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The effect of groundstroke forehand exercise on enhancing cardiorespiratory endurance (VO2 MAX) in 12- to 14-year-old tennis athletes

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ABSTRACT

This study aimed at investigating groundstroke forehand exercise's effect on improving tennis athletes' cardiorespiratory endurance (VO2Max) for six weeks. This quasi-experiment research was carried out using a randomized pre-test and post-test group design. The population of this research was 35 tennis athletes aged 12-14 years old. Using purposive sampling, the sample in this study was 20 people, and the sample was taken based on 12-14-year-old tennis athletes who were technically good. The exercise was divided into seven models, namely forehand turn core, forehand turn cone back cone, forehand forward-direction, forehand hurdle jump, forehand sideways, forehand turn cone center service to baseline, forehand one-way service center to baseline. Those exercise models have earned a decent category for use in training. An instrument used for measuring cardiorespiratory endurance (VO2Max) was multistage (bleep test). The data analysis for this study comprised descriptive analysis, prerequisite tests such as normality and homogeneity checks, and the application of the sample paired t-test to test hypotheses. Based on the results, groundstroke forehand training can improve the cardiorespiratory (VO2Max) of tennis athletes aged 12-14 years old for six weeks ($p<0.05$) Thus, this research can be a basis for coaches and athletes to improve cardiorespiratory or VO2Max. Further research is expected that groundstroke forehand exercise can be combined with other techniques or used to analyze the ability of tennis athletes.

KEYWORDS

Groundstroke Forehand Exercise; Cardiorespiratory Endurance; Tennis Athletes

1. INTRODUCTION

In today's modern life, many people forget the importance of exercising in everyday life. Exercising is a healthy lifestyle that must be familiarized because it can make the body healthy. Exercising can inhibit the decline of endurance (Ashadi et al., 2020; Furkan et al., 2021). Achievements in sports are carried out through a process of coaching and development in a planned manner and continuously with the support of sports science and technology; the problem of increasing achievement in sports is a goal to be achieved in coaching and development in Indonesia will take a long time. Exercise is the most important factor in achieving optimal performance (Umami & Ratna, 2021). Exercising which starts at an early age must be carried out continuously until the peak of achievement in sport so that later players can achieve success (Maulidin et al., 2021).

Tennis is one of the sport types that is widely loved by sportsmen, young children, adolescents, adults, and even the elderly (Dayani et al., 2020; & Putro & Haryani, 2022). The principle of tennis is to hit the ball over the net and into the opponent's court. To complicate the opponent, there are several basic techniques, namely groundstrokes consisting of forehand and backhand, volley forehand and backhand, service, lob and smash (Raibowo et al., 2020; & Gatot & Daru, 2020). However, there are still some other techniques that are the development of these techniques in tennis. The basic principle of tennis defense is attacking the opponent. In tennis, four aspects of exercising need to be considered and trained carefully by tennis players, namely physical, technical, tactical and mental aspects. Those aspects are a unit that supports each other in tennis. Moreover, physical exercise is the most important to all sports, especially tennis (Mulya & Agustryani, 2020).

Improvement in achievement is supported by various factors such as physical condition, technique, tactics, mentality, coaches, facilities and infrastructure, player status, nutrition, and others (Putri et al., 2020; Alim, 2020). Tennis is a sport that relies on the power of explosive power, which is a maximum and sudden strong movement. Thus, the endurance, speed, and strength aspects are needed in this sport as well as the ability to maintain the condition of the body's stamina which is the main factor in this activity (Saleh & Nurkadri, 2020; Alberca et al., 2022). It is common for players to experience conditions that suddenly go down during the competition period. The condition of players at the stage of the competition is a state in which the element of the physical condition has a very small percentage in the training program.

The aforesaid description illustrates that physical, technical and tactical aspects are important in achieving maximum achievement. It is based on the technical and tactical abilities of a good player. Suppose his physical abilities do not support it. In that case, it is less likely to last long in a match because it will experience fatigue so that it will interfere with technical abilities. However, there is one more thing that plays a role, which is mental (Pineda-Hernández, 2022). If physically and technically disturbed, then any tactics applied by the coach will be useless and mentally unyielding will become weak, so that performance and achievement become less optimal. It means that the four aspects are a unit that determines each other in achieving maximum achievement.

However, the goal of tennis game is to get points through a series of blows that make the opponent unable to return the ball well or put off the opponent (Fitzpatrick et al., 2021). Each player is required to have excellent individual technique skills. Physical aspect is also sometimes a problem in fighting for achievement. In this sport, endurance, strength, and speed are necessary to maintain the condition of stamina of the body. It is common for players to experience conditions that suddenly go down during the competition period. Not only the physical aspect, which is fulfilled, and eating and rest patterns must also be considered.

The basic motor in a tennis court game is Endurance, Strength, Speed, Coordination & Flexibility (García, 2020; Vuong et al., 2022). Resilience (muscular system works) is the ability to work a muscle or group of muscles within a certain period. Resilience (energy system) is the ability of the body's organs to work within a certain time. Thus, endurance is the ability of the body's organs to fight fatigue during the activity (work). VO2max is the maximum ability of the cardio respiration system to meet oxygen consumption.

One of the parameters for determining endurance is calculating or measuring VO2 max. VO2 max is a representative of endurance, so it is very important to improve tennis players' VO2 max and endurance strength. Improving endurance abilities should be a systematic and continuous exercise. The exercises should follow the rules of endurance training to improve VO2 max (Ramadani et al., 2021; Parengkuan, 2021). However, the selection of exercising methods should be in accordance with the characteristics of the sport and the players because each branch has different durability needs. In addition, the exercises performed have more varied forms so that the player or players are not saturated and bored undergoing the training process. It is because most players, especially young players, still tend to be unstable and inconsistent in undergoing physical training, especially endurance.

Basic technique exercises in improving the endurance or VO2 max is groundstroke forehand (Jatra et al., 2020). Based on the problems, data, and facts described above, it is necessary to make an update in training the physical condition of the player, especially the ability to endure. The breakthrough that the author does is expected to answer all the problems that have been described. The exercise used is the basic technique of groundstroke forehand, which will give strength to the player's endurance.

Based on the results of the researchers' observations from the students who were sampled, the groundstroke forehand was good enough. The groundstroke forehand technique is a very dominant technique used during the tennis game (Al-ribeye & Hussein, 2022). It is further said that 47% of the punching techniques performed during a tennis game are groundstroke forehand. Because of the many forehand groundstroke punches carried out in matches/exercises, players must master and have the consistency in forehand groundstroke punches (Al-ribeye & Hussein, 2022). The importance of groundstroke forehand technique does not eliminate physical conditions such as endurance to get good performance.

Through this study, it is expected to know how the endurance level will be by providing basic ground stroke forehand technique exercises. In addition, there have never conducted research on athletes in order to determine their cardiorespiratory endurance by providing groundstroke forehand exercises. Thus, the researchers were interested in conducting a study on the effect of tennis court forehand groundstroke exercise on improving cardiorespiratory endurance of tennis court athletes aged 12-14 years old. The study will also describe modifications to groundstroke forehand exercises in order to introduce novelty into the research.

2. METHODS

2.1. Participants

This study used a quasi-experiment design and is carried out using a randomized pre-post-test group design. The study population was 35 tennis athletes aged 12-14 years old. Using purposive sampling, the sample in this study was 20 people, and the sample was taken based on tennis athletes aged 12-14 years who were technically good.

2.2. Basic forehand exercising models

This study introduced seven fundamental forehand exercise models specifically designed for tennis courts. The research employed a multistage (bleep test) as its primary instrument to assess

cardiorespiratory capacity or VO2 max levels. Below is the outline of a 6-week groundstroke forehand exercise program (Table 1).

Table 1. Groundstroke Forehand Exercising Program

Week	Meeting	Intensity	Set	Repetition	Interval of Training model	Recovery of Training Model	Break
1 - 2	1 - 6	40%	3	8	1.5 minute	1 - 2 minute	5 minute
3 - 4	7 - 12	50%	3	10	1.5 minute	1 - 2 minute	5 minute
5 - 6	12 - 18	60%	3	12	1.5 minute	1 - 2 minute	5 minute

Now we present the development of seven basic exercising models that have received validation. Validation is carried out by experts who have qualified lecturers in the tennis court field, as many as three lecturers and eight nationally licensed tennis court coaches.

First Exercise: Forehand Turn Core

Procedure: The tennis player spins a new cone, after which the ball is hit with a pass from the feeder (Figure 1).

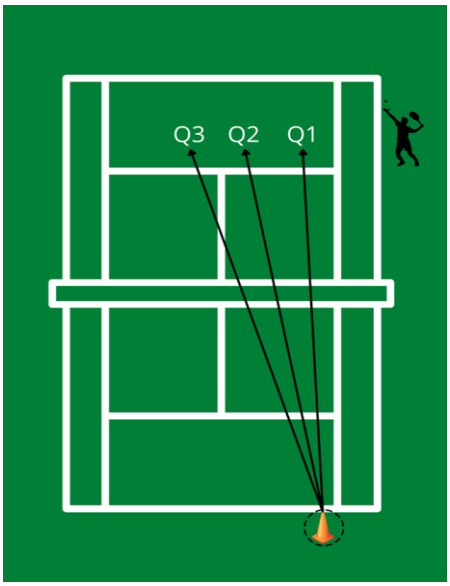


Figure 1. Forehand Turn Core

Second Exercise: Forehand Turn Cone Back Cone

Procedure: The tennis player first shifts and turns the cone, after which the ball is hit back with a pass from the feeder (Figure 2).

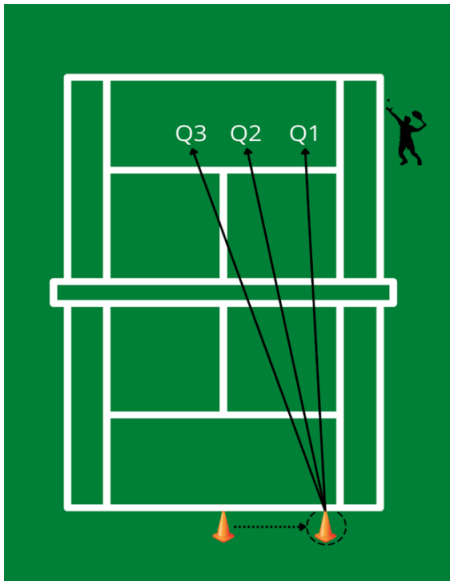


Figure 2. Forehand Turn Cone Back Cone

Third Exercise: Forehand Forward-Direction

Procedure: Run from cone 1 to cone 2 and cone 3, then hit the ball with a pass from the feeder (Table 3).

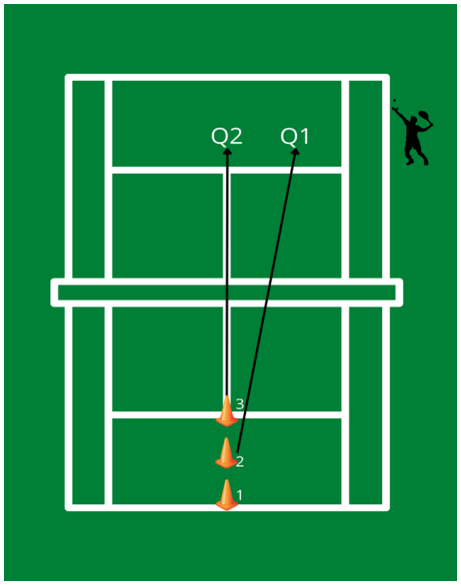


Figure 3. Forehand Forward-Direction

Fourth Exercise: Forehand Hurdle Jump

Procedure: Starting from the goal jump while running until the cone hits the ball with a pass from the feeder (Figure 4).

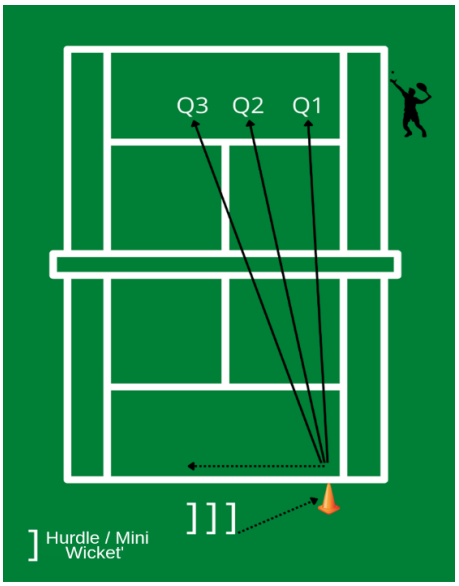


Figure 4. Forehand Hurdle Jump

Fifth Exercise: Forehand Sideways

Procedure: Start from Cone 1, run sideways to Cone 2 and sideways to Cone 1, after that hit the ball that the feeder has fed, then run sideways to Cone 3; after arriving at Cone 3, run sideways to Cone 2 and hit the ball from the feeder bait, back to cone 3 then go to the initial cone that is behind cone 2 (Figure 5).

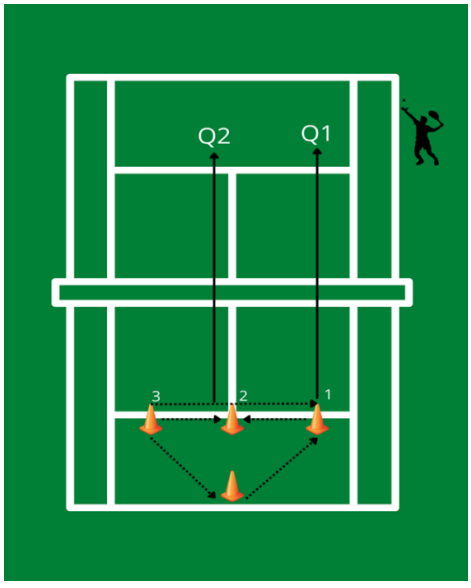


Figure 5. Forehand Sideways

Sixth Exercise: Forehand Turn Cone Center Service to Baseline

Procedure: Start from cone 1. Play. After that, hit the ball that the feeder has fed, then run to the initial cone, then run to cone 2, hit the ball that the feeder has fed, return to the initial cone and run to cone 3 hit the ball that the feeder has fed, then return to the initial cone (Figure 6).

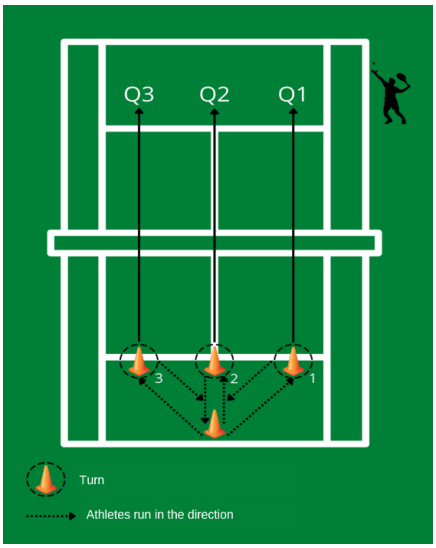


Figure 6. Forehand Turn Cone Center Service to Baseline

Seventh Exercise: Forehand One-way service center to baseline

Procedure: Start from cone 1 at the centre center line, then to Cone 2, cone 3 and cone 4 on the baseline line, Hit the ball fed by the feeder, then run to the initial cone (Figure 7).

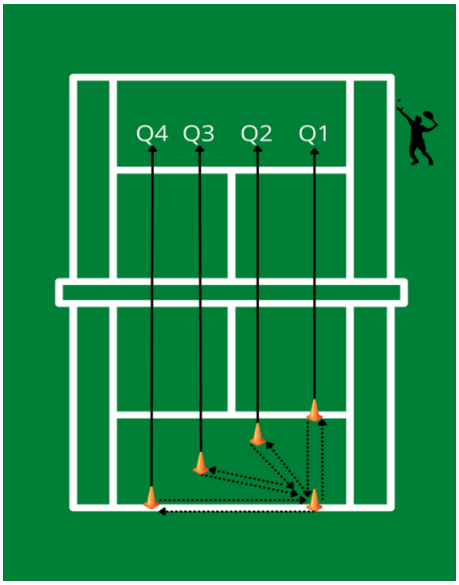


Figure 7. Forehand One-way service center to baseline

Before the seven exercising models were carried out on athletes, the model was validated using Aiken; below is the Aiken formula (Aiken, 1985):

$$\text{V Aiken: } \frac{\sum S}{n\,(c-1)}$$

S : r – lo
Lo : lowest rating score (eg 1)
C : highest rating score (eg 4)
r : the score given by the assessor

In this validation, there are aspects in developing the groundstroke forehand training model. The forehand tennis punch definition aspect obtained a value of 0.875; the material aspect obtained a value of 0.830, and the procedural clarity aspect of the implementation obtained a value of 0.857. It can be concluded that the exercise model is feasible to use to increase respiratory cardio/ VO2 Max for players aged 12 – 14 years old.

2.3. Statistical Analysis

For statistical analysis, the researcher used the SPSS (version 26). The data analysis for this study comprises descriptive analysis, prerequisite tests such as normality and homogeneity checks, and the application of the sample paired t-test to test hypotheses.

3. RESULTS

We initiate this section by presenting the statistical analysis of the pre- and post-test results of the study variables (Table 2). The data measurement was carried out using a Multistage test (bleep test) on the VO2 Max ability of the respondents that had been determined. Based on the test results, the average count = 26.36, standard deviation = 1.56, minimum score = 23.60 and maximum = 29.50, sample = 20 people (Table 2).

Table 2. Statistical data of pre- and post-test

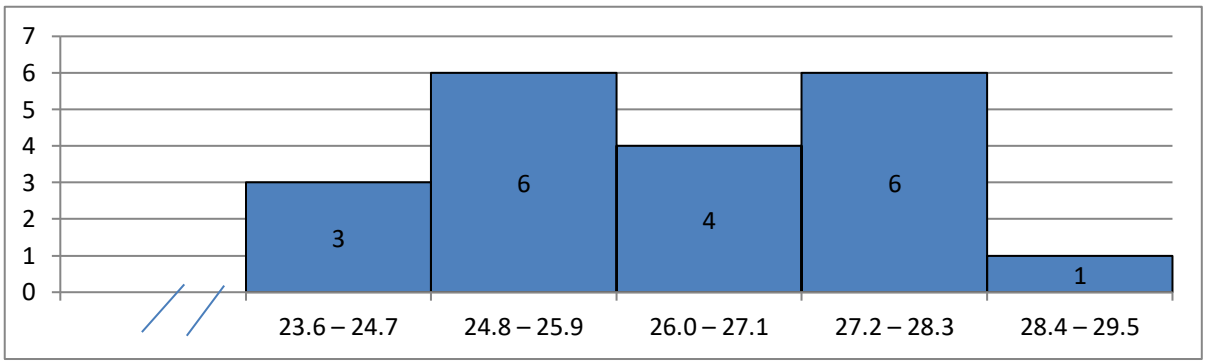
Variable		***N***	$\overline{X}$	***Std.dev***	***Min***	***Max***
Groundstroke forehand	Before	20	26.36	1.56	23.60	29.50
Exercising Group	After	20	28.99	1.40	26.20	31.00

Table 3 shows the results of multistage test (pre-test)

Table 3. Results of Pre-test Multistage Test

No	Interval Class	Absolute Frequency	Relative Frequency (%)	Category
1	23.6 – 24.7	3	15	Very Poor
2	24.8 – 25.9	6	30	Poor
3	26.0 – 27.1	4	20	Fair
4	27.2 – 28.3	6	30	Good
5	28.4 – 29.5	1	5	Very Good
	Total	20	100	

In table 3, out of 20 students, 3 players (15%) have a value category of 23.6-24.7, 6 players (30%) have a value category of 24.8-25.9, 4 players (20%) have a value category of 26.0-27.1 and 6 players (30%) have a value category of 27.2-28.3, and 1 player (5%) has a value category of 28.4-29.5. More details can be seen in the following graph (Graph 1).



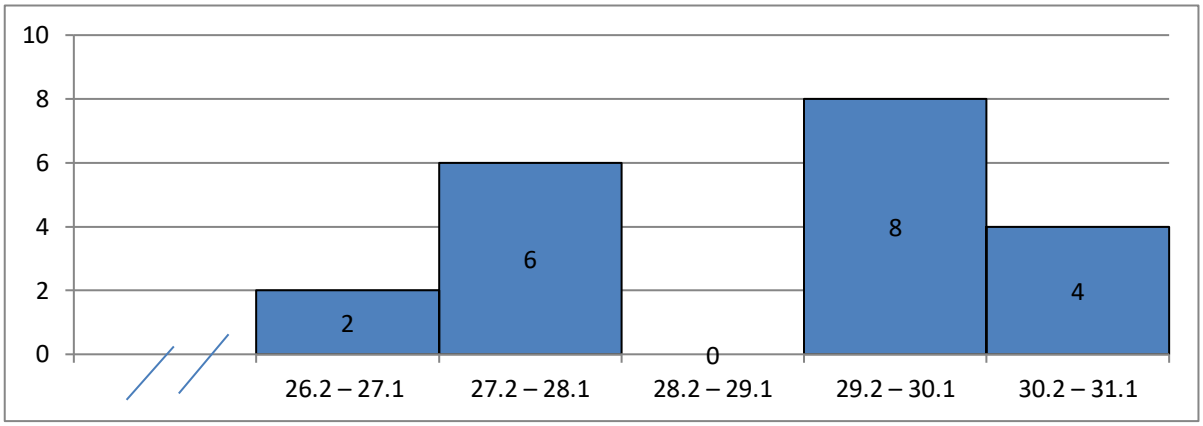
Graph 1. Pre-test Data Frequency of Groundstroke Forehand Exercise Group

Table 4 shows the results of the multistage test (post-test). From the results of data measurements, the average count = 28.99, standard deviation = 1.40, minimum score = 26.20 and maximum = 31.00, sample = 20 people (Table 4).

Table 4. Results of the multistage test (post-test)

No	Interval Class	Absolute Frequency	Relative Frequency (%)	Category
1	26.2 – 27.1	2	10	Very Poor
2	27.2 – 28.1	6	30	Poor
3	28.2 – 29.1	-	-	Fair
4	29.2 – 30.1	8	40	Good
5	30.2 – 31.1	4	20	Very Good
	Total	20	100	

From table 4 data, it can be concluded that out of 20 players, 2 players (10%) have a value category of 26.2-27.1, 6 players (30%) have a value category of 27.2-28.1, no player has a value category of 28.2-29.1 and 8 players (40%) have a value category of 29.2-30.1, and 4 players (20%) have a value category of 30.2-31.1. More details can be seen in the following graph (Graph 2):



Graph 2. Post-test Data Frequency of Groundstroke Forehand Exercise Group

In the subsequent section, we present the data's normality test conducted using the Shapiro-Wilk test. The data is considered normal if the significance value (Sig) is greater than 0.05. According to the results derived from the Shapiro-Wilk test, both the pre-test and post-test data in this study exhibit normal distributions (Table 5).

Table 5. Normality Test Results of Groundstroke Forehand

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre Test	0.111	20	0.200	0.980	20	0.932
Post Test	0.171	20	0.129	0.942	20	0.267
a. Lilliefors Significance Correction						

Regarding the data homogeneity test, the Levene test was employed. Homogeneity in data is affirmed if the significance value (Sig) exceeds 0.05. As per the outcomes obtained from the Levene test, both the pre-test and post-test data in this study demonstrate homogeneity (Table 6).

Table 6. Homogeneity Test Results

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Cardio respiratory	Based on Mean	0.263	1	38	0.611
	Based on Median	0.477	1	38	0.494

/ VO2 max result	Based on Median and with adjusted df	0.477	1	37.647	0.494
	Based on trimmed mean	0.291	1	38	0.592

We conducted a t-test to determine whether there is a significant difference between the two initial variables, namely the pre-test and the final variable (post-test), in order to assess the impact of the treatment on each variable. In the T-test, a significance value (2-tailed) of 0.000, which is less than 0.05, indicates a substantial difference between the two initial variables. This suggests a significant impact of the treatment administered to each variable. Therefore, the effect of groundstroke forehand training in enhancing endurance is affirmed and accepted based on these findings (Table 7)

Table 7. The differences between pre-and post-test results

Paired Sample Test									
		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	SD	Std. Error Mean	Lower	Upper	t	df	p
Pair 1	Pre Test - Post Test	-26,100	17,109	3,826	-34,107	-18,093	-6,822	19	.000

4. DISCUSSION

Cardiorespiratory ability or VO2 max is a component of physical condition that tennis athletes need. This ability can only be obtained from a programmed and measured exercise (Yulianto et al., 2021). Endurance training using the basic technique of forehand will provide an update in the endurance training of athletes. By training using basic techniques, athletes can feel like in the atmosphere of the actual match because players not only run but also carry out actions with the ball. In addition, training with basic techniques allows athletes to increase motivation in the training process, because training with the ball provides varied forms of exercise so that the players do not feel bored (Simozima et al., 2021; Fuentes-García et al., 2021; Harazin et al., 2022). The impact is certainly on the players themselves which is an improvement in their VO2 Max and durability. The good VO 2Max ability possessed by players is a must because tennis is a sport with a very long duration, especially those who use the Best of Five system.

This exercising model can be applied at any stage in the training period. Coaches can use this model in improving or maintaining the VO2 max of their athletes. In improving VO2 Max, the

application of this model can be done at a special preparation stage, where in this phase, the improvement of physical conditions is specific. In keeping VO2 Max stable, as in the pre-match period, coaches can also apply this model. At this time, the player only keeps the physical and technical condition to remain in his best performance. Thus, this model is very appropriate to use because it can keep both components in one training session. In addition, court tennis matches definitely take place with high intensity. The transition in the game is so fast, to the right, left, forward and backwards. Therefore, a good VO2 Max will help players to keep fighting during the game, effective and efficient in the application of techniques, as well as being able to apply the tactics applied by the coach well (Xiao et al., 2022; Deng et al., 2022). In addition, a good VO2 Max will help players to recover faster.

Based on the pre-test and post-test results, groundstroke forehand exercise effectively increases cardiorespiratory or VO2 max for six weeks. Of course, by modifying the training exercise according to the characteristics of tennis matches for the age group of 12-14 years old and the athletes' physical condition. The modification focuses on the basic tennis forehand, which is then modified into seven variations of exercise variations. With the training model and data on the pre-test and post-test results using a multistage test (bleep test), the coach or athlete can use it during training. Then in the exercise, there are also elements such as agility, where the athlete will shift to the right or left and step forward or backward. The coach, who is positioned as a feeder, can also adjust the direction or speed of the ball so that athletes can receive training in the form of reactions. Thus, it can be said that groundstroke forehand training in this study can be used to train the athletes' ability in exercising and become the basis of subsequent research.

5. CONCLUSIONS

Based on the results, groundstroke forehand training can increase the cardiorespiratory (VO2 Max) of tennis athletes aged 12-14 years old for six weeks. The exercise is divided into seven training models, namely forehand turn core, forehand turn cone back cone, forehand forward-direction, forehand hurdle jump, forehand sideways, forehand turn cone center service to baseline, forehand one-way service center to baseline. Those seven training models have been validated for use as training for 12 – 14-year-old athletes. This research can be a basis for coaches and athletes to improve cardiorespiratory or VO2 max. Further research is expected to modify the exercise by combining groundstroke forehand exercise with other techniques or use it to analyze the tennis athletes' ability.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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