

Analysis of the physical condition of soccer athletes through the yo-yo test: a survey study on preparation for the provincial sports week

Análisis de la condición física de los deportistas de fútbol mediante el test del yo-yo: un estudio de encuesta sobre la preparación para la semana deportiva provincial

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Abstract. Background and Study Aim. Activities carried out for a long time must have a good foundation of VO₂max (maximum oxygen volume). Exercise with the right prescription and in no time will increase your VO₂max ability. Characteristics of the sport of football which has a long duration of time and a wide field. Based on this, the VO₂max ability of football players should be high. The purpose of this study was to see the ability of the maximum oxygen volume of football sports which are conducting training camps in preparation for the provincial sports week. Materials and Methods. This study uses a quantitative approach through survey methods. Where in the research there were tests and measurements to find out the level of VO₂max ability. The subjects in this study were the Gabsis football club which was preparing for the provincial sports week (PORPOV). The sampling technique in this study used saturated sampling so that all athletes were sampled, namely 25 soccer athletes. The test instrument used was the yo-yo intermittent recovery test level 1. Furthermore, the data obtained in the field was analyzed using descriptive statistics assisted by the Microsoft Excel 2019 application. Results. Based on the research results, the VO₂max level is 32% in the below average category. Furthermore, there are 48% in the average category, and 20% in the good category. Based on these findings, the average VO₂max ability of soccer athletes is in the sufficient category. Conclusions. The average categorization of Club Gabsis players is still relatively low based on the results of the VO₂max ability test. However, it is important to note that the limitations of this study are the players' uncontrolled dietary consumption and their age, both of which must be taken into account by researchers. It can also find information on the impact of athlete nutrition on endurance abilities.

Keywords: Physical Condition , VO₂max , Football

Resumen. Antecedentes y objetivo del estudio. Las actividades realizadas durante mucho tiempo deben tener una buena base de VO₂máx (volumen máximo de oxígeno). El ejercicio con la prescripción adecuada y en poco tiempo aumentará la capacidad de VO₂max. Características del deporte del fútbol que tiene una larga duración de tiempo y un campo amplio. En base a esto, la capacidad VO₂max de los jugadores de fútbol debería ser alta. El propósito de este estudio fue ver la capacidad del volumen máximo de oxígeno de los deportes de fútbol que están llevando a cabo campos de entrenamiento en preparación para la semana deportiva provincial. Materiales y métodos . Este estudio utiliza un enfoque cuantitativo a través de métodos de encuesta. Donde en la investigación se realizaron pruebas y mediciones para conocer el nivel de capacidad VO₂max. Los sujetos de este estudio fueron el club de fútbol Gabsis que se preparaba para la semana deportiva provincial (PORPOV). La técnica de muestreo en este estudio utilizó el muestreo saturado, de modo que se tomó una muestra de todos los atletas, a saber, 25 atletas de fútbol. El instrumento de prueba utilizado fue el test de recuperación intermitente yo-yo nivel 1. Además, los datos obtenidos en campo se analizaron mediante estadística descriptiva asistida por la aplicación Microsoft Excel 2019. Resultados. En base a los resultados de la investigación, el nivel de VO₂máx es del 32% en la categoría por debajo de la media. Además, hay un 48% en la categoría media, y un 20% en la categoría buena. En base a estos resultados, la capacidad media de VO₂max de los deportistas de fútbol se encuentra en la categoría suficiente. Conclusiones. La categorización media de los jugadores del Club Gabsis sigue siendo relativamente baja según los resultados de la prueba de capacidad VO₂max. Sin embargo, es importante señalar que las limitaciones de este estudio son el consumo dietético no controlado de los jugadores y su edad, factores ambos que deben ser tenidos en cuenta por los investigadores. También se puede encontrar información sobre el impacto de la nutrición de los deportistas en las capacidades de resistencia.

Palabras clave: Condición física , VO₂max , Fútbol

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Introduction

VO₂max is an indicator of aerobic power metabolism that is widely used in various sports and is consistently used to determine aerobic performance. VO₂max is also considered the gold standard and the most significant measure of aerobic ability (Jemni, Prince, & Baker, 2019). As happens in long-distance runners who have efficient use of VO₂max energy during running (I. Aziz et al., 2023; Larsen & Sheel, 2015). In addition, the ability to generate great strength is supported by aerobic capacity (Ahsan & Ali, 2021). Research conducted by (Bento-Torres et al., 2019) confirms that high maximal oxygen volume levels are able to carry out activities with higher intensity, longer and reduce excessive fatigue after carrying out activities.

Many studies have been carried out on efforts to increase VO₂max such as low, medium and high interval training, the results of these exercises can increase aerobic

endurance ability (Wen et al., 2019). Subsequent research conducted by (Taufik, Widiastuti, Setiakarnawijaya, Firmansyah, & Dlis, 2021) confirmed that circuit and interval training could increase maximal oxygen volume. Subsequent research that proves various exercises that can increase maximum oxygen volume include small side games (Alben, Tirtawirya, & Niyonsaba, 2022), linear acceleration (Taskin & Taskin, 2021), fartlek (Gumantan & Fahrizqi, 2020; Syahroni et al., 2020; Syaroni & Kusuma, 2020), tabata (A, P., Munar & Pasaribu, 2020; Herlan & Komarudin, 2020) and aerobic circuits (Ashfahani, 2020).

The results of previous research illustrate that fartlek exercise is one of the exercises that is often done as an effort to increase VO₂max and has been proven to have a positive effect. Subsequent research that has an effect on increasing the maximum oxygen volume includes: doing exercises in the form of games in a simple field (Kusuma & Purnomo, 2019; Puriana, 2019; Zainudin & Kahri, 2019), triangle run

exercises (Hardinata, Gustian, & Perdana, 2021), intermittent soccer training (Bo, 2023), polarize training (Malyani & Fashi, 2021), continuous running training (Syahroni et al., 2020), high-intensity resistance circuit training (Marín-Pagán et al., 2020), High-intensity training (Alvira, Tobalina, Castagna, Casajús, & Irigoyen, 2020).

The results of the review regarding the increase in VO₂max can be increased through exercise. Various exercises from studies on how to increase VO₂max ability (Supriatna, Suryadi, Haetam, & Yosika, 2023). It can be seen that training using intensity at all levels ranging from low, medium to high can improve abilities. Furthermore, training with the method of playing games even though it can improve. Through exercise, the quality of fitness and endurance will be better (Hardinata et al., 2023; Rubiyatno et al., 2023; Saputra et al., 2023; Suryadi, 2022; Suryadi & Rubiyatno, 2022; Suryadi, Samodra, & Purnomo, 2021; Suryadi, Suganda, et al., 2023; Suryadi, Yanti, Ramli, Tjahyanto, & Rianto, 2023).

The results of subsequent studies that have been reviewed regarding increasing VO₂max provide information that is not much different. Type of exercise, movement intensity, and duration of physical activity can affect differences in VO₂max values (Charmas, 2018; Debnath, 2019). Humans who are born have the same opportunity to be able to improve their cardiovascular abilities of the heart and lungs (Tettero et al., 2018), especially those who are active in sports and exercise regularly (Manchado, Cortell-Tormo, & Tortosa-Martínez, 2018), this is because by exercising the body will become fit and indirectly will be physically healthy (Hardinata et al., 2021). Previous research has provided information that being active in sports activities will have an impact on fitness and ability. However, to increase VO₂max it should be done with a measure of intensity each time you exercise.

VO₂max is one of the important factors in sports (Naranjo Orellana & Muela Galán, 2021). Sport requires cardiovascular endurance related to the aerobic ability of athletes (Bo, 2023). Well-developed aerobic fitness helps soccer players maintain repetitive high-intensity performance in soccer matches, speed up the recovery process, and maintain their physical condition at optimal levels throughout the entire game and season [32 (Stølen, Chamari, Castagna, & Wisløff, 2005).

Football is a sport game that is very popular with the community (Suryadi, Okilanda, et al., 2023). Where is this sport which mainly focuses on running and has high requirements for its own cardiopulmonary endurance (Wright, Hurst, & Aylor, 2016). Soccer players require a maximum volume of oxygen to perform high-speed actions during soccer matches (Taskin & Taskin, 2021). Therefore aerobic capacity is very important for the performance of soccer players (Papadopoulos, Metaxas, & Fotiadou, 2022; Pulido, Ortiz-Pulido, Gómez-Figueroa, & Ortiz-Pulido, 2022). This review illustrates that soccer is a sport that has a high intensity, therefore the VO₂max ability must be possessed by soccer athletes.

In soccer, a good aerobic system is needed (Nugroho & Kusuma, 2022). An example of a soccer player using an aerobic energy system is when a soccer player is jogging (Purba & Setiowati, 2022). In addition, a positive relationship (between VO₂max and running performance during matches) can influence the way soccer players train (Papadopoulos et al., 2022). That way, it will help the coach estimate the running performance of the player's match through measurement. The VO₂max ability of football players is low, so it will be difficult for them to carry out activities for a long time. Performance during the match is not optimal until concentration becomes disturbed as the body's energy runs out which will reduce performance.

This research is important to do as an effort to prove the importance of VO₂max for athletes, especially soccer players. Football is a sport that uses complex energy processing using two energy systems, namely aerobic (maximum oxygen volume) and anaerobic (Jarkasih & Fardi, 2020). In addition, information related to VO₂max can be used as input for consideration in planning athlete development programs. This is also because a high level of aerobic capacity helps soccer players cope with physical demands and challenges (Impellizzeri, Rampinini, & Marcora, 2005), and have a faster recovery during matches (Brown, Hughes, & Tong, 2007).

Several studies that have been conducted provide information about the importance of VO₂max for athletes with good standards above ordinary people. The type of test used to measure the maximum oxygen volume is using the yo-yo intermittent recovery test level 1. By knowing the endurance of athletes, this will make it easier for coaches to design the right training program (Suryadi, Yanti, et al., 2023). Based on these problems, this study aims to see the ability of the maximum oxygen volume of the football sport which is conducting training camps in preparation for the provincial sports week.

Materials and Methods

Participants

The population of this study were all players who had registered after registering to join the Gabsis soccer team squad. Then the sampling technique uses saturated sampling, which means that all players on the team will take the VO₂max test and measurement.

Research Design

This study uses a quantitative approach through survey methods, namely the existence of tests and measurements of the sample. The instrument used in this study was the yo-yo intermittent recovery test level 1 as a valid tool for measuring the VO₂max level of football athletes (Hardinata et al., 2021)(Yanti, Gustian, Gani, & Setiawan, 2022). The implementation of the Yo-Yo Intermittent Recovery Test level 1 has a 20 meter running track. Running speed will increase according to level, with active recovery/10 second rest between 5 meter runs. To avoid injury during the

exam, the athlete first warmed up and stretched. Furthermore, the test is deemed complete if the player fails to cross the finish line twice or if the player no longer feels like completing the moderate test at the predetermined speed (Schmitz et al., 2018).

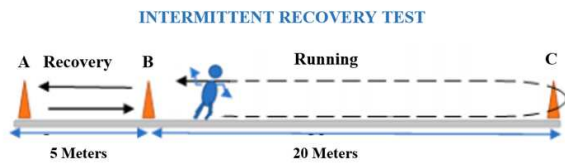


Figure 1. Yo-Yo Intermittent Recovery Test Instrument

Statistical Analysis

Data analysis in this research uses descriptive percentages, to determine the VO₂max level of soccer athletes. Then data calculations are assisted using the Microsoft Excel 2019 software application. Furthermore, the fitness norm category is used to find out an explanation of the VO₂max value achieved by athletes based on (Hardinata et al., 2021).

Table 1. VO₂max Assessment Norms through the Yo-Yo Test for Men

Ratings	Levels	ValueRange
Elite	>20.1	>56.6
Excellent	18.7-20.1	53.2-56.6
good	17.3-18.6	49.2-52.9
Average	15.7-17.2	45.1-48.8
Below average	14.2-15.6	40.8-44.8
Poor	<14.2	<40.8

Results

This research took place on the Gabsis football field, Sambas Regency, West Kalimantan Province, Indonesia. The measurement test used is the yo-yo intermittent recovery test level 1. Based on the players who took the measurement test, the results of the VO₂max value distribution are described in the following table.

Table 2. Data on the results of the physical condition test for VO₂max ability through the level 1 yo-yo test

No	Age	VO ₂ max Results	Categories
1	20	48.2	Average
2	19	45.8	Average
3	20	40.8	Below average
4	21	56.6	good
5	19	45.8	Average
6	21	45.8	Average
7	20	46.5	Average
8	18	49.2	good
9	20	46.1	Average
10	21	49.2	good
11	19	40.8	Below average
12	17	45.1	Average
13	21	44.5	Below average
14	20	45.1	Average
15	21	44.5	Below average
16	19	56.6	good
17	20	49.2	good
18	20	45.8	Average
19	20	44.1	Below average
20	21	46.1	Average
21	19	43.5	Below average
22	21	45.8	Average
23	18	42.1	Below average
24	20	43.5	Below average
25	20	45.1	Average

Table 3. VO₂max Levels in Male Soccer Athletes

Ratings	frequency	Percentage %
Elite	0	0%
Excellent	0	0%
good	5	20%
Average	12	48%
Below average	8	32%
Poor	0	0%

The value of the VO₂max level in soccer athletes is shown based on the findings data presented in Tables 2 and 3. Based on these results, the athlete's VO₂max ability is 32% in the below average category. Furthermore, there are 48% in average, and 20% in the Good category. Based on these findings, the average VO₂max ability of soccer athletes is in the sufficient category. Where this result is still relatively low for a soccer athlete who should have a good VO₂max level.

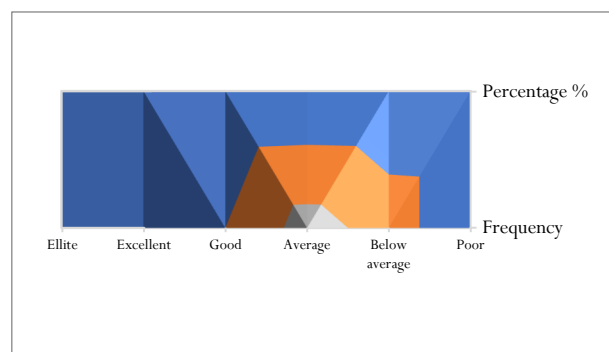


Figure 2. VO₂max Athlete Speak Bola Club Gabsis

Discussion

study aims to see the ability of the maximum oxygen volume of football sports which are conducting training camps in preparation for the provincial sports week. The results in this study describe the VO₂max condition of Club Gabsis soccer players. Where football athletes who take this test are athletes who are selected from the best regions. The results of the study show that the VO₂max value in the Gabsis men's soccer athletes has a sufficient average of 48% with a value range of 45.1-48.8. The results can be seen from the percentage of VO₂max levels in athletes. A study revealed that the VO₂max value that a male soccer player must have is 50-75 ml/kg/min (Modric, Versic, & Sekulic, 2020). However, when viewed from the competitive level, the VO₂max value in men's football ranges from 48-62 ml/kg/min (Slimani, Znazen, Miarka, & Bragazzi, 2019). Based on the results of relevant research reviews, the average VO₂max ability of the Gabsis football players is still relatively low. This can be seen from the results achieved with the most being in the moderate category. The VO₂max value for each player is different, such as position and physiology.

The results of a scientific literature review regarding VO₂max values vary between 48.4 - 57.5 ml/kg/min for goalkeepers, 53.2 - 62.8 ml/kg/min for defenders, 54.7 - 63 ml/kg/min for midfielder and 54 - 62.9 for attacker (Slimani et al., 2019). The difference in the VO₂max value

is influenced by the performance and cruising range of each football player, between the goalkeeper and the defenders, midfielders and forwards (attackers). The results of this study provide information about differences in the VO₂max ability of soccer players with existing standards. The cause of this occurrence may be due to the short duration of physical exercise or the repetition and intensity that is not quite right. Therefore for the development of endurance it should be done with well-organized training ranging from duration, repetition and intensity to have a positive effect (Bompa & Buzzichelli, 2015).

Relevant research findings explain that various studies to increase VO₂max have been carried out including the 50 meter sprint exercise (Arifin, 2019). cross-country training (Heru & Apri, 2019), interval training (Bo, 2023; Bravo et al., 2008; Faude, Steffen, Kellmann, & Meyer, 2014), training with running and plyometrics (Gómez-Molina, Ogueta-Alday, Camara, Stickley, & García-López, 2018), circuit weight training (R Bahtra, Fahrozi, & Putra, 2020), aerobics training (Lestari, Liana, & Setiono, 2019), fartlek training on sand (Ramdhon, Usra, & Destriani, 2020), training circuit (Iswahyudi, Fajar, Sugeng, & Derana, 2020)(Suryadi et al., 2021). The results of a research study on VO₂max have provided clear information that the exercise plan is carried out correctly. The prescription given is controlled, related to age, level of competition to the variety of exercises given will have an effect on increasing the maximum oxygen volume.

VO₂max has become an issue in the world of performance sports. Various studies have been carried out to increase the maximum oxygen volume capacity. this is because the maximal oxygen volume capacity is obtained through exercise adaptation (Joyner & Lundby, 2018). Through a high volume of oxygen, it can increase stamina so that it has good endurance during matches (Septiany, Basyar, & Hardian, 2019). Recovery time is faster and shows maximum performance when under high pressure (Ridho Bahtra, Asmawi, Widiastuti, & Dlis, 2020; Pratama & Bafirman, 2020). VO₂max capacity is especially important for football players because it affects running performance during matches, the number of sprints, and the amount of action with the ball (Helgerud, Engen, Wisloff, & Hoff, 2001). Up to the running distance in a match (Gamonales, León, Rojas-Valverde, Sánchez-Ureña, & Muñoz-Jiménez, 2021).

VO₂max has a relationship with running performance in a match which is usually influenced by the opponent, match level, tactical role, playing position and level of motivational stimulus boost (Slimani et al., 2019). In addition, differences in oxygen volume between players must be considered to optimize physiological responses during high-intensity running activities (Riboli, Coratella, Rampichini, Limonta, & Esposito, 2022). This is because VO₂max is a differentiator in football appearance at the age of 14, 15 and 16 years (Le, Carling, Williams, & Reilly, 2010).

Evaluation regarding the maximum oxygen volume

should also be of particular concern, because this will determine the outcome-related data to be obtained as information for planning an exercise program. Experts about 60% recommend field tests using continuous and intermittent shuttle runs (A. Aziz, Mukherjee, Chia, & Teh, 2008; Boraczyński, Boraczyński, Podstawski, & Wójcik, 2015; Canhadas, Silva, Chaves, & Portes, 2010; Gil, Ruiz, Irazusta, Gil, & Irazusta, 2007; Le et al., 2010; Reilly, Williams, Nevill, & Franks, 2000; Silvestre, West, Maresch, & Kraemer, 2006). Then validated regarding ecology, criteria and synchronization with direct assessment methods for senior athletes (Bangsbo, Iaia, & Krstrup, 2008; Castagna, Impellizzeri, Cecchini, Rampinini, & Alvarez, 2009; Rampinini et al., 2007).

Conclusions

Based on the results of research on VO₂max in soccer athletes in preparation for the provincial sports week. The research results have a strong foundation regarding VO₂max, which has been included in the results discussion. The results showed that the VO₂max ability level of Gabsis club soccer athletes on average was in the Average category. However, these results are still relatively low and football athletes should at least have good VO₂max abilities. This is also due to the need for high intensity in the game. These results have provided additional new references related to VO₂max in soccer games. With the results of this study, it can be a reference for coaches in developing appropriate training programs for athletes, especially in the sport of football. However, it should be noted that the limitations of this study lie in the condition of the players' nutritional intake which has not been controlled and their age which must also be taken into consideration by researchers. Furthermore, it can find out information on the influence of athlete nutrition on endurance.

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Conflict of interests

There is no conflict of interest.

References

- A, P., Munar, H., & Pasaribu, A. M. N. (2020). Kemampuan Vo₂Max Atlet Sepakbola PS.Tungkal Ulu U-21. *Multilateral*, 1(1), 25–34. <https://doi.org/10.31599/jces.v1i1.83>
- Ahsan, M., & Ali, M. F. (2021). Relationship between maximal oxygen uptake and dynamic stability in university rugby and

- soccer players. *International Journal of Human Movement and Sports Sciences*, 9(4). <https://doi.org/10.13189/saj.2021.090414>
- Alben, A. S. C., Tirtawirya, D., & Niyonsaba, T. (2022). Effects of Small-Sided Games Training Program on VO2 max and Football Playing Skills. *Budapest International Research and Critics Institute-Journal (BIRCJ-Journal)*, 5(1). <https://doi.org/10.33258/birci.v5i1.4249>
- Alvira, D. C., Tobalina, J. C., Castagna, C., Casajús, J. A., & Irigoyen, J. Y. (2020). High-intensity training effects on top-level soccer referees' repeated sprint ability and cardiovascular performance. *Arch Med Deporte*, 37(4), 227–233.
- Arifin, Z. (2019). Pengaruh Latihan Game Dan Sprint 50 Meter Terhadap Peningkatan Vo2Max Atlet Sepakbola Ssb Kakimas Dampit Kabupaten Malang Kelompok Umur 14-15. *Jp.Jok (Jurnal Pendidikan Jasmani, Olahraga Dan Kesehatan)*, 3(1), 103–114. <https://doi.org/10.33503/jp.jok.v3i1.561>
- Ashfahani, Z. (2020). Daya Tahan Kardiovaskuler Pada Tim Futsal Universitas PGRI Semarang. *Journal of Sport Coaching and Physical Education*, 5(2), 63–67. <https://doi.org/10.15294/jscpe.v5i2.36823>
- Aziz, A., Mukherjee, S., Chia, M., & Teh, K. (2008). Validity of the running repeated sprint ability test among playing positions and level of competitiveness in trained soccer players. *Int J Sports Med*, 29, 833–838.
- Aziz, I., Okilanda, A., Permadi, A. A., Tjahyanto, T., Prabowo, T. A., Rozi, M. F., ... Suryadi, D. (2023). Correlational study: Sports Students' special test results and basic athletic training learning outcomes. *Retos*, 49, 519–524. <https://doi.org/10.47197/retos.v49.98820>
- Bahtra, R., Fahrozi, U., & Putra, A. N. (2020). Meningkatkan volume oksigen maksimal (VO2max) melalui latihan circuit training ekstensif. *JUARA : Jurnal Olahraga*, 5(2), 201–208. <https://doi.org/10.33222/juara.v5i2.979>
- Bahtra, Ridho, Asmawi, M., Widiastuti, & Dlis, F. (2020). Improved vo2max: The effectiveness of basic soccer training at a young age. *International Journal of Human Movement and Sports Sciences*, 8(3), 93–102. <https://doi.org/10.13189/saj.2020.080304>
- Bangsbo, J., Iaia, F. M., & Krstrup, P. (2008). The Yo-Yo intermittent recovery test: A useful tool for evaluation of physical performance in intermittent sports. *Sports Medicine*, Vol. 38, pp. 37–51. <https://doi.org/10.2165/00007256-200838010-00004>
- Bento-Torres, J., Bento-Torres, N. V. O., Stillman, C. M., Grove, G. A., Huang, H., Uyar, F., & Erickson, K. I. (2019). Associations between cardiorespiratory fitness, physical activity, intraindividual variability in behavior, and cingulate cortex in younger adults. *Journal of Sport and Health Science*, 8(4), 315–324. <https://doi.org/10.1016/j.jshs.2019.03.004>
- Bo, Y. (2023). *Effects of intermittent soccer training on physical endurance in university students*. 29, 1–4.
- Bompa, T., & Buzzichelli, C. (2015). *Periodization training for sports: Human Kinetics Champaign*.
- Boraczyński, M., Boraczyński, T., Podstawski, R., & Wójcik, Z. (2015). Relationships between anthropometric traits, body composition and aerobic capacity in male soccer players aged 13–15 years. *J Kinesiology Exer Sci*, 69(25), 33–40.
- Bravo, D. F., Impellizzeri, F. M., Rampinini, E., Castagna, C., Bishop, D., & Wisloff, U. (2008). Sprint vs. interval training in football. *Int J Sports Med*, 29(8), 668–674.
- Brown, P. I., Hughes, M. G., & Tong, R. J. (2007). Relationship between Vo2max and repeated sprint ability using non-motorised treadmill ergometry. *The Journal of Sports Medicine and Physical Fitness*, 47(2), 186–190.
- Canhadas, I., Silva, R., Chaves, C., & Portes, L. (2010). Anthropometric and physical fitness characteristics of young male soccer players. *Rev Bras Cineantropom Desempenho Hum*, 12, 239.
- Castagna, C., Impellizzeri, F., Cecchini, E., Rampinini, E., & Alvarez, J. C. B. (2009). Effects of intermittent-endurance fitness on match performance in young male soccer players. *Journal of Strength and Conditioning Research*, 23(7), 1954–1959. <https://doi.org/10.1519/JSC.0b013e3181b7f743>
- Charmas, M. (2018). Hormonal and metabolic response to 12-weeks aerobic training in women (35-50 years). *Trends Diabetes Metab*, 1(1), 1–11.
- Debnath, M. (2019). Effect of training on muscle cell damage indices and cortisol level in female players of different sports discipline. *International Journal of Applied Exercise Physiology*, 8(1), 2322–2337.
- Faude, O., Steffen, A., Kellmann, M., & Meyer, T. (2014). The effect of short-term interval training during the competitive season on physical fitness and signs of fatigue: a crossover trial in high-level youth football players. *Int J Sports Physiol Perform*, 9(6), 936–44.
- Gamonales, J. M., León, K., Rojas-Valverde, D., Sánchez-Ureña, B., & Muñoz-Jiménez, J. (2021). Data Mining to Select Relevant Variables Influencing External and Internal Workload of Elite Blind 5-a-Side Soccer. *Int J Environ Res Public Health*, 18(6), 3155. <https://doi.org/10.3390/ijerph18063155>
- Gil, S., Ruiz, F., Irazusta, A., Gil, J., & Irazusta, J. (2007). Selection of young soccer players in terms of anthropometric and physiological factors. *J Sports Med Phys Fit*, 47, 25–32.
- Gómez-Molina, J., Ogueta-Alday, A., Camara, J., Stickley, C., & García-López, J. (2018). Effect of 8 weeks of concurrent plyometric and running training on spatiotemporal and physiological variables of novice runners. *European Journal of Sport Science*, 18(2), 162–169. <https://doi.org/10.1080/17461391.2017.1404133>
- Gumantan, A., & Fahrizqi, E. B. (2020). Pengaruh latihan fartlek dan cross country terhadap VO2max atlet futsal Universitas Teknokrat Indonesia. *SPORT-Mu: Jurnal Pendidikan Olahraga*, 1(1), 1–9. <https://doi.org/10.32528/sport-mu.v1i1.3059>
- Hardinata, R., Ahwan, M. T. R., Damastuti, E., Nugroho, W. F., Urahman, T., Abidin, M. Z., ... Mustotiah. (2023). Tinggi badan dengan kemampuan lay up permainan bola basket : Apakah terdapat hubungan? *Tanjungpura Journal of Coaching Research*, 1(1), 11–17. <https://doi.org/10.26418/tajor.v1i1.63857>
- Hardinata, R., Gustian, U., & Perdana, R. P. (2021). The Effectiveness of the Triangle Run Exercise Method in Improving Aerobic Resistance Soccer Player. *JUARA : Jurnal*

- Olahraga, 6(1), 115–124. <https://doi.org/10.33222/juara.v6i1.1180>
- Helgerud, J., Engen, L. C., Wisloff, U., & Hoff, J. (2001). Aerobic endurance training improves soccer performance. *Med Sci Sports Exer*, 33, 1925–1931. <https://doi.org/10.1097/00005768-200111000-00019>
- Herlan, H., & Komarudin, K. (2020). Pengaruh Metode Latihan High-Intensity Interval Training (Tabata) terhadap Peningkatan Vo2Max Pelari Jarak Jauh. *Jurnal Keolahragaan Olahraga*. <https://doi.org/10.17509/jko-upi.v12i1.24008>
- Heru, R. A., & Apri, A. (2019). Pengaruh Latihan Cross Country Terhadap Daya Tahan Aerobik Atlet Sekolah Sepakbola (SSB) Pagaruyung FC Kecamatan Tanjung Emas Kabupaten Tanah Datar. *Jurnal Stamina*, 2(1), 437–450.
- Impellizzeri, F. M., Rampinini, E., & Marcora, S. M. (2005). Physiological assessment of aerobic training in soccer. *J Sport Sci*, 23, 583–592. <https://doi.org/10.1080/02640410400021278>
- Iswahyudi, N., Fajar, M. K., Sugeng, I., & Derana, G. T. (2020). Latihan circuit training terhadap peningkatan daya tahan aerobik (VO2 Max). *Altius: Jurnal Ilmu Olahraga Dan Kesehatan*, 9(2), 61–69. <https://doi.org/10.36706/altius.v9i2.12862>
- Jarkasih, I., & Fardi, A. (2020). Pengaruh Pemberian Gula Aren Dalam Latihan Daya Tahan Terhadap Kapasitas VO2 Max SSB Tan Malaka. *Jurnal Patriot*, 2(1), 301–2014. <https://doi.org/10.24036/patriot.v2i1.548>
- Jemni, M., Prince, M. S., & Baker, J. S. (2019). Retraction Note: Assessing cardiorespiratory fitness of soccer players: is test specificity the issue?—a review. *Sports Medicine - Open*, 5(1). <https://doi.org/10.1186/s40798-019-0217-9>
- Joyner, M. J., & Lundby, C. (2018). Concepts about VO2max and Trainability Are Context Dependent. *Exercise and Sport Sciences Reviews*, 46(3), 138–143. <https://doi.org/10.1249/JES.0000000000000150>
- Kusuma, E. tirta, & Purnomo, M. (2019). Pengaruh latihan small sided games terhadap peningkatan VO2max peserta ekstrakurikuler futsal SMP Labschool Unesa. *Jurnal Prestasi Olahraga*, 3(1), 1–6.
- Larsen, H. B., & Sheel, A. W. (2015). The Kenyan runners. *Scandinavian Journal of Medicine and Science in Sports*, 4(8), 110. <https://doi.org/10.1111/sms.12573>
- Le, G. F., Carling, C., Williams, M., & Reilly, T. (2010). Anthropometric and fitness characteristics of international, professional and amateur male graduate soccer players from an elite youth academy. *J Sci Med Sport*, 13, 90–95.
- Lestari, Y. E. T., Liana, D. S., & Setiono, K. W. (2019). Pengaruh senam aerobik terhadap peningkatan nilai VO2max pada siswa SMP Negeri 2 Kupang usia 13-14 Tahun. *Cendana Medical Journal (CMJ)*, 7(2), 317–324.
- Malyani, M., & Fashi, M. (2021). The effect of 4 weeks polarize training on aerobic and anaerobic fitness variables in soccer players. *Sport Physiology & Management Investigations*, 13(3), 183–193.
- Manchado, C., Cortell-Tormo, J. M., & Tortosa-Martínez, J. (2018). Effects of two different training periodization models on physical and physiological aspects of elite female team handball players. *Journal of Strength and Conditioning Research*, 32(1), 280–287. <https://doi.org/10.1519/JSC.0000000000002259>
- Marín-Pagán, C., Blazevidh, A. J., Chung, L. H., Romero-Arenas, S., Freitas, T. T., & Alcaraz, P. E. (2020). Acute Physiological Responses to High-Intensity Resistance Circuit Training vs. Traditional Strength Training in Soccer Players. *Biology*, 9(11), 383. <https://doi.org/10.3390/biology9110383>
- Modric, T., Versic, S., & Sekulic, D. (2020). Aeoribic fitness and game performance indicators in professional football players. *Playing Position Specific and Associations. Heliyon*, 6(11), e05427. <https://doi.org/10.1016/j.heliyon.2020.e05427>
- Naranjo Orellana, J., & Muela Galán, S. (2021). Retrograde extrapolation of VO2max from recovery values recorded breath by breath (Extrapolación retrógrada del VO2max a partir de valores de recuperación recogidos respiración a respiración). *Retos*, 41, 695–700. <https://doi.org/10.47197/retos.v41i0.84525>
- Nugroho, M. A., & Kusuma, D. (2022). Pengaruh Latihan High Intensity Interval Training & Small Sided Games Terhadap Daya Tahan Aerobik Pemain Futsal. *Jurnal Prestasi Olahraga*, 5(5), 81–88. <https://doi.org/10.5281/zenodo.5824947>
- Papadopoulos, C., Metaxas, T. I., & Fotiadou, E. G. (2022). Correlations between VO 2max and match distance running performance of soccer players with visual impairment. *Research Square*, 1–12. <https://doi.org/10.21203/rs.3.rs-1453809/v1>
- Pratama, R., & Bafirman, B. (2020). Pengaruh Circuit Training Terhadap Volume Oksigen Maksimal (Vo2max) Atlet Sepakbola Rajawali Tanjung Jati Kabupaten Lima Puluh Kota. *Jurnal Stamina*, 3(5), 240–254.
- Pulido, R. O., Ortiz-Pulido, R., Gómez-Figueroa, J. A., & Ortiz-Pulido, R. (2022). Efecto del entrenamiento de intervalo en jugadores mexicanos juveniles de fútbol soccer (Effect of interval training in the performace of mexican juvenile soccer players). *Retos*, 44, 907–917. <https://doi.org/10.47197/retos.v44i0.89997>
- Purba, D. P., & Setiowati, A. (2022). Pengaruh pemberian air gula merah terhadap daya tahan aerobik pada pemain sepak bola di semarang. *Journal of Sport Science and Fitness*, 8(2), 104–111. <https://doi.org/10.15294/jssf.v8i2.60565>
- Puriana, R. H. (2019). Pengaruh latihan small sided games 3v3 dan 4v4 terhadap peningkatan VO2max atlet futsal di Lamongan. *Jurnal Pendidikan Jasmani Dan Keolahragaan*, 2(1), 187–193.
- Ramdhon, M. A. A., Usra, M., & Destriani. (2020). Latihan fartlek menggunakan lintasan pasir terhadap peningkatan VO2max sepak bola. *Altius: Jurnal Ilmu Olahraga Dan Kesehatan*, 7(1), 14–17. <https://doi.org/10.36706/altius.v7i1.8109>
- Rampinini, E., Bishop, D., Marcora, S., Bravo, D., Sassi, R., & Impellizzeri, F. (2007). Validity of simple field tests as indicators of match-related physical performance in top-level professional soccer players. *Int J Sports Med*, 8, 228–235.
- Reilly, T., Williams, A., Nevill, A., & Franks, A. (2000). A multidisciplinary approach to talent identification in soccer. *J Sport Sci*, 18, 695–702.
- Riboli, A., Coratella, G., Rampichini, S., Limonta, E., & Esposito, F. (2022). Testing protocol affects the velocity at VO2max in semi-professional soccer players. *Research in*

- Sports Medicine*, 30(2), 182–192. <https://doi.org/10.1080/15438627.2021.1878460>
- Rubiyatno, Perdana, R. P., Fallo, I. S., Arifin, Z., Nusri, A., Suryadi, D., ... Fauziah, E. (2023). Analysis of differences in physical fitness levels of extracurricular futsal students: Survey studies on urban and rural environments. *Pedagogy of Physical Culture and Sports*, 27(3), 208–214. <https://doi.org/10.15561/26649837.2023.0304>
- Saputra, E., Putra, M. E., Rianto, L., Tjahyanto, T., Widiyati, R., & Aziz, I. (2023). Profil kebugaran jasmani pada mahasiswa yang mengikuti latihan beban: Yo-yo intermittent test level 1. *Tanjungpura Journal of Coaching Research*, 1(1), 18–23. <https://doi.org/10.26418/tajor.v1i1.63856>
- Schmitz, B., Pfeifer, C., Kreitz, K., Borowski, M., Faldum, A., & Brand, S. M. (2018). The Yo-Yo intermittent tests: A systematic review and structured compendium of test results. *Frontiers in Physiology*, p. 9,870. <https://doi.org/10.3389/fphys.2018.00870>
- Septiany, M. C., Basyar, E., & Hardian, H. (2019). Pengaruh latihan naik turun bangku harvard terhadap nilai Vo2max pada atlet sepak bola. *Jurnal Kedokteran Diponegoro*, 8(1), 5–12. <https://doi.org/10.14710/dmj.v8i1.23336>
- Silvestre, R., West, C., Maresh, C., & Kraemer, W. (2006). Body composition and physical performance in men's soccer: a study of a National Collegiate Athletic Association Division I team. *J Strength Cond Res*, 20(1), 177–183.
- Slimani, M., Znazen, H., Miarka, B., & Bragazzi, N. L. (2019). Maximum Oxygen Uptake of Male Soccer Players According to their Competitive Level, Playing Position and Age Group: Implication from a Network Meta-Analysis. *Journal of Human Kinetics*, 66(1), 233–245. <https://doi.org/10.2478/hukin-2018-0060>
- Stolen, T., Chamari, K., Castagna, C., & Wisløff, U. (2005). Physiology of soccer. *Sports Medicine*, 35(6), 501–536.
- Supriatna, E., Suryadi, D., Haetam, M., & Yosika, G. F. (2023). Analysis of the Endurance Profile (Vo2max) of Women's Volleyball Athletes: Yo-yo intermittent test level 1. *Indonesian Journal of Physical Education and Sport Science (IJPESS)*, 3(1), 12–19. <https://doi.org/10.52188/ijpess.v3i1.369>
- Suryadi, D. (2022). Analisis kebugaran jasmani siswa: Studi komparatif antara ekstrakurikuler bolabasket dan futsal. *Edu Sportivo: Indonesian Journal of Physical Education*, 3(2), 100–110. [https://doi.org/10.25299/es:ijope.2022.vol3\(2\).9280](https://doi.org/10.25299/es:ijope.2022.vol3(2).9280)
- Suryadi, D., Okilanda, A., Yanti, N., Suganda, M. A., Mashud, Santika, I. G. P. N. A., ... Hardinata, R. (2023). Combination of varied agility training with small sided games: How it influences football dribbling skills? *Pedagogy of Physical Culture and Sports*, 27(3), 190–197. <https://doi.org/10.15561/26649837.2023.0302>
- Suryadi, D., & Rubiyatno. (2022). Kebugaran jasmani pada siswa yang mengikuti ekstrakurikuler futsal. *Jurnal Ilmu Keolahragaan*, 5(1), 1–8. <https://doi.org/10.26418/jilo.v5i1.51718>
- Suryadi, D., Samodra, Y. T. J., & Purnomo, E. (2021). Efektivitas latihan weight training terhadap kebugaran jasmani. *Journal RESPECS*, 3(2), 9–19. <https://doi.org/10.31949/respecs.v3i2.1029>
- Suryadi, D., Suganda, M. A., Sacko, M., Samodra, Y. T. J., Rubiyatno, R., Supriatna, E., ... Okilanda, A. (2023). Comparative Analysis of Soccer and Futsal Extracurriculars: A Survey Study of Physical Fitness Profiles. *Physical Education and Sports: Studies and Research*, 2(1), 59–71. <https://doi.org/10.56003/pessr.v2i1.182>
- Suryadi, D., Yanti, N., Ramli, Tjahyanto, T., & Rianto, L. (2023). Yo-Yo Intermitten Recovery Test: A study of football players' VO2max physical condition. *Journal Sport Area*, 8(2), 141–150. [https://doi.org/10.25299/sportarea.2023.vol8\(2\).12392](https://doi.org/10.25299/sportarea.2023.vol8(2).12392)
- Syahroni, M., Muliarta, I. M., Krisna Dinata, I. M., Putu Sutjana, I. D., Pangkahila, J. A., & Handari Adiputra, L. M. I. S. (2020). Latihan fartlek dan latihan continous running mempunyai efek yang sama dalam meningkatkan VO2max siswa ekstrakurikuler bola voli MAN 2 Manggarai. *Sport and Fitness Journal*, 8(2), 1–7. <https://doi.org/10.24843/spj.2020.v08.i02.p01>
- Syaroni, F. D., & Kusuma, I. D. M. A. W. (2020). Perbandingan fartlek dan small side games untuk meningkatkan VO2max pada siswa ekstrakurikuler. *JSES: Journal of Sport and Exercise Science*, 3(1), 37–41. <https://doi.org/10.26740/jses.v3n1.p37-41>
- Taskin, M., & Taskin, A. K. (2021). Does linear acceleration impact agility, vo2max, 30 meter speed and standing long jump in amateur soccer players? *Kinesiologia Slovenica*, 27(1), 87–96.
- Taufik, M. S., Widiastuti, Setiakarnawijaya, Y., Firmansyah, & Dis. (2021). Effect of circuit and interval training on VO2max in futsal players. *Journal of Physical Education and Sport*, 21(4), 2283 – 2288. <https://doi.org/10.7752/jpes.2021.s4305>
- Tettero, O. M., Aronson, T., Wolf, R. J., Nuijten, M. A. H., Hopman, M. T. E., & Janssen, I. M. C. (2018). Increase in physical activity after bariatric surgery demonstrates improvement in weight loss and cardiorespiratory fitness. *Obesity Surgery*, 28(12), 3950–3957. <https://doi.org/10.1007/s11695-018-3439-x>
- Wen, D., Utesch, T., Wu, J., Robertson, S., Liu, J., Hu, G., & Chen, H. (2019). Effects of different protocols of high intensity interval training for VO2max improvements in adults: A meta-analysis of randomised controlled trials. *Journal of Science and Medicine in Sport*, 23(8), 941–947. <https://doi.org/10.1016/j.jsams.2019.01.013>
- Wright, M. D., Hurst, C., & Aylor, J. M. (2016). Contrasting effects of a mixed-methods high-intensity interval training intervention in girl football players. *J Sports Sci*, 34(19), 1808–1815.
- Yanti, N., Gustian, U., Gani, R. A., & Setiawan, E. (2022). Analysis of the vo2max physical condition of tarung derajat athletes through yoyo test: Preparation for pre-PON XX. *Journal Sport Area*, 7(1), 125–133. [https://doi.org/https://doi.org/10.25299/sportarea.2022.vol7\(1\).6717](https://doi.org/https://doi.org/10.25299/sportarea.2022.vol7(1).6717)
- Zainudin, I., & Kahri, M. (2019). Analisis Komponen Kebugaran Jasmani Peserta Didik Sekolah Dasar Negeri Di Lihat Dari Sarana Dan Prasarana Pendidikan Jasmani Kelas V Usia 10-12 Tahun Kota Banjarbaru. *Multilateral: Jurnal Pendidikan Jasmani Dan Olahraga*, 18(1), 65.