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The effect of small sided games with the principles of interval, pyramid, mix on increasing VO2max and teamwork of football players

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Abstract
Athlete performance will always be side by side with physical condition because football is included in the complex achievement sport in its game which does not only rely on technical and tactical abilities but must be supported by a fit physical condition, therefore physical condition is a necessity in improving an athlete's performance, it can even be considered a basic need that cannot be postponed or negotiated. Football itself is a team game, where in the game it cannot be played alone and do not let egoism or individual play become a character. The purpose of this study was to determine the comparison of the effect of differences in increasing VO2Max and Teamwork by applying the principles of endurance training such as intervals and pyramids, as well as the principle of combining the two principles called mix. This research was conducted at the Persib U-18 Academy in 2024. The method used in this study was the experimental method with the design in this study, namely Pre Experimental Design with a pattern (pre-test, post-test design), and the sampling technique was carried out using the Random assignment technique. Based on the data, there is an increase in VO2Max with the mix group being superior compared to the interval and pyramid groups in the VO2Max variable, but there is no significant difference between the interval and pyramid groups. While for the Teamwork variable, there is an increase in each group but there is no significant difference between each group.
Keywords: football, small sided game, aerobic, VO2Max, teamwork.

INTRODUCTION

Panjang The structure of the game of football has changed dramatically over the last few decades towards a more dynamic and faster style of play. Compared to previous years, modern football is characterized by shorter contact times, increased passing rates, higher player density, and faster transitions and increased speed of play, as evidenced by a 15% and 35% increase in ball speed and passing speed, respectively (Wallace & Norton, 2015). This has led to increased game intensity, requiring good aerobic and anaerobic endurance. Therefore, it is known that football competitions emphasize both aerobic and anaerobic metabolism while demanding high-intensity activity (Selmi et al., 2020). Therefore, in football, physical fitness is highly dependent on aerobic capacity, as is well documented. During a match, professional football players cover a distance of 10–13 km with approximately 1400 activity changes, i.e. a change of activity every 4 seconds (Hostrup & Bangsbo, 2023). Furthermore, although high-intensity demands are essential during a soccer match, the aerobic energy system has been shown to dominate during low-to-moderate running demands. Thus, aerobic capacity increases the distance covered during the match, the number of sprints, and interaction with the ball.

In a normal soccer game, during the 90 minutes of normal time as the official time recognized by the laws of soccer, body functions require a high level of VO2 max in each player because ultimately winning this one game can be achieved if the player has sufficient VO2 max (Modric et al., 2020). In a

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broad sense, VO2 max is an indicator used to measure the level of health, sports performance, monitor, and measure the level of success of a given aerobic exercise (Gao et al., 2021).In addition, soccer itself is a game that cannot be played alone and should not be played egoism or individualism becomes a character. As a team game, soccer players are required to play their roles either as defenders, midfielders, or strikers so that cooperation is established well. Without cooperation between members, the soccer game will not achieve victory. The game of football means that it is absolutely necessary to have teamwork in a game, because football is played in teams and collectivity will achieve achievements, and also the effectiveness of teamwork is believed to be one of the factorsin realizing a goal (Caro et al., 2014).

Playing football by working together is a system of attacking, defending, and transitioning moments, these three moments cannot rely on individuals, meaning that in these moments they must be done together, especially PSSI has created a philosophy where one of the Indonesian national team's games is a fast transition, and becomes a part of its game tactics which certainly requires good cooperation in one team as in the research of Apriansah et al. (2017) that there is a contribution between cooperation and athlete achievement at the Pati training center football school in Pati Regency of 18.8%, Thus the better the cooperation, the better the achievements produced, and vice versa if the athlete's cooperation is low, the lower the achievements achieved (Beni et al., 2017).

One of the more enjoyable, effective, and time-saving training strategies to improve aerobic endurance performance and player cooperation is small-sided game (SSG) training, which simultaneously involves actual movement patterns and types, technical-tactical awareness, and physical fitness under simulated game conditions (Sarmento et al., 2018). Small-sided games are also present as a training method that has evolved from non-ball conditioning exercises that develop physical capacity, to new methods and exercises that are able to simultaneously improve physical abilities as well as technical and tactical skills, specifically for the demands of modern soccer matches. Small-sided games are the right training, many coaches have evolved towards integrated physical training with the aim of maximizing training time while players are in possession of the ball (Lacome et al., 2018). SSG is also referred to as skill-based conditioning games or game-based training in soccer with a small number of players on each side, played on a smaller field than a regular field and with manipulated rules (Caso & van der Kamp, 2020). Consistent use of these exercises over several weeks will likely drive changes in their fitness status (Hammami et al., 2018; Moran et al., 2019 ; (Clemente et al., 2021). Consistent use of these exercises over several weeks is likely to induce changes in their fitness status (Hammami et al., 2018; Moran et al., 2019; (Clemente et al., 2021).

Small sided games are most widely used for physical training, because many skills are used simultaneously and resemble conditions during real matches, this analysis provides some indications and recommendations for football team coaches (Francesco Sgrò et al., 2018).

The application of the endurance training method to small side games will provide good results, such as the application of intervals and mixes applied in this study. With the interval training method, it will be able to improve the physical condition of athletes. In addition, it can also provide benefits in increasing aerobic capacity and anaerobic capacity. As stated by Gambetta (1989: 96) quoted by Mulyana (2014), namely "interval training has both aerobic and anaerobic benefits". So in his explanation it is quite clear that interval training has good benefits in increasing aerobic and anaerobic.

While the Pyramid which is characterized by gradually increasing and decreasing the workload, is a more advanced and promising endurance training protocol. Pyramid style training, which involves changing distance or speed as you “rise” and “fall,” pyramids change the format of speed running. A 2022 scientific review examined how pyramid training affects effectiveness in middle to long-distance endurance runners. Adapted pyramid endurance training can produce comparable effects on peak work capacity as high-intensity interval training (Tschentscher et al., 2016). So from this explanation, the mix method can be used as a method for endurance training.

The mix method is a combination of the two previous methods, according to a concept of TID (training intensity distribution) which is defined as the amount of time an athlete spends in various training intensity zones during training. In training that is consistent with the training cycle typically used by elite endurance athletes, then switching distributions from one method to another in the final phase of the training period will result in higher performance improvements compared to maintaining the same distribution (Cattan, 2021).

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In addition to the aerobic physical endurance component, small sided games can also affect teamwork performance, research results show that SSG can improve teamwork by increasing the frequency of interaction between players, as well as communication skills, because players are more involved in quick decision making, supporting teammate movements, and coordinating strategies in limited spaces (Caro et al., 2014). In cooperation, Small Sided Games will be given regulations by providing a Center line on the field, when an attacking transition occurs, all attacking players must cross the Center line, if the ball goals but there is a player left behind the Center line, the goal is invalid, as well as the defending team, if his team concedes but there is a player left behind the Center line, the goal will be added according to the number of players left behind. With the implementation of these regulations, there will be cooperation between all players both in attacking and defending. In addition, Small side games can also increase the effectiveness of passing between players, and increase solidarity in teamwork in a combination of long and short passes Aldian Ramadhan Marnawati (2021, p. 112).

METHOD

Berisi The method used in this study is the experimental method with the design in this study, namely Pre Experimental Design with a pattern (pre-test, post-test design). Thirty Persib Academy football players aged under 18 participated in this study. To equalize or balance the three groups, namely by conducting ordinal pairing. Research based on ordinal, namely subjects whose results are the same or almost the same as the pre-test results are then paired with the formula A - B - B - A, then 3 groups are formed, namely experimental group A, experimental group B, and experimental group C which have a balanced level of ability. After that, the Random assignment technique is carried out, this is a sampling technique based on the probability that each sampling unit has an equal chance of being selected as a sample.

As for obtaining the desired research results, there is an instrument that will be used in this study. The instrument used in this study was the YoYo intermittent recovery test level I to determine the level or score of VO2Max athletes who have a validity level of = 0.968 and reliability of = 0.996 (Akbar et al., 2015). and also a questionnaire The aim is to obtain research data in the form of the level of athlete cooperation in playing football by conducting a Pretest (Initial Test), division of research groups, treatment (Treatment).

Procedure In this study, the treatment was given a total of 15 meetings for 5 weeks with a division of 3 training sessions per week with one of the training principles that must be applied, namely the principle of progressive overload by increasing the amount of volume in the set in the form of training duration. The number of players in this game is 5v5 and with an area of 35x40 and with 3 repetitions in 1 set.

In quantitative data processing, statistical tests were used on the initial and final test data values. The analysis was carried out using IBM (SPSS) Statistics software version 26.

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Table 1. Training Program Small Sided Games

mikro		1			2			3	
groups	interval	pyramid	mix	interval	pyramid	mix	interval	pyramid	mix
intensity	60-80 %	60-80 %	60-80 %	60-80 %	60-80 %	60-80 %	60-80 %	60-80 %	60-80 %
volume	2 set, 3 reps	2 set	2 set	2 set	2 set	2 set	2 set	2 set	2 set
time total	36 minutes	36 minutes	36 minutes	48 minutes	48 minutes	48 minutes	60 minutes	60 minutes	60 minutes
time per set	18 minutes	18 minutes	18 minutes	24 minutes	24 minutes	24 minutes	30 minutes	30 minutes	30 minutes
time per reps	6 minutes	5 minutes	3 reps interval	8 minutes	6 minutes	3 reps interval	10 minutes	8 minutes	3 reps interval
	6 minutes	6 minutes	3 reps pyramid	8 minutes	8 minutes	3 reps pyramid	10 minutes	10 minutes	3 reps pyramid
	6 minutes	7 minutes		8 minutes	10 minutes		10 minutes	12 minutes	
mikro		4			5				
groups	interval	pyramid	mix	interval	pyramid	mix			
intensity	60-80 %	60-80 %	60-80 %	60-80 %	60-80 %	60-80 %			
volume	2 set, 3 reps	2 set	2 set	2 set	2 set	2 set			
time total	72 minutes	72 minutes	72 minutes	84 minutes	84 minutes	84 minutes			
time per set	36 minutes	36 minutes	36 minutes	42 minutes	42 minutes	42 minutes			
time per reps	12 minutes	10 minutes	3 reps interval	14 minutes	12 minutes	3 reps interval			
	12 minutes	12 minutes	3 reps interval	14 minutes	14 minutes	3 reps interval			
	12 minutes	14 minutes		14 minutes	16 minutes				

RESULTS AND DISCUSSION

Result

Table 2. One Way Anova VO2Max Test

Result					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4389.267	2	2194.633	3.848	0.034
Within Groups	15397.700	27	570.285		
Total	19786.967	29			

Based on the results of the One Way ANOVA test, the significance value (2-tailed) was 0.034, which is smaller than 0.05. This indicates that there is an average difference between the small-sided games training interval, pyramid and mix groups on increasing VO2Max.

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Table 3. Paired Comparison Test Between VO2Max Groups

Paired Sample t test						
	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Interval-Pyramid	4.20000	33.49892	10.59329	0.396	9	0,71
Interval-mix	27.50000	36.71285	11.60962	2.369	9	0,042
Pyramid-mix	23.30000	29.35624	9.28326	2.510	9	0,033

The data above is comparative data between the interval group and the pyramid group, from the data obtained the sig value (2-tailed) obtained at 0.701 then reject H1 or accept H0. This means that there is no difference between the interval group and the pyramid group. Then the comparative data between the interval group and the mix group, from the data obtained the sig value (2-tailed) obtained at 0.042 then reject H0 or accept H1. This means that there is a difference between the interval group and the mix group, and the last comparative data between the interval group and the mix group, from the data obtained the sig value (2-tailed) obtained at 0.033 then reject H0 or accept H1. This means that there is a difference between the interval group and the mix group.

Then before comparing between groups of Cooperation variables, a calculation of the difference test from the three groups will be carried out directly whether there is a difference from Table 3 Paired Comparison Test Between VO2Max Groups the three Small Sided Game groups as explained in the following table:

Table 4. One Way Anova Test of Teamwork

Result					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.200	2	0.100	0.61	0.941
Within Groups	44.600	27	1.652		
Total	44.800	29			

The results of the One Way ANOVA test showed a significance value (2-tailed) of 0.941 which is smaller than 0.05. This indicates that there is no difference in the average between the small-sided games training interval, pyramid and mix groups on increasing cooperation. Furthermore, the data is compared with the results of each group to determine the differences between the groups.

The data above is comparative data between the interval group and the pyramid group, from the data obtained a sig value (2-tailed) of 0.853, then reject H1 or accept H0. This means that there is no difference between the interval group and the pyramid group. Then the comparative data between the interval group and the pyramid group, from the data obtained a sig value (2-tailed) of 0.798, then reject H1 or accept H0. This means that there is no difference between the interval group and the mix group, and the last comparative data between the interval group and the pyramid group, from the data obtained a sig value (2-tailed) of 0.853, then reject H1 or accept H0. This means that there is no difference between the pyramid group and the mix group.

Discussion

Physical performance improvement occurs in small-sided game format situations with large training areas, small number of players and long training duration (Arslan et al., 2017). The effects of small-sided game training in the long term have the potential to cause injury (Rodríguez-Fernández et al., 2017), but in a constant format over a long period of time it can provide increased physical

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performance, especially in terms of speed and strength endurance to withstand fatigue (Mohr & Krustrup, 2016).

Previous research (Jamshad & Praveen, 2017) found that the application of SSG for six weeks improved physical condition and performance variables among young soccer players, then (Yücesoy et al., 2019) in their research revealed that small-sided games are effective for training aerobic capacity to develop maximum oxygen absorption.

Small sided games are generally played for a constant time with the longest being 6 minutes as in A study conducted on amateur players tested different intermittent regimens (3 × 2 minutes, 3 × 4 minutes and 3 × 6 minutes) in a 3 vs. 3 format (Fanchini et al., 2011). A comparison of 5 vs. 5 interval versus continuous small sided games in Spanish amateur players showed that continuous play may cause a greater physical load than during intermittent play, but without significant differences in heart rate response (Casamichana et al., 2013). Using U-17 players, Koklu (2012) compared continuous versus interval games in 2 vs. 2 (3x2 min versus 6 min), 3 vs. 3 (3 × 3 min vs. 9 min) and 4 vs. 4 (4 × 4 min vs. 12 min) formats. There was no difference observed between continuous versus interval in all game formats, suggesting that both interval and continuous games can be used to stimulate aerobic endurance adaptation in U-17 players (Koklu, 2012).

Table 5. Paired Comparison Test Between Teamwork Groups

	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Interval-Pyramid	1.0000	1.66333	0.52599	0.190	9	0.853
Interval-Mix	2.0000	2.39444	0.75719	0.264	9	0.798
Pyramid-Mix	1.0000	0.52599	1.28987	0.190	9	0.853

Based on this, in this study the regimen in the small-sided game was formed according to the norms of Aerobic endurance training, as expressed by (Roesdiyanto, 2019) if sports activities last more than 5 minutes, they tend to use the aerobic energy system, and one of its implementations is using the principle of the Law of Overload That the training load functions as a stimulus and brings a response from the athlete's body. If the training load is heavier than the normal load on the body, the body will experience fatigue so that the fitness level will be lower than the normal fitness level. If the loading is optimal, after full recovery the fitness level will increase higher than the previous level. If the training load is never increased, then no matter how long and how often the athlete trains, the performance will not be able to increase. So in the Training program in this study, the amount of game time each week increased by 6 minutes for each set and the rest time will always remain the same each week based on the initial heart rate which is the fixed time.

The findings in this study have succeeded in increasing VO2Max which is packaged with the concept of endurance training by applying the norms of interval, mix, and mix endurance training, even so there are differences in improvement between groups.

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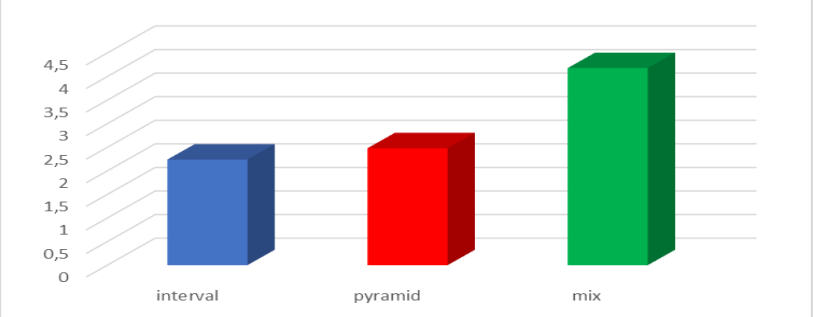

Figure 1. Difference between pretest and posttest VO2max

The implementation of small sided games carried out for 5 weeks in the interval group succeeded in increasing the average VO2Max capacity by 2.24 points, then in the interval group the average increase in VO2Max of the players was slightly greater than the interval group, which was 2.48, while in the mix group there was an increase in VO2Max capacity greater than both, with an average of 4.18 points, with this the researcher's hypothesis has been proven that the mix group has a more effective increase compared to other groups with the mix concept being a combination of the two previous methods, according to a concept of Training Intensity Distribution) defined as the amount of time an athlete spends in various training intensity zones during training. In training that is consistent with the training cycle usually used by elite endurance athletes then switching distribution from one method to another in the final phase of the training period will result in higher performance improvements compared to maintaining the same distribution (Cattan, 2021).

The training method begins with increasing the intensity of the exercise, so that a physiological response occurs with changes in heart rate, blood lactate, and twig perceived exertion. In this small sided game, several rules are given in the game by limiting the touch of the ball which aims to increase the intensity of the game and the circulation of the ball between teammates. This special rule modification has been tested with data showing that limiting the number of touches compared to free play significantly increases the acute physiological response, with an increase in heart rate, blood lactate concentration, and assessment of perceived exertion.

Then, in addition to limiting the touch of the ball, there are also other limitations, namely zonal restrictions or line markings which are also task limitations used in the Small Sided Game (Clemente, 2016). In this study, a center line was given so that both teams had their own zones, which would increase the heart rate and distance traveled (Casamichana, Román-Quintana, Castellano, & Calleja-González, 2015).

Therefore, different rule modifications can cause different responses during the small sided game. Specific adjustments are made to the design of small-sided games to increase the tactical or technical load of the game or to manage training effectively (Clemente et al., 2015). Such as the limited number of touches and instructions for marking man-to-man or zonal are concomitant conditions that increase the acute physiological load and physical demands of the match, which then lead to an increase in the execution of individual technical actions during the match. Limiting the number of consecutive touches on the ball, the type of defensive marking, or certain tactical arrangements can lead to different player decisions and performances. Thus, rule modifications are usually used by coaches to adjust to the needs on the field. Thus, this study is in line with many previous studies adopting training regimens and modifications to the rules in the game. By applying the concept of endurance training and adding these rules, the intensity of small-sided game training from week to week increased in intensity in each group.

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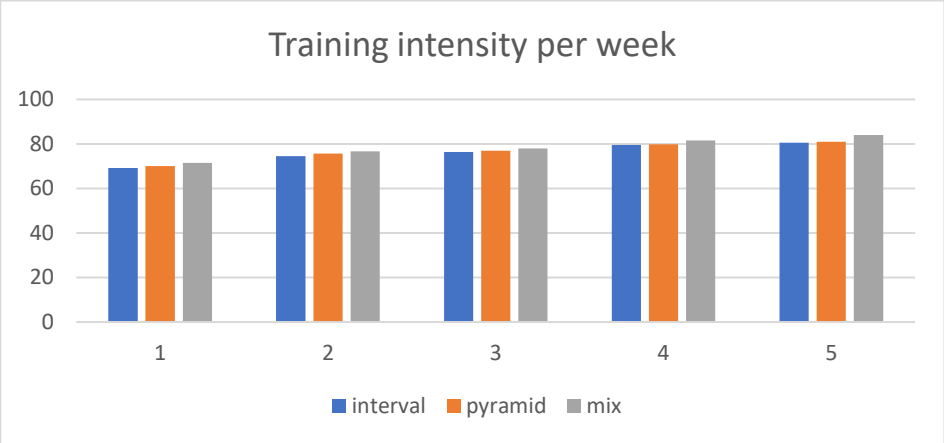

Figure 2. Average exercise intensity

CONCLUSION

Based on the results of the research that has been conducted, it shows that coaches must be able to set a training program to ensure that their athletes feel a pleasant training environment so as not to cause boredom in their athletes. Therefore, the application of small sided games becomes an endurance training method combined with the concept of the game. As for small sided games with the mix principle that can be implemented in the training process to increase aerobic endurance which is characterized by the large VO2Max, this is based on the results of research during 15 meetings that small sided games with the mix principle are superior to the interval principle group and the pyramid principle group.

To train aerobic endurance can be done not only by running, sometimes athletes will get bored when they have to run for a long time. With the results of this study, it is hoped that it will be an option when you want to train aerobic endurance, because players actually prefer to run with the ball or packaged in the form of a game than just running. If this program is carried out in stages and continuously, it is not impossible that the results will be much better.

For the Cooperation variable, there is no difference in the effect of Small-Sided Games (SSG) training between the interval, pyramid, and mix groups on increasing cooperation. This happens because each athlete in each group gets the same treatment, both in terms of training and regulation on the field, so that the three groups do not get better results. For further researchers, it is recommended to conduct research in different age groups, whether the athletes are proficient or not, the volume and intensity of their training, then measurements during the research process can be monitored with more sophisticated measuring instruments, so that not only the pulse is measured but more widely, such as covering distance traveled, fat burned, and longer time so that the research results can be maximized. Then the research time can be carried out for more than 5 weeks so that the results are even more optimal. In addition, it is recommended to explore other factors that can affect the athlete's ability so that they do not get bored in the training process. Then measurements during the research process for the Cooperation instrument can be measured by the GPAI instrument to better support football performance.

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