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# The Impact of HIIT type II on endurance optimization in young amateur futsal players

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## Abstract

Surmising non-classroom activities like playing futsal, overall sports competence is largely contingent upon the individual's physical performance and capacity, particularly their cardiovascular endurance ($Vo_2Max$) fitness level. For the initial Bleep Test, participants had a rather low average $Vo_2Max$ of 34.9 ml/kg/min. This is explained due to insufficient training periods or volume, inadequate equipment, and unrealistic progression expectations. This study aims to develop motor endurance in students through physical activity. The study uses a pre-experimental design and a single pretest-posttest group design. There were 18 subjects of the study who were active participants in futsal extracurricular activities in the school, aged 15-16 years old. Saturated sampling technique is used to take samples from the entire population. The measurement of $Vo_2Max$ was done using the Bleep Test before and after the exercise intervention to estimate the effectiveness of the program. Type II exercise (HIIT) is proven to have a significant effect. This decision is supported by a t-test value of 15.942, greater than the t-table value of 2.110 at a 5% significance level, and the 0.000 value for significance, which is less than 0.05. Thus, it has been proved that HIIT Type II exercises improve Vo2Max. This study has practical implications as it suggests a workable and quantifiable exercise program to improve adolescent biomotor endurance. This supports the proof that HIIT Type II is an effective exercise method, and it can be incorporated into non-educational school programs as a straightforward way to address the problem of poor aerobic capacity.

**Keywords:** Vo2max, High-intensity interval training, futsal.

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**Authors contribution:** a – Preparing concepts; b – Formulating methods; c – Conducting research; d – Processing results; e – Interpretation and conclusions; f - Editing the final version.

## INTRODUCTION

The problem of low motor capacity, especially cardiovascular endurance as measured by $VO_2Max$ for students at MTsN 24 Jakarta, is a significant problem in the extracurricular futsal program at the school. In the first observation, the average $VO_2Max$ value of students reached 34.9

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ml/kg/min, which is categorized as low. This ability level is further contributed to by a poorly organized training system, short training session durations, uncounted training volumes, and a lack of facilities and infrastructure. This problem is compounded by the lack of trainer competence in developing training plans using the principles of exercise physiology. This illustrates the gap between the high-intensity demands of futsal and training that is usually done in a way that is not adaptive and conventional to the specific needs of adolescent players.

In recent years, there has been an increasing concern regarding students' physical fitness levels participating in school-based sports activities, particularly in extracurricular programs. One key indicator of physical fitness is biomotor capacity, which is vital in supporting students' performance in high-intensity sports. Several studies have reported that cardiovascular endurance, measured by $VO_2$Max, among junior high school students in Indonesia tends to be below the recommended standards, especially among those involved in ball games such as futsal (Carrasco Beltrán et al., 2015; Lusianti, 2021). The issue pertaining to the low motor capacity, specifically the cardiovascular endurance measured by $VO_2$Max, stands as a significant challenge in the extracurricular futsal program at the School. Type II high-intensity interval training (HIIT) blends shorter active or passive recovery periods with high-intensity exercise. HIIT Type II is especially meant to increase aerobic and anaerobic capacity, which are vital in futsal, a game that requires fast changes in speed, frequent sprints, and explosive muscle action in brief intervals. Young futsal players should especially benefit from this type of exercise (Masjid et al., 2025; Michailidis et al., 2023). Based on field observations, the average $VO_2$Max value of students in the initial assessment reached 34.9 ml/kg/min, which is categorized as low. This capacity level is further exacerbated by poor training system organization, duration of training sessions, unaccounted training volumes, and lack of facilities and infrastructure. The problem is worsened due to the inadequate level of trainers' competencies for developing training routines using the exercise physiology framework. This

example demonstrates the mismatch between the high demands of futsal performance and the low standards of adaptive and conventional approaches to training that are done with adolescent players.

Futsal is a team sport characterized by speed and dynamic movement. This requires optimal $VO_2$Max capacity (Rosenblat et al., 2022). Rapid changes in attack and defense, as well as tight playing spaces, require good aerobic endurance and good recovery abilities from the players. If the $VO_2$Max value is low, players will tire more quickly, their decision-making abilities will be negatively affected, and their technical skills will decline substantially (Beier & Wicharz, 2024; Juniarsyah et al., 2021). Thus, increasing $VO_2$Max remains a strategic goal combined with physiological goals. It must be understood, as shown by Zubaida et al. (2024), that the prescribed training should be appropriate to the sport in question, and in the case of futsal, Type II HIIT is relevant because it covers the metabolic and neuromuscular constituents of muscle action involved in futsal.

HIIT Type II is considered time efficient and can be adapted to available equipment and facilities. This type combines the metabolic components of HIIT type I with neuromuscular fatigue that focuses on muscles that actively contract during stronger repetitive movements. Several studies have confirmed that HIIT increases $VO_2$Max (Himawan et al., 2025; Pratomo et al., 2023; Yunus & Raharjo, 2022), but only a few have discussed its use in relation to the constraints of extracurricular activities at school. This study addresses the issue of implementing Type II HIIT in the context of structured time and space restrictions to demonstrate the possibility of a significant increase in $VO_2$Max even when these restrictions are applied.

The importance of this study stems from the need to develop training methods that are feasible, measurable, and compatible with the formal education framework. Several other studies, such as Behboudi et al. (2011) and Hardinata et al. (2023), have shown that HIIT can develop students' endurance but does not specifically explain the phenomenon of the weak training paradigm that is often found in many schools with limited resources.

In this case, the main value of this study is to provide an evidence-based and contextual training model that school trainers can use to train students optimally. The selection of the right training model greatly determines the effectiveness and efficiency of the training process (Fatchurrahman et al., 2019; Zubaida et al., 2024). Therefore, this study addresses the issue of low $VO_2$Max in extracurricular futsal participants and offers a sensible and practical solution through the application of Type II HIIT. Young futsal players have had great success using HIIT Type II in enhancing energy metabolic efficiency, recovery speed following hard activity, and cardiovascular endurance. All of these are pertinent to the dynamic and high-stress environment of futsal; this training also helps build physiological adaptations, including higher $VO_2$Max, muscle strength, and the capacity to make consecutive sprints (Mendes et al., 2022; Tomsovsky et al., 2021).

Nonetheless, as young athletes are still in their development stage, HIIT Type II programs have to be carefully planned, considering training load, duration, and frequency to prevent overtraining or injury. Maximum benefits without compromising the athletes' health and development depend on experienced coaches supervising using a scientific-based method. This model has been proven to be effective in a practical sense and is suitable for settings where time and facilities are limited. In addition, this model can also be a strategic choice to improve the quality of sports coaching in schools in an integrated and long-lasting way (Rezende et al., 2024; Salazar-Martínez et al., 2023).

In addressing the problem of low $VO_2$Max among extracurricular futsal players, this study applies Type II HIIT training to offer a functional and easy solution. This model is effective and practical and can be used in settings with limited time and resources (Campos et al., 2021). In addition, this method has the potential to be a strategic choice for improving the quality of sports coaching in a holistic and long-term manner. From a technical perspective, the issue of uncontrolled external variables in the context of field studies requires the adoption of a pre-experimental single-group pretest-posttest research design for the implementation of Type II HIIT. This

design, although limited by uncontrollable situational factors, such as the absence of randomization or a control group, is more advantageous for 'discovery' studies in practical settings with limited resources. Research has shown that such a design is effective in studies involving $VO_2$Max improvement in school children and novice athletes (Bourgeois et al., 2025; Li et al., 2024).

Like other studies that focus on teenagers and young athletes, the validity and reliability of the Bleep Test to assess aerobic capacity supports its use as a $VO_2$Max measuring tool. As noted by Jabbal & Baxter-Jones (2017), The Bleep Test correlates strongly with $VO_2$Max measurements in the laboratory and can be used effectively in the classroom or in the field (As-Safa et al., 2024; Salazar-Martínez et al., 2023). Furthermore, this approach offers an impartial evaluation of the measurable physical development of students and training cycles. This research is expected to be used as a basis for further research that will adopt more sophisticated designs such as quasi-experiments or randomized control trials to enable more precise generalization of findings and to further strengthen the effectiveness of Type II HIIT in significantly increasing $VO_2$Max in different populations.

## METHOD

This study used a quantitative method with experimental techniques, specifically the pre-experimental design. The design chosen was the One Group Pretest-Posttest Design, where one group of subjects is given a test before and after treatment but does not have a control group for comparison purposes. According to Sugiyono (2022), this design allows researchers to detect changes caused by treatment, even without full control over the influence of external variables. The sample population was 18 students who actively participated in the futsal extracurricular program. The sampling method decided upon was non-probability sampling, more specifically, saturated sampling. This method was applied because all population members were eligible to be included as samples relevant to the research objectives. Classed under pre-experimental techniques, the research

design followed the One Group Pretest-Posttest Design. One set of participants was chosen and given a pretest in this design to gauge their baseline $VO_2$Max level. Participants in the Pretest then engaged in a fixed length organized exercise program utilizing HIIT Type II. Using the same measuring tool, a post-test was done at the conclusion of the treatment period to evaluate any changes or increases in $VO_2$Max. This design allows for within-subject comparisons, so the data analysis concentrates on the performance variations before and after the therapy for the same group.

The research instrument was the Bleep Test, which measures the $VO_2$Max level of the participants. The Bleep Test was chosen because it is known as a valid and reliable measure of cardiorespiratory fitness in adolescents. The Bleep Test is a competent and appropriate tool for evaluating aerobic endurance in the domain of physical education and sports coaching in schools (Samuel Purba, Zulfan Heri, 2020). The analysis was conducted quantitatively using statistical procedures with paired sample t-tests to evaluate the difference in $VO_2$Max scores before and after treatment. Before conducting the hypothesis test, normality and homogeneity tests were conducted to determine whether the data had the basic requirements for parametric analysis. The approach to analyzing the data must be appropriate to the type of data and problem definition. It should strive to evaluate the impact of the intervention through a meaningful difference analysis (Sugiyono, 2022).

Using the $VO_2$Max classification criteria, which act as a benchmark reference to ascertain individual cardiovascular endurance level, the collected data of this investigation were clarified and analyzed. Usually adjusted depending on age and gender, these normative tables classify $VO_2$Max readings into different levels, such as extremely poor, poor, fair, good, excellent, and superior.

**Tabel 1.** Clarification of the $VO_2$Max norm

| No | Category | Range |
|---|---|---|
| 4 | Good | >43 |
| 3 | Moderate | 39 - 42.9 |
| 2 | Poor | 35 - 38.9 |
| 1 | Very Poor | <35 |

The research procedure is organized in several comprehensive steps. The first step is to contact the school to request approval to conduct research and select participants who meet the criteria. Then, the $VO_2$Max of each participant is assessed by a pretest using the Bleep Test. After that, a Type II High-Intensity Interval Training (HIIT) intervention was carried out for several weeks according to the established schedule and with active supervision to ensure that the appropriate training principles were followed. After the training program was completed, a post-test was carried out to measure the $VO_2$Max value and compare it with the pretest value. The resulting data was statistically processed to determine the significance of the difference in order to draw conclusions based on the findings.

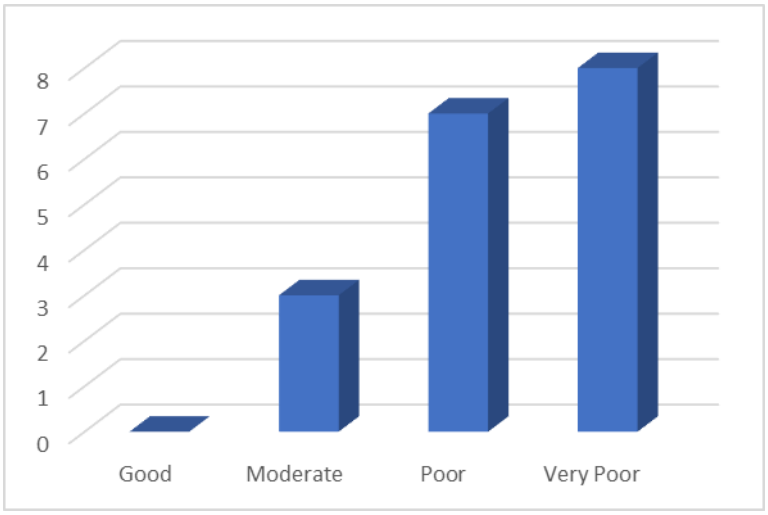
## RESULT

To describe the effectiveness of the Type II HIIT exercise intervention in increasing students' $VO_2$Max capacity, measurements were taken before (Pretest) and after (post-test) treatment. The following descriptive data shows the distribution of $VO_2$Max categories based on fitness classification norms, which include the categories Very Poor, Poor, Moderate, and Good. A comparison of the number and percentage of students in each category provides a clear picture of the improvement in cardiovascular fitness levels after the intervention.

**Table 2.** Description of test results

| Category | Range value | Pretest | | Post-test | |
|---|---|---|---|---|---|
| | | Total | Percentage (%) | Total | Percentage (%) |
| Good | >43 | 0 | 0% | 7 | 39% |
| Moderate | 39 - 42.9 | 3 | 17% | 10 | 56% |
| Poor | 35 - 38.9 | 7 | 39% | 1 | 6% |
| Very Poor | <35 | 8 | 44% | 0 | 0% |
| Total | | 18 | | 18 | |

Based on Table 1. in the secondary data section (Pretest), the overall Vo2Max of extracurricular futsal students is known from 18 people who obtained the highest score of 42.9 and the lowest score of 27.6 with an average score of 34.9 ml/kg/min with the category of very low. The lowest Vo2Max level obtained by male students was in the very deficient category, as many as 44.5%, with a total of 8 out of 18 students, moderate achievement with a deficient category, as much as 39%, with a total of 7 out of 18 students, while the highest achievement of the Vo2Max level of male students was in the sufficient category as much as 16.5%, with a total of 3 out of 18 students. The pretest results showed that the VO2max level of extracurricular futsal students was still in the category of sufficient to significantly lacking, so the researcher took 18 extracurricular futsal players as a sample to be given an experiment with the application of High-Intensity Interval Training (HIIT).




**Gambar 1.** Hasil data pretest sebelum application of High Intensity Interval Training (HIIT)

In Table 1, the results of the Pretest show that out of the 18 people tested, the highest score obtained was 50.8 ml/kg/min, while the lowest score was 38.1 ml/kg/min, with an average Vo2max score of 44.1 ml/kg/min. The Vo2max classification of these futsal players is as follows: 7 people have a good Vo2max, 10 people are classified as sufficient, and 1 person is classified as lacking. No players were classified as 'Very Lacking' in this Post-test. Thus, most of the futsal extracurricular students have a VO2 max level that is in the fair to good category. After being given High Intensity Interval Training (HIIT), the average VO2max value in the Pretest was 34.9 ml/kg/min and increased to 44.1 ml/kg/min in the post-test. This can be seen in the pie chart below to make it easier to see the comparison between the Pretest and post-test. This data shows that the VO2 max of extracurricular futsal students increased to a good category after undergoing Type II High-Intensity Interval Training (HIIT).

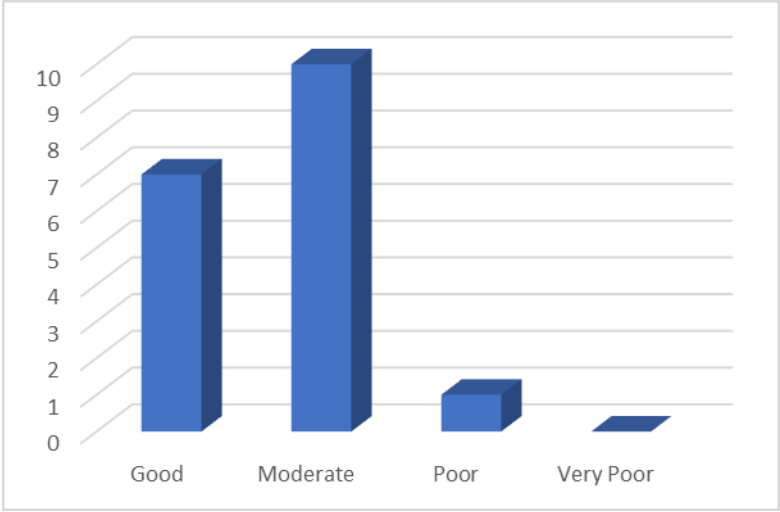



**Figure 2.** Hasil data postest setelah application of High Intensity Interval Training (HIIT)

Data normality is an essential criterion for conducting parametric analysis. This study employs the Shapiro-Wilk normality test as the foundation for decision-making in the analysis. The Shapiro-Wilk test is a statistical method suitable for small sample sizes (less than 50). This study employed the Shapiro-Wilk test due to a sample <50.

**Table 3.** Normality Test

| | Results | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|---|
| | | Statistic | df | Sig. | Statistic | df | Sig. |
| Value | Pre Test | .099 | 18 | .200* | .984 | 18 | .979 |
| | Post Test | .086 | 18 | .200* | .971 | 18 | .819 |

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

According to the data in Table 1, the significant values in the Shapiro-Wilk test are greater than 0.05, specifically 0.979 and 0.819, indicating that the data is normally distributed. Consequently, one of the non-mandatory prerequisites of the independent t-test might be satisfied. Subsequent outcomes derived from homogenous testing utilizing SPSS statistical software version 26 are presented in the table below.

Consequently, one of the non-mandatory prerequisites of the independent t-test might be satisfied. The subsequent outcomes derived from the homogeneity testing were then analyzed using an appropriate statistical approach to determine whether the assumption of equal variances could be maintained. The results are summarized in the following table.

**Table 4.** Homogeneity of test

| | | Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|---|
| Value | Based On Mean | .000 | 1 | 34 | .996 |
| | Based On Median | .000 | 1 | 34 | .989 |
| | Based On Median And With Adjusted Df | .000 | 1 | 33.253 | .989 |
| | Based On Trimmed Mean | .000 | 1 | 34 | .987 |

According to the homogeneity of variances output, the significance value of 0.996 exceeds 0.05 (0.996 > 0.05), leading to the acceptance of the alternative hypothesis; therefore, the variation among each sample is consistent (homogeneous). After completing the required tests for normality and homogeneity, hypothesis testing may be conducted. The objective is to analyze two samples subjected to distinct treatments, specifically utilizing the Paired Sample T-test due to the interdependence of the two variables. This test is employed to ascertain the existence of a mean difference between two related sample groups.

**Table 5.** Analysis paired sample results

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | PRETEST | 34.917 | 18 | 3.8777 | .9140 |
| | POST-TEST | 44.05 | 18 | 3.686 | .869 |

Table 4 indicates a significant difference in outcomes before and after implementing High-Intensity Interval Training (HIIT) as assessed by the paired sample t-test. The t-table value is determined by the degrees of freedom (df) and the significance level (α/2). The output indicates that the degrees of freedom (df) value is 17, calculated as N-1, specifically 18-1 = 17. The value of dk / df equals 17 at a significance level of 5%, with the t-table value being 2.110. The results of the paired sample t-test indicate that the calculated t-value (15.942) exceeds the critical t-value (2.110), leading to the rejection of H0 and the acceptance of Ha. It can be concluded that a disparity exists in the average Vo2Max of futsal extracurricular students between the Pre Test and Post-test, indicating that the High-Intensity Interval Training (HIIT) method positively impacts the enhancement of Vo2Max among futsal extracurricular students.

**Table 6.** Paired Sample t-test results on students' cardiovascular endurance (Pretest and Post-test $VO_2$Max)

| Variable Comparision | Mean Difference | Std. Deviations | Std. Error | 95% CI (Lower-Upper)t-value | t- value | df | p - Value |
|---|---|---|---|---|---|---|---|
| Pretest vs. post-test | -9.13 | 2.43 | 0.57 | -10.34 – 7.92 | -15.94 | 17 | <.001 |

The output of Table 4 shows that the Sig (2-tailed) value is 0.000, which is less than 0.05. This shows that there is a significant difference in the Vo2Max level of extracurricular futsal students when comparing measurements taken before and after the application of the High-Intensity Interval Training (HIIT) Type II training method. In addition to comparing the significance value (Sig.) to the probability threshold of 0.05, decision making can also be based on a comparison of the t-count value with the t-table. The results of the research data analysis show that the Type II High-Intensity Interval Training (HIIT) method significantly increases Vo2Max in extracurricular futsal students. The decision was supported by a t-value of 15.942, which exceeded a t-table value of 2.110 at a significance level of 5% with a significance value of 0.000 (2-tailed), which means that it is less than 0.05. (2-tailed) of 0.000, which is less than 0.05. Therefore, the application of the Type II High-Intensity Interval Training (HIIT) method effectively increases the Vo2Max of extracurricular futsal students.

## DISCUSSION

The results of the Type II High-Intensity Interval Training (HIIT) exercise showed a significant difference in the Vo2Max level of extracurricular futsal students by comparing measurements taken before and after the application of the training method. Type II High-Intensity Interval Training (HIIT) exercise has a significant effect on the improvement of Vo2Max in extracurricular futsal students. So that it emphasizes the application of the High-Intensity Interval Training (HIIT) Type II method to effectively increase Vo2Max in extracurricular futsal students. The findings obtained in line with Pratomo et al. (2023) highlighted that $VO_2$Max is the main marker of a person's cardiorespiratory fitness and the prime physiological parameter for his/her aerobic capacity. $VO_2$Max is important to users of futsal because the sport requires a combination of aerobic

endurance and quick recovery skills. Also, Heyward's position is undeniable that $VO_2$Max is the strongest indicator of the individual's maximal ability to transport and utilize oxygen during physical activity, with a direct bearing on the performance of the individual. The effect of HIIT training on training programs, as presented by Chandra et al. (2025), goes further to show that HIIT is effective and efficient. There are time limitations within educational and extracurricular contexts set by Gao et al. (2021) and Wiranata et al. (2023), which is one of the primary barriers identified in the research. Furthermore, these findings are based on what was conveyed by Juniarsyah et al. (2021), who explain that much of the underperformance seen for futsal within schools stems from insufficient infrastructural support, low training sessions, and uncontrolled training processes. This data correlates with the real situation at MTsN 24 futsal team, where the quantity of instruction is insufficient, and coaches are more concerned with technique and tactics than with motor components like cardiorespiratory endurance.

The baseline data of students in this investigation located the mean $VO_2$Max at 34.9 ml/kg/min (very low category), derived from the Multistage Fitness Test (Bleep Test), which is known as and employed as a standard for assessing aerobic capacity (Apriantono et al., 2023). This condition is somewhat incomprehensible since high school students should have been capable of achieving higher levels of aerobic capacity. Futsal is classified as an intermittent sport due to its reliance on repeated short bursts of high-intensity activity, so having low $VO_2$Max makes things worse (Hardinata et al., 2023; Juniarsyah et al., 2021). This type of HIIT is particularly suitable for the purposes of this research. This is in accordance with Pratomo et al. (2023); Wang & Wang (2024) differentiated it from other HIIT approaches by defining Type II as focusing not only on aerobic metabolic load but also emphasizing neuromuscular tension on specific muscle groups, like the lower extremities used in futsal.

Exercises like squat jumps, lunges, burpees, and high knees were created to meet these needs. A combination of endurance exercise along

with lower body strength training is necessary for a futsal athlete (Yunus & Raharjo, 2022). During the implementation of the intervention, the exercise dosage was modified according to the principles of HIIT Type II, which is an intensity of 80-100% of the maximum heart rate (mHR) for a duration of 30 seconds per set, 4 sets per type of exercise with 10-second rest intervals. The exercises provided are functional and explosive in nature in order to bring about optimal change in $VO_2$Max and muscle strength. The average post-test result of $VO_2$Max increased to 44.1 ml/kg/min with the category change from most of “very poor” and “poor” to “sufficient” and “good.” This indicates the positive effect of HIIT Type II intervention on the students’ fitness level in a short duration of time.

This study was conducted with a few caveats that should be addressed. To begin with, the pre-experimental design without a control group does not allow for a definitive causal claim to be made due to the fact that these outside factors are uncontrolled. Second, the model sample limited our research scope, as all participants were active male adolescents aged 15 to 16 years. Third, motivation, training participation, and health status variables were not computed, so their effects could not be examined at a deeper level. Subsequent studies might attempt to adopt quasiexperimental or controlled random designs and also include female participants of various other age groups. Nonetheless, the contribution of this research was remarkable, particularly in formulating effective and flexible exercise models in constrained time and resource environments like schools. This evidence gives a practical alternative for coaches or physical education teachers to follow in designing a formalized training program. The use of HIIT Type II was shown to have a remarkable effect on increasing $VO_2$Max, thus meeting the requirement for training in educational institutions that do not have sufficient facilities. Moreover, this research also adds to the body of literature on using HIIT for specific sports, like futsal.

## CONCLUSION

This study shows that the HIIT Type II training program has raised young amateur futsal players' $VO_2$Max capacity. The rise in $VO_2$Max values following intervention attests to the success of this approach in overcoming frequent constraints in educational environments, such as restricted training time, inadequate facilities, and the absence of organized endurance-oriented exercise. This study shows that a well-organized and time-efficient training program catered to the particular needs of futsal students can improve their physiological fitness, particularly cardiovascular endurance. Moreover, this study underlines the need to create school-based training courses depending on physical demands related to a particular sport instead of concentrating just on technical abilities. The results imply that coaches and PE teachers should use a more integrated strategy combining controlled biomotor conditioning with technical instruction. Future studies could extend this model over other age groups and fitness levels and include female participants to increase the generalizability and application of HIIT Type II training in more general educational and sports environments.

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