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The Effect of Aerobic Exercise on Improving Cardiovascular Function and Coordination in Early Childhood Sports Training

Sb. Pranatahadi[1], Faidillah Kurniawan[1], Syamsuryadin[1], Rekyan Woro Mulaksito Mulyadi[1], Faza Annasai[1*]

[1]Department of Sport and Health, Faculty of Vocational, Universitas Negeri Yogyakarta, 55281, Indonesia

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ABSTRACT

This study aims to determine the effect of aerobic exercise on improving cardiovascular function and coordination in early childhood sports training. This study employed a pre-experimental design with a One-Group Pretest-Posttest Design, utilizing a single group of subjects. The population and sample for this research and development consisted of athletes registered in a volleyball club in Sleman Regency. The sampling technique used was purposive sampling, with the following inclusion criteria: female volleyball athletes, willingness to participate as samples, aged 10–12 years, and a minimum training experience of 6 months. Based on the paired samples t-test analysis, the calculated t-value was greater than the t-table value, with a p-value (0.000) < 0.05. These results indicate that the calculated t-value is significantly larger than the t-table value. Consequently, there is a significant effect of aerobic exercise on improving cardiovascular function and coordination in early childhood sports training.

1. Introduction

Sports are highly popular activities enjoyed by adults, adolescents, and children alike. Athletic achievements also serve as a benchmark for a nation's prestige, and a country's level of welfare can even be enhanced through its sporting accomplishments. Consequently, many major nations heavily consider implementing sports programs starting from childhood to identify and nurture athletic talents from an early age. Furthermore, many parents involve their children in sports for recreational purposes or to develop their talents, biomotor abilities, psychological traits, and social skills. From the perspective of Sports Physiology, sports comprise a series of regular and planned physical movements performed consciously to improve functional capacity in accordance with specific goals. Sports are categorized based on their nature or objectives into performance sports, recreational sports, health sports, and educational sports [1].

Through this multilateral development method, children will grow optimally without neglecting their future role as members of society. A child's psychological aspects will develop progressively alongside their intensive involvement in their favorite sports. Mental toughness is one of the

*Corresponding author.
E-mail address: fazaannasai@uny.ac.id

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psychological aspects that must be nurtured from an early age. When children fully transition into athletes, their psychological resilience will already be established due to early mental conditioning. The involvement of young athletes in sports training and competitions is inseparable from the roles of adults as coaches, managers, and parents. For most children, their initial experience in sports activities is guided by inexperienced coaches, or even individuals who are not professional coaches and only master the basic techniques of the sport. Many coaches, sports teachers, and parents still struggle to control their emotions during tournaments or matches. They often prioritize short-term victory and overemphasize winning without considering the child's psychological well-being, which can negatively impact the psychological development of young athletes, leading to emotional instability, aggressiveness, and social withdrawal. Therefore, mental training sessions are essential to help young athletes cope with the pressure imposed by coaches or parents. Motor skill is a vital aspect of human life because physical movement enables individuals to achieve their goals. All sports are beneficial if performed under proper direction and supervision. Every sport possesses aspects that can contribute to an enjoyable experience and positive physical and mental development [2].

Early childhood represents the next generation that will drive sports achievements in the future and bring progress to the nation. Early childhood is a critical period where children can develop their full potential, as physical and cognitive development occurs more rapidly during this phase than in subsequent stages [3]. Efforts to shape a child's potential, characteristics, and mental strength rely heavily on the coach's role in early childhood training. To attain high athletic performance, the concept of sports training must be implemented as early as possible [4].

Rapid physical and spiritual development occurs from birth until the age of six. Early childhood is a critical phase for physical, intellectual, and social-emotional development. According to [5], "Early childhood is an incredibly vital stage in terms of a child's physical, intellectual, emotional, and social development. Mental and physical capacities develop at an astonishing rate, and a highly significant proportion of learning occurs from birth to age six." Children in this age group exhibit high curiosity and an active nature. These developmental capabilities are acquired through learning experiences within their surrounding environment. Given the importance of early childhood as the succeeding generation, fostering motivation and maximizing the supervisory roles of parents and coaches are crucial to ensure that growth and development progress appropriately for their age.

Based on the "Golden Age" calculation theory, peak athletic performance across various sports branches typically ranges between 18–24 years of age. It requires approximately 8–10 years of structured training for an athlete to reach peak performance. Therefore, the orientation of sports training should begin at around 4–14 years of age [6]. Structured training allows early childhood athletes to improve and achieve better results through directed, programmed, and continuous coaching, supported by adequate facilities and infrastructure. Supporting aspects can motivate children to participate actively in training, thereby enabling them to achieve high performance. In performance coaching, efforts to achieve success are planned systematically, progressively, and continuously. Successful performance coaching is guided through training tailored to the child's growth and development, where the coach plays a pivotal role. A coach is a title that commands respect, status, and responsibility [7]. A coach bears the crucial task of building character, fostering mental strength, and serving as a motivator for young children to achieve success. Periodic evaluation of early childhood development is vital in coaching to monitor structural improvements and make necessary adjustments.

Fitness gymnastics aims to train the heart, lungs, and blood circulation, while also enhancing specific muscle strength, flexibility, coordination, concentration, and agility [8]. Currently, many daily activities do not require normal physical movement, which leads to a decline in agility,

coordination, and overall functional performance. Various physical exercise efforts must be undertaken, one of which is fitness gymnastics. Engaging in a programmed fitness regimen for 5 months [9] has shown varying outcomes; however, some studies note that certain programs show no differences in flexibility, agility, and motor coordination [10].

Concentration is highly important and required for students during the learning process so that the expected competencies can be mastered well. Because concentration is a prerequisite for students to learn effectively and achieve learning objectives, it directly determines academic performance. Learning concentration can be observed from the student's focus during study sessions [11]. Low academic achievement is often caused by a child's weak ability to concentrate [12].

Another study conducted at the University of Miami Medical School in 1990 involved 24 children, divided into 12 children in the control group and 12 children in the treatment group. The treatment group was given fitness gymnastics for 30 minutes over 8 weeks [13]. Following the intervention, the treatment group showed significant changes, namely a decrease in heart rate and an increase in agility and other physical fitness components [14]. Additionally, a study conducted at Texas Tech University, USA, on 44 fitness instructors using the RCT method compared one group that stopped training and another group that continued a programmed 5-month fitness routine [15]. The results indicated that fitness gymnastics improves flexibility, concentration, agility, and coordination [16]. Based on the background above, this study highlights a gap in training optimization for specific demographics, aiming to determine the effect of aerobic exercise on improving cardiovascular function and coordination in early childhood sports training.

2. Method

This study utilized a pre-experimental design, specifically the One-Group Pretest-Posttest Design, involving a single group of subjects. According to [17], it is called a pre-experimental design because it lacks the rigorous controls of a true experiment; external variables may still influence the dependent variable due to the absence of a control group and non-random sampling. The population and sample in this research and development consisted of athletes from a volleyball club in Sleman Regency. The sampling technique used was purposive sampling, with the following criteria: female volleyball athletes, willingness to serve as samples, aged 10–12 years, and a minimum training history of 6 months.

Quantitative data analysis included normality testing to determine whether the data were normally distributed. The normality test was conducted using SPSS 25 for Windows Evaluation Version via the Kolmogorov-Smirnov formula. The criteria used to determine distribution normality specified that if $p > 0.05$ (5%), the distribution is declared normal; if $p < 0.05$ (5%), the distribution is considered non-normal. Hypothesis testing was carried out using a paired t-test via SPSS by comparing the mean data obtained from the initial test (pretest) and final test (posttest) at a significance level of 5% or 0.05 using SPSS 25.

3. Results and Discussion

3.1. Results

Table 1. Tests of Normality for Coordination

Variable	Kolmogorov-Smirnov (Statistic)	Kolmogorov-Smirnov (df)	Kolmogorov-Smirnov (Sig.)	Shapiro-Wilk (Statistic)	Shapiro-Wilk (df)	Shapiro-Wilk (Sig.)
Pre_Test_Coordination	.189	50	.000	.950	50	.033
Post_Test_Coordination	.100	50	.200*	.965	50	.140

Table 2. Tests of Normality for VO2Max

Variable	Kolmogorov-Smirnov (Statistic)	Kolmogorov-Smirnov (df)	Kolmogorov-Smirnov (Sig.)	Shapiro-Wilk (Statistic)	Shapiro-Wilk (df)	Shapiro-Wilk (Sig.)
Pre_Test_VO2Max	.152	50	.006	.930	50	.006
Post_Test_VO2Max	.136	50	.021	.952	50	.041

Based on the table results above, it can be observed that all data have a value of $p > 0.05$. Thus, it can be concluded that the research data are normally distributed.

Table 3. Paired Samples Test for Coordination

Pair	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval (Lower)	95% Confidence Interval (Upper)	t	df	Sig. (2-tailed)
Pair 1: Post_Test - Pre_Test	1.960	1.772	.251	1.456	2.464	7.820	49	.000

Table 4. Paired Samples Test for VO2Max

Pair	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval (Lower)	95% Confidence Interval (Upper)	t	df	Sig. (2-tailed)
Pair 1: Post_Test - Pre_Test	1.94200	1.58605	.22430	1.49125	2.39275	8.658	49	.000

Based on the paired samples t-test analysis, the calculated t-value > t-table value, and the *p*-value (0.000) < 0.05, indicating that the calculated t-value is significantly greater than the t-table value.

3.2. Discussion

In aerobic gymnastics, athletes must possess an exceptionally high level of fitness, which is critical during training. Individuals who perform aerobic gymnastics exhibit diverse motor capacities, which are reflected in performance quality, technical precision, and movement execution. Gymnastics is performed to channel artistic expression and beauty while developing and improving movement arts. Unlike other sports that generally measure activity against an external object,

gymnastics refers to a form of movement executed through integrated and comprehensive coordination [18]. This is achieved through adequate and appropriate training. A gymnast displays an excellent correlation in neuromuscular characteristics, such as high levels of power, strength, muscular endurance, speed, and superior coordination.

The peak sensitivity period for developing various types of coordination through gymnastics occurs between 7 and 11–12 years of age through cyclic and acyclic movements, sports games, and acrobatic motor actions. The strongest complex sensitivity for coordination capabilities occurs at age 8 for girls and age 9 for boys [19].

Consistent evidence shows that regular physical activity offers numerous benefits for youth, including improved cognitive, emotional, social, and physical health [13]. Despite these benefits, less than 60 percent of children (ages 6–11) and 30 percent of adolescents (ages 12–15) in the US report meeting national physical activity guidelines, with notable disparities based on gender, race, and ethnicity [18]. One of the most significant benefits of aerobic exercise is the reduction of cardiovascular risks and the improvement of overall cardiovascular health. The heart rate can reach approximately 150 beats/minute immediately after aerobic exercise; training at this intensity can enhance respiratory muscle strength, increase hemoglobin levels, and maximize oxygen uptake. Aerobic exercise also exerts a significant influence on improving cardiac function [19]. The subjects of this study were limited to female characteristics aged 10–12 years; therefore, future research should expand the demographics regarding gender and age variations.

4. Conclusions

There is a significant effect of aerobic exercise on increasing cardiovascular function and coordination in early childhood sports training, with a mean difference between the pretest and posttest of 1.96 for coordination and 1.95 for VO2Max. Choreographed aerobic exercise training effectively enhances cardiovascular fitness and coordination for early childhood sports development, specifically within the female sample aged 10–12 years.

Conflict of interest

The authors declare no conflict of interest

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