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The Effect of Interval Training Methods on Aerobic Endurance in Soccer Playing Skills

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ABSTRACT

The objectives of this study were: 1) To determine the effect of intensive and extensive interval training methods on improving soccer skills in the high and low aerobic endurance groups; 2) To determine the interaction between interval training methods and aerobic endurance on improving soccer skills. The study used an experimental method with a 2x2 factorial design. Participants were 28 soccer players from the West Java Zone 4 League. The soccer skills research instrument used the Game Performance Assessment Instrument (GPAI). Hypothesis testing was carried out using factorial analysis of variance (ANOVA). Based on the analysis of the research data processing and discussion, the following conclusions can be drawn from this study: 1) The application of intensive interval training methods has a better effect than the extensive interval training method in improving soccer skills in the high and low aerobic endurance groups; 2) There is no interaction between interval training methods and aerobic endurance in improving soccer skills. These findings suggest that intensive interval training is more effective regardless of aerobic endurance level.

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1. INTRODUCTION

Executing soccer skills requires players to move explosively, thus requiring prime physical condition. The components of physical condition required in soccer are aerobic endurance and maximum oxygen intake by the lungs, which play a role in achieving the desired performance. Low oxygen consumption makes it difficult to maintain a strong and resilient body for prolonged activity [1], [2], [3].

When soccer players have good physical abilities, they can demonstrate movements ranging from light to heavy, from relaxed to explosive, repeatedly. This can delay fatigue and accelerate partial recovery (on-field recovery) and complete recovery (off-field

recovery) [4], [5]. The training method to improve physical abilities is interval training. The interval training method is important to include in the overall training program to improve physical abilities. However, there are several things to consider when applying the interval training method, namely how far the distance is used, how much capacity will be used by each athlete and knowing the athlete's pulse for recovery after work or doing the first activity (repetition) as a benchmark for rest time between repetitions or sets. The interval training method is a training system interspersed with intervals in the form of rest periods [6], [7].

Interval training is relevant to the nature of soccer, which involves repetitive activity and changes in intensity, thus potentially increasing aerobic capacity, which supports playing performance. In training physical components using the interval training method, the things that must be paid close attention to are: Distance or time covered, speed or effort made, number of repetitions of the work interval, distance or time of the recovery period and type of recovery activity. Interval training methods are divided into extensive interval training methods and intensive interval training methods. The extensive interval method is a training method that is carried out with low - medium intensity with a pulse rate below 170x / minute, many repetitions, short intervals and many sets/series [8], [9]. While the intensive interval training method is a training method that is carried out with medium - high training intensity with a pulse rate of more than 180-190x / minute, few repetitions, not many intervals, a maximum of 3 sets [10], [11]. Extensive interval training is performed in the training zone of 40-70% of the athlete's maximum capacity (V02max) with a pulse rate of 60-80 MHR (maximum heart rate), while the intensive training zone is performed at 70-90% of the athlete's maximum capacity (V02max) with a pulse rate of 80-95 MHR (maximum heart rate) [12], [13]. Football players are required to be in good physical condition because when competing, athletes will be able to carry out their duties without experiencing excessive fatigue, and can avoid injuries due to fatigue that interfere with their performance. The process of physical condition training that is carried out well and done repeatedly with increasing loads will allow players' abilities to increase [14], [15].

During long matches, players are required to maintain consistent technical and physical performance; therefore, it is important to examine the effectiveness of training methods on aerobic capacity. Good physical condition is essential for good ball control. Effective and intensive training methods will achieve the goal of good ball control in football. Any form of sports training, if sufficiently intensive and carried out intensively, will help improve dynamic abilities, which can be characterized by increased aerobic capacity [16], [17]. Interval training has been shown to be effective, but it remains unclear which method is more appropriate for groups of athletes with different levels of aerobic endurance for soccer playing skills. Recognizing the important role of physical abilities, training methods are needed to support the improvement of soccer skills. Physical abilities must be improved to prevent fatigue, as they are the basis for athletic skills [18], [19]. Interval training is a method for improving endurance. In interval training sessions, periods of high-intensity work are interspersed with rest intervals. By implementing both intensive and extensive interval training methods, it is hoped that each player can demonstrate high-

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intensity soccer skills.

A soccer player's performance is determined not only by technical mastery but also by the physical capacity that allows them to maintain their technical quality throughout the match. One of the most crucial physical components is aerobic endurance, as over 90% of the energy required during a soccer match comes from the aerobic system. Players with good aerobic capacity tend to be able to maintain work intensity, decision-making quality, and technical skills over the long duration of a match. Previous studies have generally only compared the effectiveness of various training methods on improving physical fitness or competitive performance without considering individual athlete characteristics, particularly pre-training aerobic endurance levels. However, adaptive responses to interval training can differ between players with high and low aerobic capacity [20], [21].

The novelty of this study lies in examining the effect of interval training methods on soccer skills, considering aerobic endurance as an attribute variable. Unlike previous studies that focused more on improving aerobic capacity or physical performance, this study analyzes how aerobic endurance levels moderate the effectiveness of interval training methods in improving soccer skills. This study also examines the interaction between training methods and aerobic endurance, thus providing a scientific basis for developing more specific and individualized soccer training programs. This study will focus on training methods using interval training and aerobic endurance to improve soccer playing skills. Based on the explanation that has been presented, the objectives of this study are: 1) To determine the differences between intensive interval training methods and extensive interval training methods in improving soccer playing skills; 2) To determine the effect of intensive interval training methods with extensive interval training methods in groups with high aerobic endurance abilities in improving soccer playing skills; 3) To determine the effect of intensive interval training methods compared to extensive interval training methods in groups with low aerobic endurance abilities in improving soccer playing skills; 4) To determine the interaction of interval training methods with aerobic endurance abilities in improving soccer playing skills.

2. METHOD

The experimental method was used in this study because the researcher conducted an experiment to determine the effect of independent variables or treatments on dependent variables or outcomes under controlled conditions using a factorial design 2 x 2 [22], [23]. Participants in this study were 28 soccer players from the West Java Zone 4 League team. This study was conducted 18 times, consisting of one initial soccer skills test, 16 research program sessions (treatment), and one final soccer skills test. Each session lasted for 2 x 60 minutes (120 minutes).

In this study, the researchers used random assignment for sampling. After all samples had taken the aerobic endurance ability test using the Test Multi Stage Fitness (Bleep Test) [24]. The researchers divided the total number of samples into four groups with the following provisions: 1) Ranking the total sample from 1 to 28; 2) Dividing the respondents into two groups: Group A, ranked 1 to 14, with high aerobic endurance, and Group B, ranked 15 to 28, with high and low aerobic endurance; 3) Both groups (Group A

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and Group B) were further divided into two groups using a matching pairing technique, each consisting of seven participants; 4) Each group was then randomly assigned to determine which group would receive which treatment. 5) Determine that group A1 will receive intensive interval method treatment with a high aerobic endurance category, group A2 will receive intensive interval method treatment with low aerobic endurance, group B1 will receive extensive interval method treatment with high aerobic endurance, and group B2 will receive extensive interval method treatment with low aerobic endurance. The following division of each group can be seen in Table 1.

Table 1. Division of Player Groups by Aerobic Endurance Ability

A1 *High Aerobic Endurance Player Group Using Intensive Intervals*	*B1* *High Aerobic Endurance Player Group Using Extensive Intervals*
1,4,5,8,9,12,13	2,3,6,7,10,11,14
A2 *Low Aerobic Endurance Player Group Using Intensive Intervals*	*B2* *Low Aerobic Endurance Player Group Using Extensive Intervals*
15,17,19,21,24,25,27	16,18,20,22,23,26,28

The research design used a factorial design experiment. Factorial design is an experimental design used to test the influence of two independent variables (factors) on one dependent variable, while also testing the interaction between the two factors [25]. The following is the division of research groups using the 2x2 factorial design used in this study:

Table 2. 2 x 2 Factorial Research Design

Training Method / Aerobic Endurance	Interval Intensive	Interval Extensive
	A_1	**A_2**
High B_1	A_1 B_1	A_2 B_1
Low B_2	A_1 B_2	A_2 B_2

with

A1 : Intensive interval training method
A2 : Extensive interval training method
B1 : High aerobic endurance
B2 : Low aerobic endurance

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A1B1 : Players who use intensive interval training methods with high aerobic endurance
A1B2 : Players who use intensive interval training methods with low aerobic endurance
A2B1 : Players who use extensive interval training methods with high aerobic endurance
A2B2 : Players who use extensive interval training methods with low aerobic endurance

To maintain consistency in research in maintaining and determining the pulse rate during exercise, researchers use a watch as a pulse measuring tool. The research instrument is a measuring tool with validity and reliability, thus ensuring reliable results in the field. The instrument used to measure soccer playing ability is the Game Performance Assessment Instrument (GPAI) with a validity value of 0.85 and a reliability of 0.90 [26] [27]. Data analysis used descriptive statistics to determine the mean and standard deviation. Hypothesis testing used the two-way factorial analysis of variance (ANOVA) technique at a significance level of α=0.05, and if there was an interaction, it was continued with the Tukey test. All analyses were conducted using SPSS 25 [28].

3. RESULTS AND DISCUSSION

3.1. Results

The results of improving the soccer skills of players trained through intensive interval training methods are better than those trained through extensive interval training methods. Overall, the training group using the intensive interval training method showed a higher average score compared to the group using the extensive interval training method. Training programs with moderate to high intensity training with a heart rate of more than 180-190x/minute, few repetitions, not many intervals, a maximum of 3 sets with rest periods between repetitions and between sets showed a better effect on improving soccer playing skills [29] [30]. Players in the high aerobic endurance group who received intensive interval treatment experienced an average increase in their soccer playing ability of 45.14 seconds in the pretest and 43.78 seconds in the posttest, with an average score gain of 1.37 seconds. This can be seen in the following graph 1:

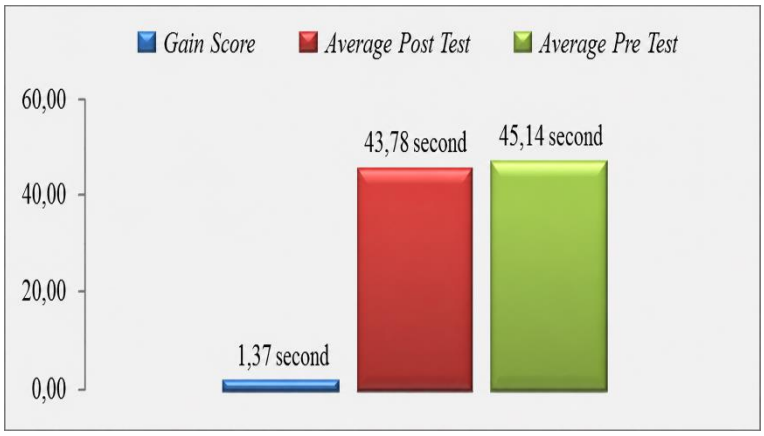

Figure 1. Average Improvement in the High Aerobic Endurance Intensive Interval Training Group

Low aerobic endurance athletes who received intensive interval training experienced an average improvement in their soccer playing ability, with pretest scores of

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48.56 seconds and posttest scores of 47.37 seconds, for an average score increase of 1.18 seconds. This can be seen more clearly in the following graph 2:

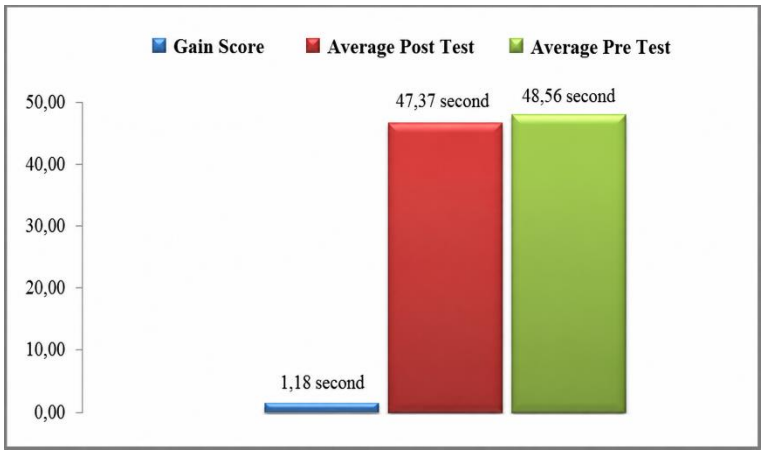

Figure 2. Average Improvement in the Low Aerobic Endurance Intensive Interval Training Group

Physical conditioning training plays a crucial role in improving and maintaining soccer skills. Higher physical abilities determine soccer skill performance. Intensive interval training with high intensity, few repetitions, and short rest periods can improve aerobic endurance, which can maximize soccer skills. Intensive interval training methods develop physical conditioning, particularly aerobic endurance. The application of intensive interval training can improve complex motor neurons [31] [32]. This incomplete rest can be achieved through passive rest, which involves resting without any activity (sleeping, standing, sitting), or active rest, which involves resting with light activity (jogging, walking). Intensive interval training methods have a greater impact on the soccer skills of players with high aerobic endurance than those with low endurance. The participants' physical readiness, psychological state, differences in anxiety, and readiness to face training pressure contribute to the superiority of intensive interval training methods in high aerobic endurance compared to low aerobic endurance groups [33].

In addition to physiological aspects, high-intensity interval training can improve players' ability to manage fatigue while performing skills with a high degree of precision. The long duration of soccer requires players to maintain accuracy even under high physical pressure. Systematic intensive interval training can improve lactate tolerance and neuromuscular efficiency, enabling players to perform various skills more optimally during long matches, and is an effective strategy for improving physical training outcomes on player performance in matches [34].

Furthermore, based on field data, players in the high aerobic endurance group who received the extensive interval training method experienced an average increase in their soccer playing ability, with a pretest score of 45.11 seconds and a posttest score of 44.25 seconds, with an average score increase of 0.85 seconds. This is further explained in the following graph 3:

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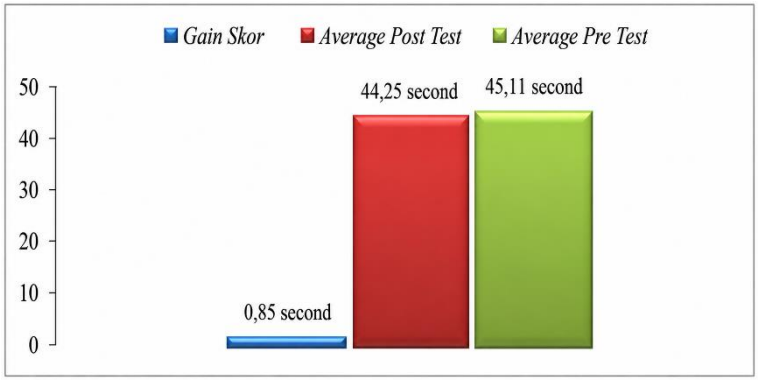

Figure 3. Average Improvement in the High Aerobic Endurance Extensive Interval Training Group

Meanwhile, players in the low aerobic endurance group who received the extensive interval training experienced an average increase in their soccer playing ability, with a pretest score of 50.25 seconds and a posttest score of 49.52 seconds, for an average score increase of 0.73 seconds. This is further explained in the following graph 4:

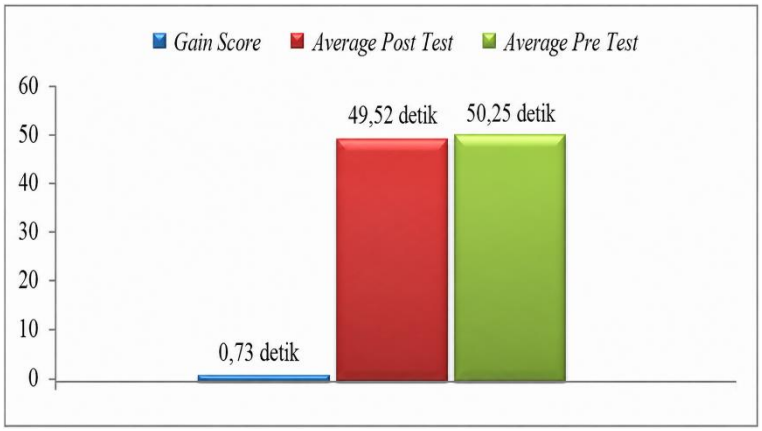

Figure 4. Average Improvement in the Low Aerobic Endurance Extensive Interval Training Group

The ability to play soccer in samples with high aerobic endurance who received intensive interval method treatment increased, with an average score of 1.37. In contrast, the ability to play soccer in samples with low aerobic endurance who received intensive interval method treatment increased, with an average score of 1.18. Meanwhile, the ability to play soccer in samples with high aerobic endurance who received extensive interval method treatment increased with an average score of 0.85, and the ability to play soccer in samples with low aerobic endurance who received extensive interval method treatment increased with an average score of 0.73. Testing the normality of research data using the intensive interval method and the extensive interval method with groups with high and low aerobic endurance abilities produced the following results:

3

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Table 3. Data Description from Data Normality Test Results

Group	N	Asym. Sig. (p-value)	Condition	Description
Intensive Interval Method High Aerobic Endurance	7	0,889	p>0,05	Normal
Intensive Interval Method Low Aerobic Endurance	7	0,756	p>0,05	Normal
Extensive Interval Method High Aerobic Endurance	7	0,657	p>0,05	Normal
Extensive Interval Method Low Aerobic Endurance	7	0,648	p>0,05	Normal

Hypothesis testing was carried out using analysis of variance (ANOVA), which carried out conditional tests and obtained the following results:

Table 4. Two-Way ANOVA Calculation

Source	Type III Sum of Squares	Df	Mean Square	F	Condition	Description
Methods	455.657		455.657	5.550	.039	Sig
Aerobic Endurance	74.350		74.350	.905	.355	
Methods * Aerobic Endurance	30.156		30.156	.345	.565	
Error	14566.00	0	1.150			
Total	51176.00	4				

The results of the two-way ANOVA calculation obtained a significance value of 0.039 < 0.050 for the calculation score. Therefore, it is known that in this study, there is a difference in soccer playing skills between players who received intensive interval training and extensive interval training methods. Proven by the difference in soccer playing skills between players who used the intensive interval method and the extensive interval method with high or low aerobic endurance.

Table 5. Average Value for Each Interval Group and Soccer Playing Skills

Interval Methods / Football Playing Skills	Intensive	Extensive	Total
High	43,78	44,25	88.03
Low	47,37	49,52	96.89
Total	91.15	93.78	

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The two-factor interaction ANOVA calculation yielded a significance value of 0.565 > 0.050 for the improvement score. Therefore, this study indicates no significant interaction between training method and aerobic endurance on soccer skills. Further details can be seen in the following figure:

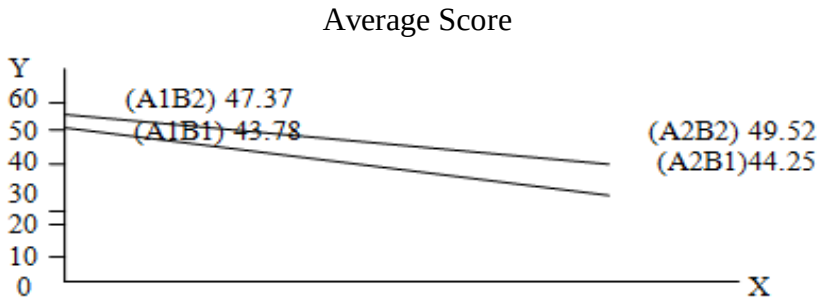

Figure 5. There is no interaction between training methods and aerobic endurance ability on soccer playing skills

3.2. Discussion

The group of players given the intense interval training method demonstrated higher average soccer skill scores than the group given the extensive interval training method. This finding can be explained by the fact that intensive interval training is performed at a higher intensity (±85–95% HRmax), which simultaneously increases aerobic and anaerobic capacity, which impacts players' ability to maintain technical quality and decision-making during games. A five-week high-intensity interval training (HIIT) program significantly improves physical performance and soccer skills. This increased physical capacity allows players to maximize their skills and make better decisions during matches [35]. High-intensity interval training is an effective method for improving soccer performance because it increases aerobic endurance, repeated sprinting ability, and high-intensity work capacity, which are fundamental to modern soccer skills [36] [37].

The results of the present study demonstrated that the improvement in soccer playing skills of players trained using the intensive interval training method was significantly greater than that of players trained using the extensive interval training method. Overall, the group receiving intensive interval training showed higher mean scores in soccer-playing skills than the group receiving extensive interval training. These findings indicate that intensive interval training possesses superior effectiveness in enhancing soccer-specific skills [38].

The superiority of intensive interval training may be attributed to the characteristics of the training program, which involved moderate-to-high exercise intensity with heart rates exceeding approximately 180–190 x/min, limited repetitions, a relatively small number of intervals, a maximum of three sets, and carefully controlled recovery periods between repetitions and sets. Such training characteristics provide substantial physiological stress, resulting in greater cardiovascular, metabolic, and neuromuscular adaptations. Previous studies have shown that high-intensity interval training (HIIT) performed at approximately 85–95% of maximal heart rate significantly improves aerobic capacity, anaerobic performance, and repeated sprint ability, all of which are critical determinants of soccer performance [39] [40] [41].

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The present findings are also consistent with previous research indicating that high-intensity interval training produces greater improvements in soccer performance than conventional training methods [42]. Appropriate manipulation of training load is essential for developing soccer skills because exercise intensity, volume, and density influence the physiological adaptations that support technical and tactical performance. Both internal training load indicators, such as heart rate, training impulse (TRIMP), and session rating of perceived exertion (session-RPE), and external training load indicators, including total distance covered, high-speed running distance, and player load, are associated with changes in technical execution and tactical behavior during matches. Properly designed training loads enable players to maintain technical quality, effective decision-making, and overall game performance throughout the duration of competition [43].

The differences in training responses observed between intensive and extensive interval training may be explained by the distinct exercise intensity zones applied in each method. Intensive interval training was implemented at a higher intensity zone of approximately 85–95% HRmax, whereas extensive interval training was generally performed at a moderate intensity of approximately 60–80% Hrmax [44]. Exercise performed at higher intensities provides greater physiological stimulation, leading to more pronounced adaptations in aerobic and anaerobic systems, enhanced lactate tolerance, improved repeated sprint ability, and increased resistance to fatigue [45]. These adaptations are particularly important in modern soccer, which requires players to repeatedly perform high-intensity actions while maintaining technical precision and tactical effectiveness.

Improved physical capacity enables players to sustain high-quality technical performance under physically demanding conditions. Soccer players with superior aerobic and anaerobic capacities are better able to tolerate fatigue, recover more rapidly between high-intensity efforts, and maintain concentration and decision-making accuracy throughout the match [46]. Consequently, the greater physiological stimulus provided by intensive interval training results in larger improvements in soccer playing skills compared with extensive interval training.

Furthermore, the findings of this study reinforce the fundamental principle that physical conditioning forms the foundation of soccer skill performance. Physical capacities, particularly aerobic endurance, are indispensable for supporting technical execution and tactical performance during prolonged competition [47]. However, environmental factors should also be considered during training implementation. Field conditions can substantially influence skill performance because better playing surfaces facilitate ball control and movement execution, whereas poor field conditions may hinder players' ability to control the ball and perform technical actions effectively [48]. Therefore, optimizing both training design and environmental conditions is essential to maximize the development of soccer-specific skills.

Recognizing that physical ability plays a crucial role, it must be improved to form the foundation for a soccer player's skills. When training, the condition of the field must be taken into account. The better the condition, the easier it will be to control the ball when

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performing various soccer skills. Conversely, if the field is not in good condition, it will be difficult to control the ball.

4. CONCLUSION

Based on the analysis of research data processing and research discussion, the following conclusions can be drawn from this study: 1) The application of the intense interval training method provides a better effect than the extensive interval training method in the high and low aerobic endurance groups in improving soccer playing skills; 2) There is no interaction between the interval training method and aerobic endurance ability in improving soccer playing skills.

Based on the conclusions of the research results, the researchers recommend: 1) The intensive interval method can be prioritized in training programs to improve soccer skills; 2) Coaches should still consider the players' condition, training objectives, and the context in which it is implemented; 3) Further research is needed to test the effectiveness of this method on other technical variables or in a more controlled field context.

THANK-YOU NOTE

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