretest) and final data (posttest)

Group		N	t_h	t_t	Remark
Agility Training	Pre-Test	20	16,81	2,09	Significant
	Post-Test				

The effect of agility training on the footwork skills of badminton athletes at the State University of Padang. By utilising a t-test methodology with a rigorous significance level of $\alpha = 0.05\%$, the analysis produced convincing outcomes. The calculated t-value (t_h) for the agility training group, which is 16.81, is much higher than the crucial t-value (t_t) of 2.09 obtained from the t-table. The significant difference between the two values clearly leads to the rejection of the null hypothesis (Ho) and the subsequent acceptance of the alternative hypothesis (Ha). The clear result highlights a crucial discovery: agility training has a statistically significant impact on improving the footwork skills of badminton athletes. Further analysis of these findings reveals the significant influence of the carefully crafted agility training programme. The workouts were designed based on principles that improve footwork. The students were not just simple repetitions, but instead a deliberate combination of effective movements and focused muscle activation. The incorporation of specialised equipment, such as cone markers and other media, ensured a methodical and organised approach that went beyond focusing solely on isolated muscle growth. Instead, it aimed to improve movement patterns in a comprehensive and interconnected manner. The implementation of this diverse strategy, together with the athletes' committed involvement, resulted in noticeable enhancements in footwork expertise. Based on the results of group footwork with agility exercises, the exercises are specifically designed according to the rules of increasing footwork movement because it refers to repetition of exercises with movement effectiveness. The contribution of training with cone marking equipment and other media provides an arranged step by step, not just training certain muscle parts.

4. Discussion

Based on the results of the data analysis that has been carried out, there is a significant effect of agility training on the footwork ability of badminton athletes at Padang State University because it obtained $t_{count} = 16.81$ and t_{table} ($\alpha = 0.05$) = 2.09. Right is in accordance with the explanation in

the previous chapter that agility training has an effective effect on improving badminton footwork ability. Footwork is a technique that must be possessed by badminton athletes, because footwork is a movement of footsteps that regulates the body to position the body in such a way as to make it easier to make hitting movements [31], [32] having the right footwork will make it easier for athletes to return strokes. From this statement it can be said that footwork has the function of bringing the body to all corners of the court so that the body is in a fast and precise position to make badminton shots both in defense and attack.

Good footwork ability is of course supported by good physical ability as well, one of these physical conditions is agility. Agility is a bio motor ability of the elements of physical ability in general, namely the ability to change the direction of movement of the body or body parts [9]. Furthermore, D. J. Paul et al [33] argues that agility is the ability to change the direction and position of the body precisely while moving, without losing balance and awareness of the position of the body. And exercises that can help increase agility are shuttle run, skipping, sprint, ladder drill and shadow using shuttle and count. Through this form of exercise, badminton athletes can improve their footwork ability so that they can move quickly, their feet are lighter and their steps are more directed so that when changing the direction of movement, the body will not lose balance and coordination. This was also stated by Brown [15] that there is a significant effect of agility training on footwork ability in badminton games. Thus, agility training is one way to improve the ability of badminton footwork, so that during their appearance on the court, athletes can move quickly and precisely, without losing balance and coordination of motion in playing badminton.

Agility training is one way to improve badminton footwork, so that during their appearance on the court athletes can move to and fro quickly and precisely, without losing balance and coordination of motion in playing badminton [34], [35]. In terms of support for the agility training carried out in this experiment, it pays attention to the pattern of agility steps repeated by an athlete. So that these movements provide good support in moving places and changing directions [36]. Apart from the movement of the legs, this agility is also supported by the movement of the upper body which encourages and balances the movement of the athlete's steps. Another factor that becomes a recommendation for further research is that footwork is also supported by the coordination of upper body movements, so further research is needed.

Coordination contributes a lot to the joint movement between footwork and agility because when hitting the two movements alternately it gives a response starting from the preparatory motion to the follow through so it is important to carry out a more in-depth study in the future regarding the coordination variables together. This belief is evidenced by the results of quite good agility, but there are drawbacks in the footwork movement.

5. Conclusions

The ability to move properly, which is called footwork, is very dependent on the motion habits of an athlete. The increase in this ability is greatly influenced by the repetition of motion which gives the meaning of improving motion quickly in athletes. The findings in studies with stiff initial movements are known through the athletes' answers because it is very rare to practice changing direction movements so that athletes do not move freely in changing directions. It is important that moving agilely is influenced not only by the feet which play a role but by the whole body which is able to drive the transfer of motion. The analysis obtained in addition to the results of the movement of the foot of the ball that is hit is on the pedestal of the upper body so it is very necessary to get data results in further research on the movement of the upper body when the athlete performs the footwork movement. In order for the ability to effectively increase badminton footwork, you want to use agility training, in this case, not only moving straight, but with an arranged pattern of steps as well.

In agility training an athlete can get used to the field conditions in the movements traversed by the training load in the form of cone barriers or areas arranged in such a way as a match. From the start the trainer also gets used to moving the upper body in a balanced manner at the same speed as the foot speed so that when moving the legs quickly the upper body also has the same fast coordination as the feet.

6. Recommendations

Based on the conclusions that have been put forward, it can be suggested that:

1. Athletes of the State University of Padang Sports Activity Unit, to improve badminton footwork skills effectively, should be able to use agility training.
2. To the coach, in an effort to improve the ability of badminton footwork effectively members should be able to use agility exercises.
3. Researchers who wish to examine this issue further, so that they can consider various limitations in this study, such as the number of samples, the gender of the sample and so on. The aim is for the benefit of the findings obtained.

REFERENCES

[1] D. Paup, Skills, drills & strategies for badminton. Routledge, 2017.

[2] T. Grice, “Petunjuk Praktis Untuk Pemula dan Lanjutan.” Jakarta, 2004.

[3] M. Phomsoupha and G. Laffaye, “The science of badminton: game characteristics, anthropometry, physiology, visual fitness and biomechanics,” Sports Med., vol. 45, no. 4, pp. 473–495, 2015.

[4] Y. Hong-Zhi and L. Wei, “Analysis of the badminton match-throwing in London Olympics,” Procedia Comput. Sci., vol. 17, pp. 1222–1230, 2013.

[5] N. Amir, “Instrument Development of Self-Confidence for Badminton Athletes,” ANIMA Indones. Psychol. J., vol. 30, no. 2, pp. 101–110, 2015.

[6] L. A. Curry, C. R. Snyder, D. L. Cook, B. C. Ruby, and M. Rehm, “Role of hope in academic and sport achievement.,” J. Pers. Soc. Psychol., vol. 73, no. 6, p. 1257, 1997.

[7] A. Mousavi and M. VaezMousavi, “Introducing the Sport Success Scale (SSS),” Mot. Behav., vol. 7, no. 19, pp. 42–123, 2015.

[8] S. Sturgess and R. U. Newton, “Design and implementation of a specific strength program for badminton,” Strength Cond. J., vol. 30, no. 3, pp. 33–41, 2008.

[9] S. Paterson, D. T. McMaster, and J. Cronin, “Assessing change of direction ability in badminton athletes,” Strength Cond. J., vol. 38, no. 5, pp. 18–30, 2016.

[10] B. Sun and C. Yan, “Strengthen badminton training and improve students’ physique,” Front. Educ. Res., vol. 2, no. 11, 2019.

[11] J. Barreira, J. G. C. Chiminazzo, and P. T. Fernandes, “Analysis of point difference established by winners and losers in games of badminton,” Int. J. Perform. Anal. Sport, vol. 16, no. 2, pp. 687–694, 2016.

[12] H. Chaabene et al., “Validity and reliability of a new test of planned agility in elite taekwondo athletes,” J. Strength Cond. Res., vol. 32, no. 9, pp. 2542–2547, 2018.

[13] N. Ihsan, A. Sujana, and A. Y. Permana, “Design Of Instrument Explosive Power Leg Muscles Sensor Based,” in Journal of Physics: Conference Series, IOP Publishing, 2020, p. 012038.

[14] K. Azmi and N. W. Kusnanik, “Effect of exercise program speed, agility, and quickness (SAQ) in improving speed, agility, and acceleration,” in Journal of Physics: conference series, IOP Publishing, 2018, p. 012043.

[15] L. Brown and V. Ferrigno, Training for speed, agility, and quickness, 3E. Human Kinetics, 2014.

[16] Nurul Ihsan , Rony Hidayat , Damrah , Hendri Neldi , Sepriadi , Muslimin , "The Contribution of Leg Muscle Explosive Power, Agility, and Self-confidence on Sickle Kick Performance," International Journal of Human Movement and Sports Sciences, Vol. 10, No. 4, pp. 683 - 688, 2022. DOI: 10.13189/saj.2022.100408.

[17] J. Cronin, P. J. McNair, and R. N. Marshall, “Developing explosive power: a comparison of technique and training,” J. Sci. Med. Sport, vol. 4, no. 1, pp. 59–70, 2001.

[18] W. Y. Sheng, A. Ginanjar, and G. T. Wei, “The Effects of Teaching Badminton Practice on Improving Badminton Capabilities of Sports Department Students,” Eur. J. Mol. Clin. Med., vol. 7, no. 1, pp. 3853–3866, 2020.

[19] N. Promrit and S. Waijanya, “Model for practice badminton basic skills by using motion posture detection from video posture embedding and one-shot learning technique,” in Proceedings of the 2019 2nd artificial intelligence and cloud computing conference, 2019, pp. 117–124.

[20] W. Gawin, C. Beyer, H. Hasse, and D. Büsch, “How to attack the service: an empirical contribution to rally opening in world-class badminton doubles,” Int. J. Perform. Anal. Sport, vol. 13, no. 3, pp. 860–871, 2013.

[21] M. A. Nando, “Pengaruh Latihan Ledder Drill (Agility) terhadap Kemampuan Footwork Bulutangkis Mahasiswa Unit Kegiatan Olahraga Universitas Negri Padang,” J. Performa Olahraga, vol. 3, no. 02, pp. 109–109, 2018.

[22] Silvi Aryanti , Hartati , Syafaruddin , "Learning of Badminton Model through Animation Video on Physical Education Students," International Journal of Human Movement and Sports Sciences, Vol. 8, No. 6A, pp. 47 - 50, 2020. DOI: 10.13189/saj.2020.080708.

[23] C. H. Ooi et al., “Physiological characteristics of elite and sub-elite badminton players,” J. Sports Sci., vol. 27, no. 14, pp. 1591–1599, 2009.

[24] M. YÜKSEL and L. Aydos, “The effect of shadow badminton trainings on some the motoric features of badminton players,” J. Athl. Perform. Nutr., vol. 4, no. 2, pp. 11–28, 2018.

[25] Donie, A. A. Yudi, Hermanzoni, Y. Kiram, and E. Edmizal, “Badminton Skills Diagnostic Model (BSDM),” Int. J. Sci. Technol. Res., vol. 9, no. 3, pp. 6295–6299, Mar. 2020.

[26] E. Sepdanius and N. Novselia, “Development of Footwork Exercise Tool Based on Android for Badminton,” in 1st Progress in Social Science, Humanities and Education Research Symposium (PSSHERS 2019), Atlantis Press, 2020, pp. 919–923. Accessed: Feb. 05, 2024. [Online]. Available: https://www.atlantis- press.com/proceedings/psshers-19/125943730

[27] D. Donie, R. Yenes, A. S. Wahyuri, and E. Edmizal, “The Effect of Agility, Eye Coordination and Concentration on The Skills of Playing Badminton Athletes,” Hal. Olahraga Nusant. J. Ilmu Keolahragaan, vol. 6, no. 1, pp. 39–49, 2023.

[28] Y.-L. Chiu, C.-L. Tsai, W.-H. Sung, and Y.-J. Tsai, “Feasibility of smartphone-based badminton footwork performance assessment system,” Sensors, vol. 20, no. 21, p. 6035, 2020.

[29] J. F. Rabek, Polymer photodegradation: mechanisms and experimental methods. Springer Science & Business Media, 2012.

[30] A. Field and G. Hole, How to design and report experiments. Sage, 2002.

[31] J. Galeano, M.-Á. Gomez, F. Rivas, and J. M. Buldú, “Entropy of badminton strike positions,” Entropy, vol. 23, no. 7, p. 799, 2021.

[32] C.-L. Hung, M.-H. Hung, C.-Y. Chang, H.-H. Wang, C.-S. Ho, and K.-C. Lin, “Influences of lateral jump smash actions in different situations on the lower extremity load of badminton players,” J. Sports Sci. Med., vol. 19, no. 2, p. 264, 2020.

[33] D. J. Paul, T. J. Gabbett, and G. P. Nassis, “Agility in team sports: Testing, training and factors affecting performance,”

Sports Med., vol. 46, no. 3, pp. 421–442, 2016.

[34] E. Edmizal and V. Soniawan, "Development Analysis of Badminton Specific Agility Test," in 1st Progress in Social Science, Humanities and Education Research Symposium (PSSHERS 2019), Atlantis Press, 2020, pp. 445–447. Accessed: Feb. 05, 2024. [Online]. Available: https://www.atlantis-press.com/proceedings/psshers-19/125943724

[35] E. Edmizal et al., "Exploring the interplay: Hand muscular power, hip flexibility, and lob shot proficiency in badminton," J. Phys. Educ. Sport, vol. 23, no. 12, pp. 3318–3324, 2023.

[36] N. Ihsan, K. R. Amum, W. Rasyid, and H. Neldi, "Development of Information and Technology-based Learning Media in Athletic Materials for Short Distance Running Numbers for Quality Junior N 2 Students in Lubuk Linggau City, South Sumatra Province," Sciences, vol. 9, no. 1, pp. 124–129, 2021.