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Analysis of Volleyball Learning and Its Impact on Physical Fitness: A Longitudinal Review of Speed, Strength, and Flexibility in the Perspective of the Sport Pedagogy Approach to Physical and Health Education

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ABSTRACT

Purpose of the study: The importance of physical fitness in volleyball and its application in physical education which has not been maximized has encouraged research on the analysis of the impact of physical fitness on volleyball learning in relation to a longitudinal review of the aspects of speed, strength, and flexibility from the perspective of a sports pedagogy approach.

Methodology: This study uses a longitudinal approach to analyze changes in aspects of learning evaluation and physical fitness of students over a period of 24 weeks involving three main parameters, namely: strength, speed, and flexibility through test instruments, to then be analyzed using repeated measurements of one factor (ANOVA) and measuring effect size with Hedges' g.

Main Findings: The results of the study revealed that volleyball learning has a positive impact on students' learning achievement patterns and physical fitness in terms of speed, strength, and flexibility viewed from sports pedagogy. The implications of these findings are relevant to the development of physical education curricula and sports training programs along with their assessments that provide a scientific basis for planning sustainable training programs.

Novelty/Originality of this study: The analysis of volleyball learning and its impact in the field of physical education evaluation in this study focuses on analyzing the sports pedagogy approach so that it not only analyzes the impact of learning but also develops an analysis related to aspects of physical fitness and learning as a whole using a longitudinal review from a sports pedagogy perspective.

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1. INTRODUCTION

Health and physical fitness are fundamental aspects in maintaining the quality of human life. The era of increasingly advanced globalization makes an active and productive lifestyle one of the main solutions to face health challenges due to sedentary lifestyles [1]. This has also been proven by several previous studies which state that physical activity can have an impact on reducing the risk of various chronic diseases [2], [3]. In

addition to the physical benefits, of course, exercise also contributes to improving mental health, which has been shown to reduce symptoms of depression, improve a person's mood, and an individual's quality of sleep [4-5]. Therefore, sports education is one of the components of health and physical fitness that creates opportunities to become an important need in everyday life.

One of the branches of sports education studies that is popular and useful in improving physical fitness is volleyball. This is supported by the opinion that volleyball offers significant benefits to individual physical fitness and is an effective means to build better social [6]-[8]. In addition, volleyball is also a dynamic sport that combines fast movements, high jumps, and good coordination between players so that it can be said to be an activity that combines elements of physical fitness such as strength, speed, and flexibility [9]-[14]. Therefore, volleyball is very important as a sport that contains important elements to improve physical fitness performance and body mobility.

The current physical education curriculum covers various topics and aspects to better support students' abilities [15]. The purpose of the curriculum in volleyball subjects certainly has a significant impact that not only improves physical skills but also instills the values of cooperation, discipline, and sportsmanship. However, the facts in the field are that the higher education curriculum that applies to volleyball courses still has not had a significant impact on learning and physical fitness, this is evidenced by the limited ability of educators and students to understand and apply aspects of coaching and sports education and physical fitness development in volleyball learning [16], [17]. This is also proven by several previous studies which tend not to dissect the specific influence of volleyball sports learning on physical fitness and body mobility, for example when experiencing injury or other supporting factors [18]-[20].

One of the solutions to the above factual disparity is to integrate a sports pedagogy approach that allows for the analysis of aspects of physical education, especially comprehensive physical fitness, in volleyball learning [21], [22]. This is supported by the opinion that the sports pedagogy approach to volleyball learning does not only focus on how to deepen playing techniques, but also aims to develop physical and overall fitness [23], [24]. In addition, there are several factors that influence the sports pedagogy approach in the world of physical education towards aspects of physical fitness through volleyball learning, including speed (responsiveness); strength; and flexibility. Responsiveness in volleyball in relation to the sports pedagogy approach provides an overview of how knowledge is needed to deal with changing situations and their adjustments [25], [26]. In addition, the strength aspect also provides its own knowledge in learning volleyball about mastering basic game techniques and how to understand the strength of body parts in the accuracy of a movement and game control [27]-[29]. The flexibility aspect in volleyball also plays an important role in increasing the effectiveness of knowledge of the dynamic movements of the game and how to increase the accuracy of the flexibility of stroke movements in the game to be more precise and effective [30]-[34].

The importance of physical fitness aspects in physical education in volleyball games and their application and analysis that have not been maximized. One solution is to analyze opportunities to increase the effectiveness of volleyball learning. Therefore, researchers try to analyze the impact of physical fitness on volleyball learning in relation to a longitudinal review of the aspects of speed, strength, and flexibility in the perspective of a sport pedagogy approach.

2. RESEARCH METHOD

This study used a longitudinal approach to analyze changes in students' physical fitness throughout the volleyball learning process with a period of 24 weeks conducted at four time points: pre-test (first week), middle-test (13th week), post-test (24th week), and last follow-up at week 28. This research approach allows educators to analyze and observe changes in students' physical fitness continuously at three stages, namely before, middle of the program, and end of the program. Therefore, this study is expected to evaluate the long-term impact of volleyball learning on students' physical fitness in terms of speed, strength, and flexibility.

The sample in this study was selected using a total sampling technique, involving 104 students of the Faculty of Sport Science, Semarang State University in volleyball courses. The sample consisted of 63 male students with an average age of 18 ± 0.7 years, an average height of 1.69 ± 0.12 meters, and an average weight of 65.3 ± 9.5 kilograms. While the other 41 students were female with an average age of 18 ± 0.4 years, an average height of 1.61 ± 0.08 meters, and an average weight of 61.3 ± 7.1 kilograms. Physical fitness measurement involves three main parameters, namely: strength, speed, and flexibility. Muscle strength is measured using data-based dynamometer data to measure grip strength and leg muscles. While speed is measured through a test related to a 20-meter sprint using a stopwatch measurement to obtain accurate data.

Data collection for this study was conducted in four stages, namely pre-test in the first week, middle-test in the 13th week, post-test in the 24th week, and follow-up in the 28th week, which were conducted four weeks after the end of volleyball learning by following a volleyball learning program with a focus on developing technical and physical skills (figure 1). Data collection was conducted after participants had done a 5-minute warm-up consisting of light jogging and joint mobilization exercises, to prepare their bodies. Students were also

given an explanation of the measurement procedures that would be carried out at each stage. Measurements were conducted in the physical fitness laboratory of Semarang State University, ensuring consistent testing conditions in each session. The process of measuring participants' physical fitness was measured by tests that included muscle strength, agility, and endurance that had been standardized and proven to be valid and reliable.

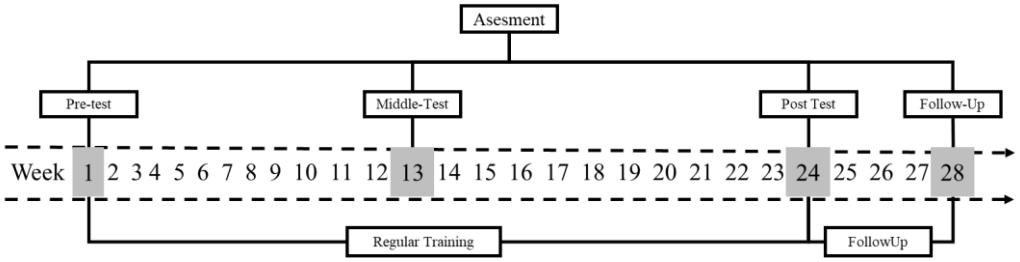

Figure 1. Timeline of Research Series

The data obtained regarding the speed, strength, and flexibility of the participants were measured at four time points: pre-test (first week), middle-test (13th week), post-test (24th week), and follow-up (28th week) will be analyzed the effect of volleyball learning time on the three variables, using analysis of variance with repeated measures of one factor (ANOVA). Meanwhile, the Bonferroni post-hoc test was conducted to compare the differences between each time point with the chronological order of the assessment, namely between pre-test and middle-test, middle-test and post-test, and post-test and follow-up. The measurement process for effect size was carried out using Hedges' g, with the interpretation of values less than 0.19 indicating trivial effects, between 0.20 to 0.49 indicating small effects, between 0.50 to 0.79 indicating moderate effects, and more than 0.80 indicating large effects.

3. RESULTS AND DICUSSION

Based on the results of data analysis in Table 1, it can be shown that the average value and standard deviation for all variables at four measurement points by conducting ANOVA tests and post-hoc comparisons are presented as in Table 2, the performance of all types of physical conditions such as speed, strength, and flexibility experienced significant changes during volleyball learning.

Tabel 1. Mean ± standard deviation of the study variables

Variable	Gender	N	Pre-test	Middle-test	Post-test	Follow-up
Speed	Men	63	4.07 ± 0.88	3.79 ± 0.48	3.67 ± 0.65	3.67 ± 0.67
	Women	41	4.45 ± 0.48	4.37 ± 0.42	4.18 ± 0.56	4.18 ± 0.44
Strength	Men	63	35.60 ± 9.11	38.10 ± 8.44	42.27 ± 7.19	42.30 ± 8.86
	Women	41	35.08 ± 4.06	37.15 ± 4.05	36.56 ± 4.66	36.24 ± 4.15
Flexibility	Men	63	38.42 ± 4.17	40.49 ± 4.19	43.31 ± 4.71	42.94 ± 3.94
	Women	41	35.32 ± 5.77	38.08 ± 3.89	41.95 ± 4.6	41.02 ± 4.55

Tabel 2. Results of ANOVA and Bonferroni's post-hoc comparisons

	Outcame	ANOVA		Post-hoc tests		
		F	*p*	pretest vs. Middle-tetst	Middle-test vs. Post-test	Post-test vs. Follow-up
Men	Speed	13.842	0.000	0.003 (ES: 0.394)	0.000 (ES: 0.197)	1.000
	Strength	25.517	0.000	0.000 (ES: 0.283)	0.000 (ES: 0.532)	1.000
	Flexibility	23.206	0.000	0.000 (ES. 0.497)	0.002 (ES: 0.633)	1.000
Women	Speed	28.057	0.000	0.003 (ES: 0.187)	0.000 (ES: 0.364)	1.000
	Strength	39.943	0.000	0.000 (ES: 0.511)	0.000 (ES: 0.251)	0.746
	Flexibility	25.326	0.000	0.001 (ES: 0.560)	0.000 (ES: 0.676)	1.000

Based on the results of the data analysis of the two tests conducted on the speed aspect, both men and women showed a significant increase from the pre-test to the post-test stage ($p < 0.01$). This also shows that the effect size is in the small to medium category for both groups, indicating that this volleyball learning approach is able to develop the reactions and responses of participants evenly. The results from the post-test to the follow-up were also stable, indicating that the speed obtained remained consistent. In addition, based on the data processing and statistical tests conducted, it was found that volleyball learning also succeeded in increasing the strength of participants, both men and women, this occurred significantly from the pre-test to the middle-test stage ($p < 0.01$) and continued until the post-test ($p < 0.01$). However, in this aspect, the male group showed a higher absolute

strength value, with the pattern of increase from learning remaining balanced in both groups. Based on the data analysis conducted at the follow-up stage, there was also a balance in both groups, so it can be interpreted that the strength aspect of the participants remained stable without a significant decrease.

Furthermore, in the flexibility aspect, men and women both experienced significant improvements during the learning process ($p < 0.01$). In addition, the effect size on this flexibility aspect is quite high, which also means that volleyball learning not only improves sport-specific skills but also supports general physical abilities such as range of motion. Therefore, there is no significant difference between the post-test and follow-up results, indicating the stability of the results. Based on these three aspects, we get the results that the impact has a significant impact on students' physical fitness during volleyball learning in relation to the longitudinal review of the aspects of speed, strength, and flexibility so that it will certainly emphasize practical benefits with a great influence on the learning process and physical mobility of students in terms of sport pedagogy.

Based on the research results, we can see that there was a significant increase in the three longitudinal measurement variables, namely speed, strength, and flexibility, which are based on a review of sports pedagogy in learning volleyball games for male and female students. This is reinforced by the opinion that increasing the longitudinal measurement aspect is physiologically based on the body's adaptation to training and also the learning patterns experienced by students, where adaptation and learning apperception need to be carried out before being given training, which in turn helps students to better understand the learning process or often referred to as sports pedagogy and of course is based on the aspect of physical fitness where the body is able to overcome muscle and ligament tension, which leads to increased flexibility and reduced risk of injury and miscommunication during the learning process [35], [36]. In the significant increase in speed itself, substantial changes can be seen, which are marked by the implementation of learning in volleyball material running effectively and the level of processing of training in mastering game techniques which is getting better [37]. This also indicates that there is coordination and precision of movement as well as an appropriate physical education curriculum so that the speed of students in the learning process can be more balanced [38]. Meanwhile, in terms of strength, there has also been a significant increase, as indicated by the high motivation of students to exercise, thus helping to build fitness components, one of which is greater muscle mass, which ultimately has a higher effect on volleyball playing technique skills and of course provides more confidence to further develop other components of the physical education curriculum, especially in the fitness aspect of more mature volleyball learning [39], [40].

In addition, if viewed from the aspect of strength, an implication can be drawn that the physical education curriculum, especially in relation to volleyball training, plays a role in improving the training patterns and mastery of students, and has an influence on the fitness aspect of arm muscle strength, which is very necessary to master the basic techniques of the game better [41], [42]. This is also supported by research [43], [44] which shows that exercises involving strength in every physical education learning, especially volleyball, are the most important factors that support the focus of explosive movements in basic game techniques such as smash and block. However, if we look at the research results, there are limited findings in the evaluation of different strength aspects between men and women and are caused by physiological differences in the muscle mass of each of the research sample student personnel themselves [45]-[47]. Furthermore, based on the flexibility aspect in this study, it was found that there was a significant increase in both fitness and learning aspects. This is evidenced by the increasing ability and mastery of all volleyball learning steps that are carried out, including giving an effect on changes in body movements to become wider [48]-[50]. This is supported by the opinion stating that the process of increasing the flexibility aspect in volleyball emphasizes the importance of exercises involving stretching and body rotation, especially in providing encouragement to further reduce the risk of decreasing flexibility, fitness, training and the learning process in it. In addition to the opinion above, there are also implications stating that flexibility in learning big balls, especially volleyball, has a significant impact, especially in the pattern of increasing dynamic movement patterns and mastery of techniques and components of learning materials in it [51], [52].

Therefore, based on the findings above, a fact was obtained where the increase in speed, strength, and flexibility aspects was maintained for four weeks without further learning. This has implications for the positive effects of volleyball learning that can persist even without further intervention [53]. This finding is in line with research [54], [55] which shows that although training in volleyball learning can improve physical fitness in the short term, the results in the future can experience a slight decline over time, but this is the opposite if continuous training is carried out even though there are different internal factors of students or subjects and of course also supported by pedagogical aspects of teachers and a more complex physical education curriculum. This certainly still provides limitations to this study so that it is necessary to think about how training is carried out continuously but it still needs to be re-analyzed the balance analysis between internal factors of students and pedagogical aspects that are developed so that the effect of the training will run significantly and be maintained in the long term.

In addition, this study also found the fact that there was a significant increase in all three aspects including speed, strength, and flexibility, but no significant changes were found in both groups (men and

women) during the follow-up phase which lasted for four weeks. This shows that the improvements achieved during the 24-week training period still have consistency in the pattern of training memory even after four weeks without any volleyball training sessions [56], [59]. In other words, even though there was no direct learning during the period, there was still a positive impact from the training that had been done previously, and of course this shows the long-term effectiveness of the training program that had been implemented. This phenomenon can be explained by the physiological adaptation process that occurs during training, which results in the body being able to maintain increased physical fitness even though the time without training [60]-[62].

Based on the research, of course we know that the analysis of volleyball learning is still limited by involving relevant factors reviewed from the aspect of sport pedagogy related to longitudinal studies such as speed, strength, flexibility, which has not been able to provide a significant effect on the process of student understanding, especially in relation to developing further analysis of fitness maintenance patterns in order to obtain maximum results in mastering volleyball techniques and materials provided. The limitations of this research certainly also provide hope for how to develop a physical education curriculum related to volleyball games to build a picture that physical education learning, especially volleyball, is not only learning about theory and concepts but there is reinforcement of several aspects, for example the addition of a physical education and health learning curriculum related to training programs involving agility, training on how to combine movements and game techniques will provide reinforcement in the strength aspect, and how to compile a curriculum so that students also understand how to overcome injuries or errors in movement [63]-[65]. In addition, it is also necessary to develop further research related to how to develop students' abilities so that they can maintain and adapt during the training process even without any repetition from educators, so it is felt necessary to develop a model and process of training on success which is a learning process [66], [67].

4. CONCLUSION

This study shows that there is a significant increase in the three longitudinal measurement variables, namely speed, strength, and flexibility, which are based on a review of sports pedagogy in learning volleyball games in male and female students. The study also found the fact that although there were no significant changes in both research groups, there was still a positive impact from the previous training, and this finding certainly provides new implications that the physiological adaptation process that occurs during training is able to maintain increased physical fitness even though the training time is limited. The implications of these findings are very relevant to the development of physical education curricula and sports training programs so as to provide a scientific basis for planning more structured and sustainable training programs, both for recreational purposes and improving athletic performance.

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