Effects of HIIT Model Progressive Sprint-Release and TUJA Shuttle Run in increasing aerobic capacity, anaerobic capacity, and speed: a comparative study in female volleyball athletes

Efectos del modelo HIIT Progressive Sprint-Release y TUJA Shuttle Run en el aumento de la capacidad aeróbica, la capacidad anaeróbica y la velocidad: un estudio comparativo en atletas femeninas de voleibol

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Abstract

Introduction: The HIIT training model has many variations and these variations are known to have a positive effect on physical improvement.
Objective: the purpose of this study was to reveal the differences between two different HIIT models, namely Progressive Sprint-Release (PSR) and TUJA Shuttle Run (TUJA) in increasing aerobic capacity, anaerobic capacity, and speed.
Methodology: The research design used was a quasi-experimental comparative study. The participants were 12 people who were divided into two groups, 6 people in the PSR group and 6 people in the TUJA group. The instruments used included MFT to measure aerobic capacity, a 300-meter sprint to measure anaerobic capacity, and a 20-meter sprint. Descriptive statistics, paired sample t-test, and Mann-Whitney test were used as data analysis techniques with the help of Microsoft Office Excel 2016 and SPSS version 25 applications.
Results: The results of the paired sample t-test showed that the PSR group and TUJA group were equally able to increase aerobic capacity ($p < 0.05$), anaerobic capacity ($p < 0.05$), and speed ($p < 0.05$). However, from the results of the Mann-Whitney U test, it is known that aerobic capacity and speed have significant differences ($p < 0.05$), while not in the anaerobic capacity variable ($p > 0.05$).
Discussion: The results of this study support the previous studies. HIIT PSR and TUJA models have a positive effect.
Conclusions: The two new HIIT models, namely PSR and TUJA, can increase aerobic capacity, anaerobic capacity, and speed. Then, PSR and TUJA have significant differences in increasing aerobic capacity and speed, while in the anaerobic capacity variable, there is no significant difference.

Keywords

Aerobic capacity; anaerobic capacity; HIIT; progressive sprint-release; speed; TUJA shuttle run.

Resumen

Introducción: El modelo de entrenamiento HIIT tiene muchas variaciones y se sabe que estas variaciones tienen un efecto positivo en la mejora física.
Objetivo: El propósito de este estudio fue revelar las diferencias entre dos modelos diferentes de HIIT, a saber, Progressive Sprint-Release (PSR) y TUJA Shuttle Run (TUJA) en el aumento de la capacidad aeróbica, la capacidad anaeróbica y la velocidad.
Metodología: El diseño de investigación utilizado fue un estudio comparativo cuasiexperimental. Los participantes fueron 12 personas que se dividieron en dos grupos, 6 personas en el grupo PSR y 6 personas en el grupo TUJA. Los instrumentos utilizados incluyeron MFT para medir la capacidad aeróbica, un sprint de 300 metros para medir la capacidad anaeróbica y un sprint de 20 metros. Se utilizaron estadísticas descriptivas, prueba t de muestra pareada y prueba de U de Mann-Whitney como técnicas de análisis de datos con la ayuda de las aplicaciones Microsoft Office Excel 2016 y SPSS versión 25.
Resultados: Los resultados de la prueba t de muestras pareadas mostraron que el grupo PSR y el grupo TUJA fueron igualmente capaces de aumen-tar la capacidad aeróbica ($p < 0,05$), la capacidad anaeróbica ($p < 0,05$) y la velocidad ($p < 0,05$). Sin embargo, a partir de los resulta-dos de la prueba de Mann-Whitney, se sabe que la capacidad aeróbica y la velocidad tienen diferencias significativas ($p < 0,05$), mientras que no en la variable de capacidad anaeróbica ($p > 0,05$).
Discusión: Los resultados de este estudio respaldan los estudios anteriores. Los modelos HIIT PSR y TUJA tienen un efecto positivo.
Conclusiones: Este estudio concluye que dos nuevos modelos de HIIT, a saber, PSR y TUJA, pueden aumentar la capacidad aeróbica, la capacidad anaeróbica y la velocidad. Entonces, PSR y TUJA tienen diferencias significativas en el aumento de la capacidad aeróbica y la velocidad, mientras que, en la variable de capacidad anaeróbica, no hay diferencia significativa.

Palabras clave

Capacidad aeróbica; capacidad anaeróbica; HIIT; sprint-release progresivo; velocidad; TUJA shuttle-run.

Introduction

As one of the popular team sports, volleyball has been played in almost all countries in the world (Carvalho et al., 2020). More than 200 countries have participated in volleyball and become members of the Federation Internationale de VolleyBall (FIVB) (FIVB, 2024; Olympics, 2024), and has even been played by more than 500 million people worldwide (Puga & Dias, 2020). Volleyball has the characteristics of intermittent play, short and explosive movement patterns, fast and agile position changes, to jumping for smashes and blocks (Joksimovic et al., 2023). This sport is known as a high-intensity sport and various movements performed require explosive movements such as jumping, serving, acceleration, deceleration, smashing or ball-striking, and landing (Alcaraz et al., 2017; Matłosz et al., 2023). Thus, volleyball is a sport that requires high aerobic and anaerobic capacity (Charitonidis et al., 2019; Langaroudi et al., 2021) and good speed (Fellingham et al., 2013; Šimonek et al., 2017).

To achieve the goal of becoming a champion, athletes need to practice improving their physical, technical, tactical, and mental abilities (Xiao et al., 2021). The physical aspect is a basic thing that is very much needed by athletes because if athletes have a good physical condition, it increases the possibility of athletes to achieve the highest performance (Patah et al., 2021; Siramaneerat & Chaowilai, 2022). To meet the needs of physical components that follow the characteristics of volleyball, it is necessary to do specific physical training. HIIT is one of the training models that can be implemented by coaches for their athletes.

HIIT known as High-Intensity Interval Training is an explosive movements and short heavy activity, performed periodically (usually involving 85%-95% of peak heart rate or <100% [70%-90%] VO2peak) interspersed with periods of active rest (Gibala et al., 2012; Ito, 2019). Many studies have proven that HIIT is very beneficial in significantly improving the performance of athletes (Liu et al., 2024). Including increasing anaerobic capacity (Monks et al., 2017), aerobic capacity (Kumari et al., 2023; Vasconcelos et al., 2020), and speed (Engel et al., 2018; Ojeda-Aravena et al., 2015) which are very much needed for volleyball athletes.

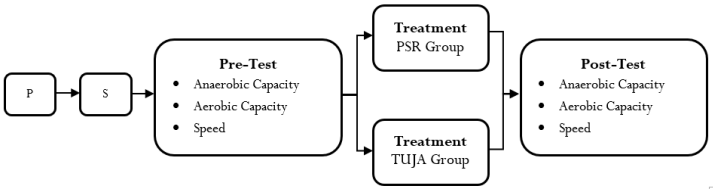
This study will compare two of the latest HIIT models, namely Progressive Sprint-Release (PSR) and TUJA Shuttle Run (TUJA). The results of previous research, the HIIT model Progressive Sprint-Release (PSR) can significantly increase speed, aerobic capacity, and anaerobic capacity (Jatmiko at al., 2024). On the other hand, the research results also show that the HIIT model TUJA Shuttle Run (TUJA) has a significant positive effect in increasing speed, agility, and anaerobic capacity (Jatmiko et al., 2023). However, the two latest HIIT models have never been carried out on female volleyball athlete participants. Thus, this study aims to determine the differences between the two latest HIIT models, namely Progressive Sprint-Release (PSR) and TUJA Shuttle Run (TUJA) in increasing aerobic capacity, anaerobic capacity, and speed in female volleyball athletes.

Method

Study Design

This study is a quasi-experimental study with a comparative study design. This was done to see the differences between the two HIIT models in increasing aerobic capacity, anaerobic capacity, and speed. The two HIIT training models in question are Progressive Sprint-Release (PSR) and TUJA Shuttle Run (TUJA). Below is a picture of the research design carried out:

Figure 1. Research Design



Description: P= Population & S=Sample

Participants

The research participants used were female volleyball athletes from the Kediri Regency Porprov team with a total of 12 people. The sampling technique to determine the research participants was purposive sampling with the criteria of female athletes aged 18-25 years, healthy, not injured, and actively training routinely 3 times per week. The 12 athletes who were the research subjects were divided into two groups randomly so that each group had 6 subjects. Six subjects were in the PSR group and the other six were in the TUJA group.

Instrument and Data collection

There are three instruments used, including the 300-meter sprint, MFT, and 20-meter sprint. The 300-meter sprint is used to measure anaerobic capacity (Thornton et al., 2023), the MFT is used to measure aerobic capacity (Paradisis et al., 2014), and the 20-meter sprint is used to measure speed (Haugen et al., 2012; Yanci et al., 2016). Aerobic capacity, anaerobic capacity, and speed data were taken twice from the pre-test and post-test results. The pre-test was conducted before the implementation of the training treatment and the post-test data was taken after the participants completed the training treatment of 18 meetings.

Treatment Procedure

After the pre-test, athletes underwent training treatment according to their group for 6 weeks with a frequency of 3 times a week. Subjects in the PSR group performed HIIT exercise activities using the Progressive Sprint-Release model (Jatmiko et al., 2024), while the TUJA group performed HIIT exercise activities using the TUJA Shuttle Run model (Jatmiko et al., 2023). Each group was given training activities with a load of 4 sets of 6 repetitions with a ratio of activity and rest (t work: t rest) of 1: 3. The duration of the exercise consisted of 10 minutes of warm-up, 40-60 minutes of core activity, and 10 minutes of cooling down. The exercise intensity used was in the high-intensity zone (85%-100% of HR max) which was monitored using a polar heart rate monitor type H10 (Schaffarczyk et al., 2022; Speer et al., 2020). After undergoing treatment at the 18th meeting, the subjects took a post-test.

Statistical Analysis

This study uses descriptive statistical data analysis techniques, paired sample t-test, and Mann-Whitney U test. The level of significance used in this study is 0.05. The process of data analysis techniques uses the help of Microsoft Excel 2016 and SPSS version 25 applications.

Ethics

This research protocol has been declared ethically appropriate by the Central Research Ethics Commission of Universitas Negeri Surabaya with ethics number 008/UN38.III.1/DL.01.012/2024 because it is in accordance with the seven WHO 2011 standards referring to the 2016 CIOMS Guidelines.

Results

The results of this study present descriptive statistical test data related to the characteristics of research participants and descriptive statistics from the pre-test and post-test on the variables of aerobic capacity, anaerobic capacity, and speed. The results of the descriptive statistical test can be seen in table 1 below.

Table 1. Results of descriptive statistics on participant characteristics and dependent variables

Variable	Mean ± SD	
	Average DT	Average DT
Participant:		
➢ Age (years)	20.00 ± 1.41	20.17 ± 1.47
➢ Height (cm)	160.50 ± 4.32	167.17 ± 3.43
➢ Weight (kg)	58.67 ± 4.41	61.50 ± 3.76
➢ BMI (kg/m²)	22.74 ± 0.70	22.01 ± 1.11
Physical capacity as dependent variables:		
➢ Aerobic Capacity (ml/kg/min)		
• Pre-test	40.83 ± 5.39	36.23 ± 7.54
• Post-test	42.22 ± 5.74	41.18 ± 4.50
➢ Anaerobic Capacity (seconds)		

• Pre-test	66.00 ± 6.42	71.83 ± 8.42
• Post-test	55.83 ± 6.37	63.33 ± 8.94
➢ Speed (seconds)		
• Pre-test	3.58 ± 0.13	3.71 ± 0.15
• Post-test	3.52 ± 0.12	3.43 ± 0.11

Note: SD = Standard Deviation

Data collection on three dependent variables including aerobic capacity, anaerobic capacity, and speed was carried out twice, before carrying out the exercise treatment and after carrying out the treatment. Below, a table containing the results of the paired sample t-test and the Mann-Whitney test is presented.

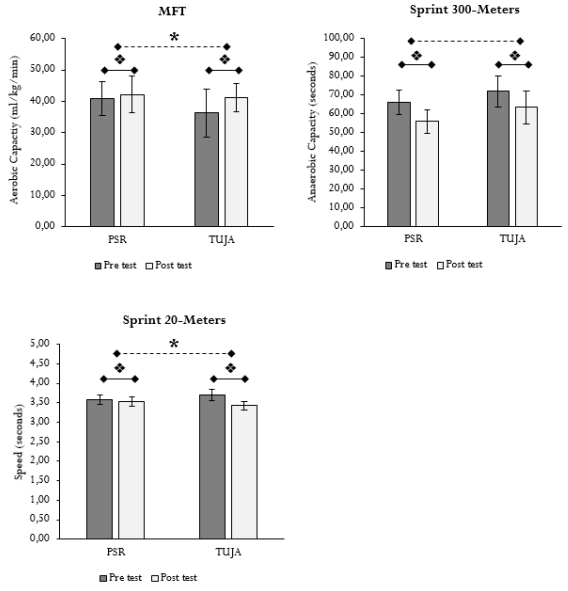
Table 2. Table Title

Variable	Group	p-value	
		Paired sample t-test	Mann-Whitney U test
Aerobic Capacity	PSR	0.007❖	0.013*
	TUJA	0.028❖	
Anaerobic Capacity	PSR	0.000❖	0.102
	TUJA	0.000❖	
Speed	PSR	0.009❖	0.004
	TUJA	0.001❖	

❖: there is a significant difference between pre-test and post-test with p-value <0.05;
*: there is a significant difference between PSR and TUJA groups with p-value <0.05

Below is a graphical image of the changes that occurred in the PSR group and the TUJA group between the pre-test and post-test in three variables, namely aerobic capacity, anaerobic capacity, and speed.

Figure 2. Graph of pre-test and post-test changes between the PSR and TUJA groups in aerobic capacity, anaerobic capacity, and speed variables.



Note: ❖: there is a signifi-cant difference between the pre-test and post-test with p-value <0.05; *: there is a significant difference between the PSR and TUJA groups with p-value <0.05

Discussion

The results of this study found that the PSR and TUJA groups could increase aerobic capacity, anaerobic capacity, and speed. This is evidenced by the results of the paired sample t-test in both groups in the three variables with a p-value <0.05. The difference between the PSR and TUJA groups in increasing aerobic capacity, anaerobic capacity, and speed can be seen from the results of the Mann-Whitney test. From the results of the Mann-Whitney test, there was a significant difference between the PSR and TUJA groups in increasing aerobic capacity and speed (p <0.05). The TUJA group was better than the PSR

group in increasing aerobic capacity and speed. On the other hand, there was no significant difference in increasing anaerobic capacity (p>0.05). The value being compared is the difference between the pre-test and post-test scores of each group. So it doesn't matter even if there is only a slight difference in the pre-test score in a group, if a group has a greater difference value, it means that the group is better than other groups. In addition, in this study it is assumed that the research participants have the same level, because they are athletes in the same team from Kediri Regency who will represent their hometown in the East Java Porprov multi-event.

Movement activities carried out in volleyball require high physical capacity, because athletes need to make explosive movements such as shifting, running, jumping, and landing, and do these movements repeatedly (Baugh et al., 2018; Haupenthal et al., 2023; Pastor et al., 2015). Therefore, in the volleyball team sport game known as an intermittent type sport, athletes will feel changes in low and high-intensity periods, including female athletes (Aschendorf et al., 2019; Taylor et al., 2016; Wright et al., 2016). With the HIIT program, it has been proven to support special requirements in team sports (Martins et al., 2016), because HIIT is the right strategy used by coaches to save time in developing athlete performance as an important prerequisite for success in team sports (Kunz et al., 2019). The HIIT training process must still be well planned because structured, organized, and programmed physical training needs to be carried out so that athletes can have good physical capacity (Handayani et al., 2024).

The results of this study are in accordance with initial research conducted by Jatmiko et al. (2024), where the Progressive Sprint-Release HIIT model can improve speed, aerobic capacity, and anaerobic capacity in female rugby athletes. Another study by Jatmiko et al. (2023) on the TUJA Shuttle Run HIIT model can be implemented in handball athletes to improve speed, agility, and anaerobic capacity. The results of other studies also prove that there is a significant effect of the TUJA Shuttle Run HIIT model in increasing the vo2max of young athletes aged 14-17 years (Jatmiko, Kusnanik, Nurhasan, et al., 2024). This is reinforced by other studies that show the positive effects of HIIT treatment on team sports athletes, including female athletes (Aschendorf et al., 2019; Kumari et al., 2023; Kunz et al., 2019).

The results of a literature review study related to the effects of HIIT on young athletes have proven that there is a significant effect on increasing important physical components related to aerobic and anaerobic performance (Engel et al., 2018). HIIT is known to involve both energy systems in the body, both aerobic and anaerobic, thus increasing the possibility for athletes to increase their speed and power (Panissa et al., 2021). A significant increase in VO2max occurs when doing HIIT because when doing HIIT activities there is optimal oxygen utilization, so an increase in VO2max indicates better aerobic endurance or capacity and allows an individual to train in the submaximal zone continuously for a long duration (Aparecido da Silva et al., 2022). In addition to having a positive effect on increasing anaerobic capacity, HIIT can also help athletes develop energy systems and muscle adaptations that are tailored to the needs of each type of sport (Zhu et al., 2023).

This study has limitations in the number of participants which is still minimal. In addition, the participants in this study were only female volleyball athletes who will represent Kediri Regency in the East Java Provincial Sports Week (PORPROV) event, in Indonesia. Despite the shortcomings and limitations mentioned above, the results of this study have an impact on increasing the physical capacity of the research participants, especially in terms of anaerobic capacity, aerobic capacity, and speed. Therefore, recommendations for future research need to increase the number of research participants so that the results of this study can be generalized to athletes as a whole. In addition, research needs to be conducted on male participants and athletes from other types of sports, both team sports and individual sports. Future research also needs to prove the effects of HIIT Progressive Sprint-Release and TUJA Shuttle Run models on other physical components (power, agility, etc.), and the psychological changes experienced by athletes.

Conclusions

The conclusion obtained from this study is that HIIT training with the Progressive Sprint-Release model and TUJA Shuttle Run can increase aerobic capacity, anaerobic capacity, and speed. However, the two groups did not show significant differences in increasing anaerobic capacity. The results of this study

can be a reference for coaches to implement training programs so that athletes can increase aerobic capacity, anaerobic capacity, and speed effectively.

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