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Increasing Anaerobic and Aerobic Capacity Through Complementary Training for West Java Female Futsal Players in Preparation for the 21st National Sports Week

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Abstract

The purpose of this study is to reveal the application of strength training models to training methods (complementary training) that complement each other to maximize the process of developing and increasing anaerobic capacity as well as aerobic capacity. Physical training should be conducted gradually and continuously, without interruption. Likewise, there are stages in the physical components, specifically in strength training. This research is experimental. The population in this study consisted of West Java Female Futsal Players in Preparation for the 21st National Sports Week, totaling 16 individuals, and the sample taken was the entire population. Sampling technique with total sampling. The research instrument consisted of anaerobic and aerobic tests. The anaerobic power endurance test was conducted using the hurdle jump test, while the aerobic capacity test was conducted using the bleep test. Data analysis techniques using SPSS software. Statistical analysis showed a significant increase in anaerobic capacity (from 112 to 116 repetitions) and aerobic capacity (from 40,3 to 42,2 ml/kg/min) with $p < 0,05$. This study concludes that the implementation of complementary training can increase anaerobic capacity and aerobic capacity in West Java Female Futsal Players in Preparation for the 21st National Sports Week.

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INTRODUCTION

The physiological role in physical training for athlete performance in modern sports is highly evident. This is primarily due to the increasing level of competition, which in turn raises the demands for more intensive and effective training. Several key factors contribute to achieving high athletic performance, including physical preparation, technical preparation, tactical preparation, and mental preparation. These factors must be thoroughly understood by every coach in order to maximize the athlete's potential, develop and enhance their capabilities, and ultimately contribute significantly to achieving peak performance.

In achieving sporting excellence, particularly in futsal, especially when entering the elite athlete level, physical training is a very important component. Futsal is a high-intensity sport that involves a lot of acceleration, running and changing direction repeatedly over a long period of time. This requires players to have good anaerobic and aerobic physical capacity (Castagna & Castellini, 2013). Aerobic capacity is the ability to maintain high performance over a long period of time, while anaerobic capacity is the ability to perform high workloads repeatedly (Sumpena & Sidik, 2017).

Aerobic capacity is the amount of energy that can be provided to perform work in the aerobic energy system, while anaerobic capacity is the amount of energy that can be provided to perform work in the anaerobic energy system (Doewes, 2012). Aerobic capacity can be seen from the maximum oxygen capacity (VO2max), which is the maximum amount of oxygen that can be used by the body per minute when performing maximum physical activity, expressed in ml/kg/minute (P.O & U.G, 2016). The anaerobic energy system is divided into two types: the alactic anaerobic system, such as speed, agility, maximum strength, and power; and the lactic anaerobic system, such as power endurance and speed endurance (Sidik et al., 2019).

In futsal, the anaerobic capacity component known as power endurance is very important because passing and shooting are performed repeatedly over a long period of time. Based on the analysis by Justika & Sidik (2017), during the 2012 World Cup in Spain, the Spanish team made 908 passes in 2 x 25 minutes, while shooting 15 times. Power endurance is the ability of muscles to contract repeatedly, quickly, and strongly over a long period of time. The maximum duration of power endurance work is between 30-120 seconds, with energy sources being Adenosine Triphosphate-Creatine Phosphate (ATP-PC) and glycogen (Sidik et al., 2019).

Given the importance of these physical abilities in maintaining performance during high-intensity and repetitive matches, a structured and systematic training approach is necessary to develop and optimise aerobic and anaerobic (power endurance) capacity. Training that has long-term and short-term planning is usually called periodisation. According to Lambert et al. (2005), periodisation is defined as the process of systematically planning short-term and long-term training programmes by varying training load and recovery. Williams et al. (2017) describe periodisation as a method of organising training into sequential phases to increase the potential for achieving goals. Similarly, DeWeese et al. (2015) consider periodisation to be an integral part of the training process and provide a conceptual framework for designing training programmes.

Training programmes that are designed and structured through periodisation provide maximum improvement effects compared to training programmes that are not structured periodically with training periodisation (Williams et al., 2017). Periodisation is the basis of an athlete's training plan, which functions as a method of dividing training into smaller, more manageable segments, commonly referred to as training phases (Bompa & Buzzichelli, 2019). Periodisation is a training scheme in which precisely planned variations in training variables (e.g. number of sets and repetitions, exercise order, load and rest) are manipulated at regular intervals in an effort to produce optimal gains; for example in terms of speed, strength, power, endurance, and so on. At the same time, performance stagnation such as adaptation plateaus and overtraining conditions must be avoided (Antretter et al., 2018).

In this study, in order to achieve maximum results at the peak required and demanded of each athlete or player according to the characteristics of the sport and the player's position during competition, it is certainly part of the analysis of requirements that must be met in the training process. Therefore, the importance of complementary training in planning the periodisation of the training programme means that coaches strive to design strength training programmes in accordance with the stages of strength. This approach not only maximizes the process of physical development but also enhances both anaerobic and aerobic capacities.

Complementary training is an additional training method used in conjunction with traditional training to improve an athlete's performance. This method involves the use of additional exercises or techniques that are not usually inclu-

ded in an athlete's regular training routine with the aim of improving their overall performance (Urichianu, 2018). Complementary training can include various types of exercises, such as strength training, speed training, agility training, cardiovascular training, and flexibility training to develop athletes' skills and abilities holistically (Jovanović, 2020; Luís Marques et al., 2022; Romero-Caballero et al., 2020).

The aim of complementary training is to create a balanced and effective training programme that can improve athletes' performance in various physical and technical aspects (Romero-Caballero et al., 2020). In addition, complementary training may also involve exercises aimed at improving weaknesses or imbalances in the athlete's body, as well as exercises aimed at recovery and maintenance of the body to keep it in optimal condition (Luís Marques et al., 2022). In this study, complementary training will be applied to the maximum strength component and harness training. Harness training is a complementary exercise in strength training after maximum strength training treatment. The physiological impact of this training model is the acceleration of adaptation to more intensive muscle work..

Research conducted by Urichianu (2018) shows that the use of complementary training can improve the performance of rowing athletes. This highlights the importance of combining modern and complementary training methods to improve athlete performance. The novelty of this study lies in the implemantation of the complementary training method using harness training for female futsal players. Therefore, this study aims to examine the effects of complementary training on increasing anaerobic capacity and aerobic capacity in West Java Female Futsal Players in Preparation for the 21st National Sports Week.

METHODS

The method used in this study is the experimental method. The research design employed is a One-Group Pretest-Posttest Design (Yuwanto, 2019). In this design, tests are administered before and after the treatment to determine the effect of the intervention. The variables examined in this study include the strength training method (complementary training model) (X) and its effect on anaerobic and aerobic capacity (Y).

Table 1. One-Group Pretest-Posttest Design

O1	X	O2
Pretest	Treatment	Posttest

(O1): Pre-test of the experimental group
(X) : Treatment involving the application of strength training models using complementary training methods
(O2): Post-test of the experimental group

This research was conducted at the Faculty of Sport and Health Education of the Indonesia University of Education (UPI) Padasuka Campus, located on Padasuka Street, Cibeunying Kidul, Bandung City. The population of this study consisted of 16 female futsal players from the West Java Female Futsal Players in Preparation for the 21st National Sports Week. The sample in this study included all members of the population, meaning that the total sampling technique was employed. The selection was based on the consideration that all participants possessed adequate physical fitness and were capable and willing to participate in regular training sessions throughout the duration of the study.

In the initial stage of the implementation, the researcher conducted pre-tests and baseline measurements of anaerobic and aerobic capacities to determine the subjects' initial physical condition. The tests were administered after the participants completed a warm-up session and before engaging in any strenuous training activities. Following this, the subjects underwent a strength training intervention using the complementary training method for a total of 12 sessions. The training sessions were held three times per week, specifically on Mondays, Wednesdays, and Fridays. After completing the intervention, post-tests and final measurements were conducted to evaluate the improvements resulting from the training program. All data collection procedures were carried out in accordance with established testing protocols.

The research instruments used in this study consisted of test items designed to assess the athletes' performance based on two components: anaerobic capacity (power endurance) and aerobic capacity. The hurdle jump test was used to measure anaerobic capacity, while the bleep test was employed to assess aerobic capacity. Data analysis techniques using SPSS software.

RESULTS AND DISCUSSION

This study aimed to examine the effect of complementary training on increasing anaerobic capacity and aerobic capacity in West Java Female Futsal Players in Preparation for the 21st National Sports Week.

Table 2. Descriptive Statistics

	Test	N	Min	Max	Mean	Std. Dev
Anaerobic	Pre	16	78	144	112	21,664
	Post	16	83	150	116	22,479
Aerobic	Pre	16	30,2	45,2	40,3	4,237
	Post	16	35,7	48	42,2	3,382

Based on the **Table 2** descriptive statistics, after the implementation of the training program, there was an increase in the average scores between the pretest and posttest, with anaerobic capacity increasing from 112 to 116 repetitions and aerobic capacity increasing from 40,3 to 42,2 ml/kg/min.

A Shapiro-Wilk test indicated that both pretest ($p = 0,389$) and posttest ($p = 0,203$) anaerobic scores were normally distributed ($p > 0,05$), allowing the use of parametric tests for further analysis. A Shapiro–Wilk test indicated that both pretest ($p = 0,059$) and posttest ($p = 0,651$) aerobic scores were normally distributed ($p > 0,05$), allowing the use of parametric tests for further analysis. The results of the paired sample t-test showed a statistically significant increase in anaerobic capacity after the implementation of the training program, with a p-value of $0,000 < 0,05$. The results of the paired sample t-test showed a statistically significant increase in aerobic capacity after the implementation of the training program, with a p-value of $0,000 < 0,05$.

Based on the results of the statistical analysis, the implementation of complementary training had a significant effect on increasing both anaerobic capacity and aerobic capacity in West Java Female Futsal Players in Preparation for the 21st National Sports Week. This finding is supported by Urichianu (2018) and Jovanović (2020), who stated that combining modern training methods with complementary training is essential for enhancing athletic performance. The results of this study are also consistent with the findings of Petrescu et al. (2022), which demonstrated that complementary training has a highly significant effect on improving athletes' physical condition.

In futsal, the physical components of anaerobic and aerobic capacity are crucial, as players must be able to maintain consistent maximal strength repeatedly throughout the match (Rodriguez-Lorenzo et al., 2016). Complementary training serves as an effective training method to enhance both anaerobic and aerobic capacities, including strength, speed, agility, endurance, and flexibility (Luís Marques et al., 2022; Romero-Caballero et al., 2020). In addition to improving physical performance, complementary training can also provide positive effects in various aspects, such as expanding the range of motion, preventing injuries, reducing injury rates, and accelerating recovery (Lindblom et al., 2023; Pessali-Marques, 2021).

Complementary training must be implemented in accordance with the principle of individualization. The principle of individualization refers to the process of tailoring training programs, strategies, or interventions to meet the specific needs, characteristics, and goals of each athlete (Kozina et al., 2015). Training processes that incorporate modern technology should be carried out rationally while considering individual characteristics, age, and the morpho-functional profile of the athlete's body (Boichuk et al., 2018). In the physical and physiological profile of female futsal players, individualization involves adjusting training protocols, nutrition plans, recovery strategies, and performance assessments based on each player's unique attributes, such as body composition, aerobic capacity, anaerobic capacity, and individual technical skills in various aspects of futsal. This individualized approach can help maximize athletic potential, prevent injuries, and enhance the overall performance of the team during competition.

CONCLUSION

This study concludes that the implementation of complementary training can increase anaerobic capacity and aerobic capacity in West Java Female Futsal Players in Preparation for the 21st National Sports Week. Statistical analysis showed an increase in anaerobic capacity (from 112 to 116 repetitions) and aerobic capacity (from 40,3 to 42,2 ml/kg/min) with $p < 0,05$. These findings are consistent with previous studies emphasizing the effectiveness of combining modern training methods with complementary training to enhance athletic performance. Furthermore, the application of the principle of individualization in designing training programs is crucial for optimizing physical adaptation, preventing injuries, and enhancing overall team performance. Future research is recommended to explore further the application of complementary training in futsal, particularly in designing recovery-oriented training processes.

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