Comparison of Arm Muscle Strength, Flexibility, and Agility Components between Elite and Sub-Elite Men's Badminton Athletes

Hari Setijono[1] Kunjung Ashadi[2] Sapto Wibowo[3] Oce Wiriawan[1]
Heryanto Nur Muhammad[3] Muhammad Labib Siena Ar Rasyid[1]

[1] Department of Sports Coaching Education, Faculty of Sports Science, Universitas Negeri Surabaya
[2] Department of Sports Coaching, Faculty of Vocational, Universitas Negeri Surabaya
[3] Department of Physical Education, Faculty of Sports Science, Universitas Negeri Surabaya
Email: harisetijono@unesa.ac.id

Abstract. This study's purpose was to compare the components of arm muscle strength, flexibility, and agility between elite and sub-elite men's badminton athletes. The method used in this study is comparative research with a quantitative approach. The research subjects used were 22 male athletes divided into two groups: six elite athletes and 16 sub-elite athletes. Data collection uses secondary data consisting of three components: arm muscle strength, flexibility, and agility. The instruments used were 30-second push-ups to measure arm muscle strength, standing trunk flexion to measure flexibility, and side steps to measure agility. Data analysis techniques used include descriptive statistics and the Mann-Whitney test. Microsoft Excel and SPSS applications were used to perform data analysis. The results of the study from the Mann-Whitney test showed that the significance value of the arm muscle strength variable was 0.001 ($p<0.05$), the flexibility variable was 0.555 ($p>0.05$), and the agility variable was 0.000 ($p<0.05$). Thus, this study concludes that there is a significant difference between elite and sub-elite men's badminton athletes in arm muscle strength and agility variables, while in the flexibility variable, there is no significant difference.

Keywords: Athlete, Badminton, Cardio, Games, Performance, Physical Conditioning

1 Introduction

Badminton is one of the most popular racquet sports [1] dan and has been played by around 200 million people worldwide [2]. The popularity of badminton is believed to have increased when it became an Olympic sport in 1992 [3]. There was a change in the point calculation system, which made badminton games even more attractive [4]. In this Sport, Indonesia is one of the countries that dominates and has very proud achievements [5].

T. D. Tama et al. (eds.), *Proceedings of the 5th International Scientific Meeting on Public Health and Sports (ISMoPHS 2023)*, Advances in Health Sciences Research 70, https://doi.org/10.2991/978-94-6463-320-7
https://doi.org/10.2991/978-94-6463-320-7_6

Known as the fastest racquet sport in the world, even the shuttlecock's speed in high-intensity rallies can exceed 400 km/hour [6], [7]. This Sport is characterized by intermittent activity with high intensity [8]. According to research, currently, the relationship between several physical components such as shoulder strength, muscle endurance, power, agility, flexibility, and speed are the determining factors for the performance of badminton players [9].

Until this research was done, there had not been any research in badminton that had previously analyzed the differences in the components of arm muscle strength, flexibility, and agility between elite and sub-elite men's badminton athletes. Previous studies have examined badminton players' physical and physiological characteristics in a country and compared elite and non-elite athletes [10]–[12]. With this research, empirical evidence will be known about the differences between elite and sub-elite men's badminton, especially in arm muscle strength, flexibility, and agility.

2 Method

3.1 Research Design

This study uses a comparative research method with a quantitative approach. Comparative research was used in this study because it aims to compare one sample group with another sample group based on specific variables and measures [13]. This study will compare three variables (arm muscle strength, flexibility, and agility) in two sample groups (elite and sub-elite male badminton athletes).

3.2 Participants

The subjects in the study were male badminton athletes with a total of 22 athletes. These athletes were divided into two groups based on their ability to compete: 6 elite and 16 sub-elite athletes. Participants who are considered elite athletes are badminton athletes who are on the Indonesian national team. In contrast, sub-elite athletes are badminton athletes at the provincial level. The sub-elite athletes in this study were athletes in East Java Province.

3.3 Data Collection and Instrument

The data collected in this study is secondary data collected by the Achilles Sport Science and Fitness Center, State University of Surabaya. The data collected included arm muscle strength, flexibility, and agility. The instruments used were 30-second push-ups to measure arm muscle strength [14], standing trunk flexion to measure flexibility [15], [16], and side steps to measure agility [17], [18].

3.4 Data Analysis

The data analysis technique used in this study is a descriptive statistical test using the mean and standard deviation, a data requirements test using normality and homogeneity tests, and hypothesis testing using the Mann-Whitney test. The applications used to perform data analysis are Microsoft Excel and SPSS.

3 Results

The results of the descriptive analysis in this study presented data on the characteristics of the research subjects, including age, height, weight, and body mass index. Data on the characteristics of the research subjects are presented using the mean and standard deviation (SD).

Table 1. Descriptive statistics on the characteristics of the research subjects

No	Variable	Mean ± SD	
		Elite (N = 6)	Sub-elite (N = 16)
1	Age (years)	18,83 ± 1,33	21,63 ± 2,75
2	Height (cm)	174,27 ± 4,79	166,44 ± 13,51
3	Weight (kg)	62,9 ± 5,45	61,06 ± 14,92
4	BMI (kg/m^2)	20,69 ± 1,28	21,72 ± 3,83

The Shapiro-Wilk normality test and Levene's homogeneity test were used in this study to determine whether to test the hypothesis using para-metric or non-parametric statistics. The following normality test results can be seen in the table below.

Table 2. Shapiro Wilk normality test

No	Variable	Group	p-value (sig.)
1	Arm muscle strength	Elite	0.679*
		Sub-elit	0.184*
2	Flexibility	Elite	0.772*
		Sub-elit	0.240*
3	Agility	Elite	0.338*
		Sub-elit	0.487*

*p>0.05, it can be concluded that the data is usually distributed

The above normality test results show that all data variables in this study have a normal distribution (p>0.05). Furthermore, the homogeneity test results are presented in the table below.

Table 3. Homogeneity test

No	Variable	p-value (sig.)
1	Arm muscle strength	0.806*
2	Flexibility	0.009
3	Agility	0.647*

*p>0.05 indicates a homogeneous data variant

Table 3 above shows the results of the Levene's homogeneity test. The homogeneity test results showed variables with non-homogeneous data variances, namely the flexibility variable ($p<0.05$). Therefore, the hypothesis test used in this study is the Mann-Whitney test, which aims to compare two groups between elite and sub-elite athletes. The table below presents the results of the Mann-Whitney test.

Table 4. Mann-Whitney test

No	Variable	p-value (sig.)
1	Arm muscle strength	0.001*
2	Flexibility	0.555
3	Agility	0.000*

*$p<0.05$, there is a significant difference

The results of the Mann-Whitney test revealed that two variables showed a significant difference between elite and sub-elite athletes, namely arm muscle strength and agility ($p<0.05$). At the same time, there was no significant difference in the flexibility variable ($p>0.05$). It can be seen in the image below to make it easier to see the difference between elite and sub-elite men's badminton athletes in each variable.

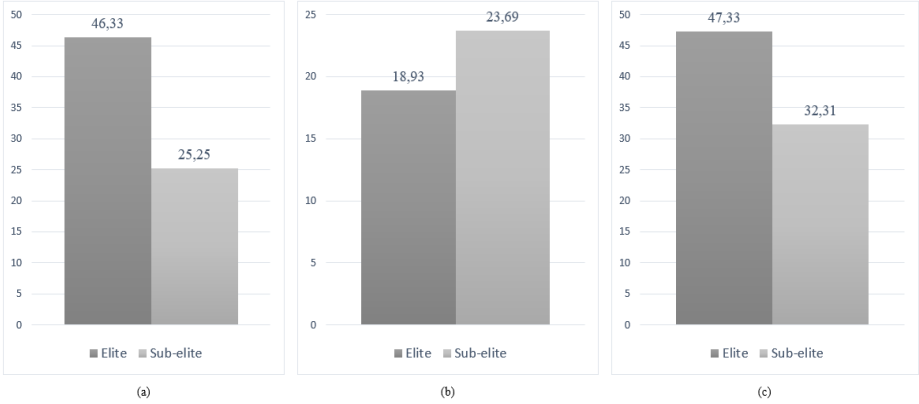

Figure 1. Differences between elite and sub-elite athletes in all variables: (a) arm muscle strength, (b) flexibility, and (c) agility

The graphic above shows that elite athletes are better than sub-elite athletes on arm muscle strength and agility variables. In contrast, on flexibility variables, sub-elite athletes have better flexibility than elite athletes.

4 Discussion

The results of the Mann-Whitney test data showed significant differences between elite and sub-elite men's badminton athletes in the variables of arm muscle strength and

agility ($p<0.05$). On the other hand, the flexibility variable did not show a significant difference between elite and sub-elite athletes ($p>0.05$). These results are appropriate because elite athletes have a higher level of ability when compared to sub-elite athletes, both physically, technically, and mentally.

As is well known, this badminton sport is characterized by specific movement patterns and intense action, consisting of decelerations, rapid acceleration, and changes in direction over short distances with explosive movements. [19]. With the type of game that requires fast and repetitive movements with high intensity for a short duration [20], elite badminton athletes need better performance in maximum strength, speed, agility, endurance, power, and flexibility [21].

This study's results show that the components of arm muscle strength and agility in elite athletes are significantly better compared to sub-elite athletes. However, the flexibility variable found that sub-elite athletes had better flexibility than elite athletes, although the difference between the two was not significant. The results of this study are in line with previous research, which states that flexibility and strength have a negative correlation direction; that is, the greater a person's strength, the more flexibility will decrease, and vice versa [22]–[24]. However, other studies reveal that muscle strength is not affected by the degree of muscle flexibility, but flexibility can affect the maximum angle of exertion of muscle strength, which is one of the factors causing injury [25], [26]. Even so, it should be remembered that skeletal muscle is a motor system that plays a vital role in the body, where the level of muscle strength and flexibility components in skeletal muscle is crucial in preventing injury for athletes [27], [28].

5 Conclusion

This study concludes that there is a significant difference between elite and sub-elite men's badminton athletes in the arm muscle strength and agility variables. In contrast, in the flexibility variable, there is no significant difference. This research implies that the results of this research can be used as material for consideration and attention to trainers as practitioners in the field so that they pay attention to the development of the physical condition of each athlete. For athletes who have reached the elite level, remember the flexibility component in improving the physical aspect. Flexibility is one of the physical components that significantly impacts athletes in achieving the highest performance. The limitations and shortcomings of this study were that the subjects used were only male athletes, and the number of subjects was relatively small. Suggestions and recommendations for further research are that research subjects need female athletes. Besides, athletes at the sub-elite level are used not only for athletes in one province.

References

1. M. Phomsoupha and G. Laffaye, "The science of badminton: game characteristics, anthropometry, physiology, visual fitness and biomechanics,"

Sport. Med., vol. 45, no. 4, pp. 473–495, Apr. 2015, doi: 10.1007/S40279-014-0287-2.

2. M. Kwan, C. L. Cheng, W. T. Tang, and J. Rasmussen, "Measurement of badminton racket deflection during a stroke," *Sport. Eng.*, vol. 12, no. 3, pp. 143–153, Mar. 2010, doi: 10.1007/S12283-010-0040-5/FIGURES/10.
3. D. Cabello Manrique and J. J. González-Badillo, "Analysis of the characteristics of competitive badminton," *Br. J. Sports Med.*, vol. 37, no. 1, pp. 62–66, Feb. 2003, doi: 10.1136/BJSM.37.1.62.
4. H. L. Chen, C. J. Wu, and T. C. Chen, "Physiological and Notational Comparison of New and Old Scoring Systems of Singles Matches in Men's Badminton," *Asian J. Phys. Educ. Recreat.*, vol. 17, no. 1, pp. 6–17, Jun. 2011, doi: 10.24112/AJPER.171882.
5. A. Maksum and N. Indahwati, "Personality traits, environment, and career stages of top athletes: An evidence from outstanding badminton players of Indonesia," *Heliyon*, vol. 9, no. 3, p. e13779, Mar. 2023, doi: 10.1016/J.HELIYON.2023.E13779.
6. Y. Ramasamy, J. Usman, V. Sundar, H. Towler, and M. King, "Kinetic and kinematic determinants of shuttlecock speed in the forehand jump smash performed by elite male Malaysian badminton players," *Sport. Biomech.*, pp. 1–16, Mar. 2021, doi: 10.1080/14763141.2021.1877336.
7. Y. L. Chen, J. H. Hsu, D. H. L. Tai, and Z. F. Yao, "Training-Associated Superior Visuomotor Integration Performance in Elite Badminton Players after Adjusting for Cardiovascular Fitness," *Int. J. Environ. Res. Public Health*, vol. 19, no. 1, p. 468, Jan. 2022, doi: 10.3390/IJERPH19010468.
8. I. Hussain, S. Ahmed, M. A. Bari, A. Ahmad, A. Mohammad, and A. Khan, "Analysis of Arm Movement in Badminton of ForehandLong and Short Service," *Innov. Syst. Des. Eng.*, vol. 2, no. 3, 2011, Accessed: Aug. 23, 2023. [Online]. Available: www.iiste.org
9. S. Li, Z. Zhang, B. Wan, B. Wilde, and G. Shan, "The relevance of body positioning and its training effect on badminton smash," *J. Sports Sci.*, vol. 35, no. 4, pp. 310–316, Feb. 2017, doi: 10.1080/02640414.2016.1164332.
10. Y. Abdullahi, A. L. Toriola, D. Ter Goon, Y. Paul, N. U. Igbokwe, and M. A. Suarau, "Anthropometric and motor performance characteristics of Nigerian badminton players," *Asian J. Sci. Res.*, vol. 10, no. 3, pp. 244–251, 2017, doi: 10.3923/AJSR.2017.244.251.
11. J. Jaworski, G. Lech, M. Żak, E. Madejski, and K. Szczepanik, "The level of selected coordination abilities in badminton players at various ages and sport skill levels as compared to non-athletes," *Balt. J. Heal. Phys. Act.*, vol. 9, no. 3, pp. 33–43, Sep. 2017, doi: 10.29359/BJHPA.09.3.03.
12. C. H. Ooi *et al.*, "Physiological characteristics of elite and sub-elite badminton players," *J. Sports Sci.*, vol. 27, no. 14, pp. 1591–1599, Dec. 2009, doi: 10.1080/02640410903352907.
13. A. Maksum, *Metodologi Penelitian dalam Olahraga*, Kedua. Surabaya: Unesa University Press, 2018.
14. P. Kellner, J. Neubauer, and M. Polách, "Objectivity of push-up tests and

technique assessment," *J. Phys. Educ. Sport*, vol. 21, no. 4, pp. 1629–1634, 2021, doi: 10.7752/jpes.2021.04206.
15. Y. L. Chen, W. C. Lin, Y. H. Liao, and C. J. Lin, "Effect of individual flexibility and knee posture on the lumbar curvature and back muscle flexion-relaxation phenomenon," *Int. J. Ind. Ergon.*, vol. 68, pp. 82–88, Nov. 2018, doi: 10.1016/J.ERGON.2018.06.009.
16. Y. L. Chen, Y. M. Hu, Y. C. Chuan, T. C. Wang, and Y. Chen, "Flexibility Measurement Affecting the Reduction Pattern of Back Muscle Activation during Trunk Flexion," *Appl. Sci.*, vol. 10, no. 17, p. 5967, Aug. 2020, doi: 10.3390/APP10175967.
17. I. K. H. Kardiawan and K. C. A. Kusuma, "PENINGKATAN KELINCAHAN PADA PEBULUTANGKIS USIA DEWASA 40 TAHUN MENGGUNAKAN MODEL LATIHAN LARI SEGITIGA DAN FOOTWORK PERINTAH," *J. Kejaora (Kesehatan Jasm. dan Olah Raga)*, vol. 7, no. 1, pp. 1–6, May 2022, doi: 10.36526/KEJAORA.V7I1.1741.
18. Widiastuti, *Tes dan Pengukuran Olahraga*. Depok: Rajawali Pers, 2015.
19. P. Huang, M. Liang, and F. Ren, "Assessment of long-term badminton experience on foot posture index and plantar pressure distribution," *Appl. Bionics Biomech.*, vol. 2019, 2019, doi: 10.1155/2019/8082967.
20. P. Deka, K. Berg, J. Harder, H. Batelaan, and M. McGRATH, "Oxygen cost and physiological responses of recreational badminton match play," *J. Sports Med. Phys. Fitness*, vol. 57, no. 6, pp. 760–765, Jun. 2017, doi: 10.23736/S0022-4707.16.06319-2.
21. A. Rusdiana, H. Subarjah, I. Imanudin, Y. Kusdinar, A. M. Syahid, and T. Kurniawan, "Effect of Fatigue on Biomechanical Variable Changes in Overhead Badminton Jump Smash," *Ann. Appl. Sport Sci.*, vol. 8, no. 3, pp. 0–0, Oct. 2020, doi: 10.29252/AASSJOURNAL.895.
22. G. R. Hunter, J. P. McCarthy, D. R. Bryan, P. A. Zuckerman, M. M. Bamman, and N. M. Byrne, "Increased strength and decreased flexibility are related to reduced oxygen cost of walking," *Eur. J. Appl. Physiol.*, vol. 104, no. 5, p. 895, 2008, doi: 10.1007/S00421-008-0846-Z.
23. B. Akinoğlu, B. Kabak, E. Ünüvar, and T. Kocahan, "Investigation of the relationship between hamstring flexibility and hamstring and quadriceps muscle strengths in athletes," *Med. dello Sport*, vol. 73, no. 3, pp. 392–404, Sep. 2020, doi: 10.23736/S0025-7826.20.03582-6.
24. H. Nagahori and N. Shida, "Relationship between Muscle Flexibility and Characteristics of Muscle Contraction in Healthy Women during Different Menstrual Phases," *Phys. Ther. Res.*, vol. 25, no. 2, p. 68, Aug. 2022, doi: 10.1298/PTR.E10173.
25. X. Wan, F. Qu, W. E. Garrett, H. Liu, and B. Yu, "Relationships among hamstring muscle optimal length and hamstring flexibility and strength," *J. Sport Heal. Sci.*, vol. 6, no. 3, pp. 275–282, Sep. 2017, doi: 10.1016/J.JSHS.2016.04.009.
26. J. Alonso, M. P. McHugh, M. J. Mullaney, and T. F. Tyler, "Effect of hamstring

flexibility on isometric knee flexion angle-torque relationship," *Scand. J. Med. Sci. Sports*, vol. 19, no. 2, pp. 252–256, Apr. 2009, doi: 10.1111/J.1600-0838.2008.00792.X.

27. C. S. Ahmad, L. H. Redler, M. G. Ciccotti, N. Maffulli, U. G. Longo, and J. Bradley, "Evaluation and management of hamstring injuries," *Am. J. Sports Med.*, vol. 41, no. 12, pp. 2933–2947, Dec. 2013, doi: 10.1177/0363546513487063.
28. D. A. Padua *et al.*, "National Athletic Trainers' Association Position Statement: Prevention of Anterior Cruciate Ligament Injury," *J. Athl. Train.*, vol. 53, no. 1, pp. 5–19, Jan. 2018, doi: 10.4085/1062-6050-99-16.