

PODIUM

Journal of Science and Technology in Physical Culture

UNIVERSITY EDITORIAL

Volume 18
Issue 1

2023

University of Pinar del Río “Hermanos Saíz Montes de Oca”

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Translated from the original in spanish

Original article

Importance of VO₂max and the recovery capacity of soccer players

Importancia del VO₂máx y la capacidad de recuperación de los futbolistas

A importância do VO₂max e a capacidade de recuperação dos jogadores de futebol

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Received: 01/09/2022.

Approved: 26/10/2022.

ABSTRACT

The maximum oxygen consumption is considered an indicator directly related to aerobic endurance, so this capacity becomes decisive in the performance of the soccer player. Knowing the national theoretical criteria that supported the importance of VO₂max in the recovery capacity in soccer was a previous step towards shaping prospective strategies of direct intervention for decision making. In this sense, the objective of the research was to determine, by consulting specialists, the existing criteria of the importance of VO₂max in the recovery capacity of soccer players. The research was descriptive-correlational with an exploratory orientation; 13 specialists were surveyed who issued criteria on five indicators. The importance of aerobic endurance in soccer training obtained a score of (\bar{X} 4.62) and in relation to the rest of the physical capacities applied to soccer a (\bar{X} 3.23); the importance of VO₂max in the direction process a (\bar{X} 4.46); the correlation between VO₂max and recovery a (\bar{X} 4.54) and the need to improve aerobic endurance in Ecuadorian soccer a (\bar{X} 4). The concordance index between specialists obtained an acceptable level ($w=0.527$). All the analysis indicators obtained a qualification between high and very high, so the research highlighted the theoretical importance provided by specialists on maximum oxygen



consumption as an indicator directly related to aerobic endurance and the link between this and the ability to recovery of footballers.

Keywords: maximal oxygen consumption, soccer, recovery.

RESUMEN

El consumo máximo de oxígeno se considera un indicador directamente relacionado con la resistencia aeróbica, por lo que dicha capacidad se hace determinante en el rendimiento del futbolista. Conocer los criterios teóricos nacionales que sustentaron la importancia del VO₂máx en la capacidad de recuperación en el fútbol constituyó un paso previo hacia conformar estrategias prospectivas de intervención directa para la toma de decisiones. En tal sentido, se planteó como objetivo de la investigación determinar, por consulta de especialistas, los criterios existentes de la importancia del VO₂máx en la capacidad de recuperación de los futbolistas. La investigación fue descriptiva-correlacional de orientación exploratoria; se encuestaron a 13 especialistas que emitieron criterios sobre cinco indicadores. La importancia de la resistencia aeróbica en el entrenamiento del fútbol obtuvo un puntaje de (\bar{X} 4.62) y en relación al resto de las capacidades físicas aplicadas al fútbol un (\bar{X} 3.23); la importancia del VO₂máx en el proceso de dirección un (\bar{X} 4.46); la correlación entre VO₂máx y la recuperación un (\bar{X} 4.54) y la necesidad de perfeccionar la resistencia aeróbica en el fútbol ecuatoriano un (\bar{X} 4). El índice de concordancia entre especialistas obtuvo un nivel aceptable ($w=0.527$). Todos los indicadores de análisis obtuvieron una cualificación entre alta y muy alta, por lo que la investigación resaltó la importancia teórica brindada por los especialistas sobre el consumo máximo de oxígeno como indicador directamente relacionado con la resistencia aeróbica y el vínculo entre este y la capacidad de recuperación de los futbolistas.

Palabras clave: Consumo máximo de oxígeno, fútbol, recuperación.

SÍNTESE

O consumo máximo de oxigênio é considerado um indicador diretamente relacionado à resistência aeróbica, tornando esta capacidade um fator determinante no desempenho de um jogador de futebol. Conhecer os critérios teóricos nacionais que sustentavam a importância do VO₂max na capacidade de recuperação no futebol foi um passo anterior para a formação de estratégias prospectivas de intervenção direta para a tomada de decisões. Neste sentido, o objetivo da pesquisa foi determinar, consultando especialistas, os critérios existentes sobre a importância do VO₂max na capacidade de recuperação dos jogadores de futebol. A pesquisa foi descritiva-correlacional com uma orientação exploratória; 13 especialistas foram pesquisados e deram critérios sobre cinco indicadores. A importância da resistência aeróbica no treinamento de futebol obteve uma pontuação de (\bar{X} 4,62) e em relação ao resto das capacidades físicas aplicadas ao futebol a (\bar{X} 3,23); a importância do VO₂max no processo de gerenciamento a (\bar{X} 4,46); a correlação entre VO₂max e recuperação a (\bar{X} 4,54) e a necessidade de aperfeiçoar a resistência aeróbica no futebol equatoriano a (\bar{X} 4). O índice de concordância entre especialistas obteve um nível



aceitável ($w=0,527$). Todos os indicadores de análise obtiveram uma qualificação entre alto e muito alto, portanto a pesquisa destacou a importância teórica dada pelos especialistas sobre o consumo máximo de oxigênio como um indicador diretamente relacionado à resistência aeróbica e a ligação entre esta e a capacidade de recuperação dos jogadores de futebol.

Palavras-chave: Máxima absorção de oxigênio, futebol, recuperação.

INTRODUCTION

The physical preparation for the sciences of physical activity and sport implies the application of a set of rational exercises that allow the development and improvement of motor qualities in order to increase general and specific sports performance, to strengthen the organs and systems of organs to increase the functional possibilities that includes, in addition to the aforementioned motor skills, physical qualities such as strength, speed, flexibility and endurance (Dantas, 2019; Morales & González, 2015), aspects that must be socialized in the modeling of sports training with the athlete since the factors of physical performance are directly related to sports performance (Mon-López *et al.*, 2019).

For the specific case of physical preparation applied to soccer, there are determining capacities that are prioritized in the comprehensive process of managing applied sports training (Brüggemann, 2019), among them is the capacity for endurance, since the soccer player in his game manifests a maximum, submaximal and long duration work. Taking into account the characteristics of the athletes in terms of game functions and soccer being an acyclic sport with high technical-tactical mobility and varied intensities, it therefore requires specialized training as defined by Alfano (2018).

Endurance capacity training in soccer is a recurring theme that can be consulted in the national and international literature, where much is theorized about the most common techniques and methods in optimizing sports preparation, as is the case of Arroyo *et al.* (2019); in addition, various strategies are implemented that from a practical point of view make it possible to specifically improve endurance capacity, such as the combination of endurance and plyometric strength training (Zghal *et al.*, 2019) or simply, the assessment of the influences of endurance training on physical performance in training and competition (Raya-González *et al.*, 2021; Cruz *et al.*, 2017).

In the specific case of the soccer player's performance, regardless of the type of endurance to be enhanced, the training of said capacity seeks to establish a high development of functional qualities, specifically cardiovascular and respiratory. They include the aerobic, anaerobic and mixed capacity, the volume, density and intensity of the sport, as well as the quality of the efforts made in soccer.

In the specific case of aerobic capacity, this is defined as carrying out an effort of greater or lesser intensity for as long as possible, as one of the fundamental indicators of its potentiation is the so-called maximum volume of oxygen (Vo_{2max}) according to (Ruiz *et al.*, 2019) and the relationships that can be established between said indicator and aerobic capacity, (Gill, 2020a) which is the most widely used measure to qualify such capacity.



Based on the above, the literature describes the use of Vo_2max as the indicator that, from the scientific point of view and especially from the practical point of view, establishes the basis for the control of aerobic endurance in sports including soccer, as well as the variable that allows delimiting enhancing variations after the implementation of some development strategy (Vasileios *et al.*, 2018; Singh & Singh, 2021; Gill., 2020b).

Vo_2max as an indicator is directly related to the athlete's organic recovery capacity; in this sense, Gill (2020) delimits this relationship by establishing a link between VO_2max and maximum aerobic speed in professional Paraguayan soccer players, given that a greater presence of VO_2max determines the existing capacity to face a greater number of actions through of aerobic metabolism (Medina *et al.*, 2001).

It is precisely the body's recovery capacity, an indicator that is related to VO_2max , if one bears in mind that the higher the maximum oxygen consumption, the greater the body's recovery will be in an aerobic exercise, since the energy used to performing physical exercise occurs in the presence of oxygen and therefore, training thresholds can establish work parameters that methodologically are usually modeled in the sports training management process based on VO_2max quantification.

For this reason, optimizing VO_2max derives in the optimization of the organic recovery process and is a perfectly trainable indicator, although it depends in part on the genetic factor; for this reason, empowerment models are designed such as running, climbing, cycling, swimming and the use of classic methods such as continuous and interval exercises, typical of cooperation-opposition sports such as soccer.

Improving organic recovery capacity in an aerobic exercise is a prospective issue to be promoted with a view to the future in Ecuadorian soccer players of various categories from a practical point of view, an aspect that the authors of this research propose when drawing work actions to short and medium term. Despite the exploratory nature that every study must present in its genesis, the purpose of this research is to determine, by consulting specialists, the existing criteria of the importance of VO_2max and the recovery capacity of soccer players.

MATERIALS AND METHODS

The research was of a descriptive-correlational type with an exploratory orientation, 13 national and international specialists in the soccer area were surveyed, using five indicators that were related to the criteria on the importance of VO_2max and the recovery capacity of soccer players.

In the selection of the specialists to be surveyed, the following inclusion criteria were taken into account:

- Professional experience of at least 10 years in the soccer area.
- Academic degree in Physical Activity and Sports or related.



- Relevant national results in the soccer area.
- Each specialist consulted should not know the rest of the specialists participating in the study.

The indicators that governed the survey on the object of study of the research are described below:

1. Importance of aerobic endurance in soccer training (IRA).
2. Importance of aerobic endurance in relation to the rest of the physical capacities applied to soccer (IRC)
3. Importance of the VO₂máx indicator in the process of directing sports training in soccer (IVO₂máx).
4. Correlation between VO₂max and recovery in soccer players (CR)
5. Need to improve aerobic endurance in Ecuadorian soccer (NRE).

All the indicators analyzed were directly related to the field of study addressed in the present research, except indicator 5, designed prospectively to know the future need to improve aerobic endurance in Ecuadorian soccer players, through the use of indicators such as VO₂max. The main author of the research will use this aspect as a foundation to design higher level research (master's degree), from the point of view of practical contribution.

The specialists surveyed used a five-level Likert-type scale (1 point: very low; 2 points: low; 3 points: medium; 4 points: high; 5 points: very high); their criteria were validated in relation to the previously studied and described indicators and the index of importance that the indicators had in the process of directing sports training applied to soccer was qualified.

As there was no evidence of a normal distribution of the data, the usual case in a survey with integer ratings, the Kendall concordance index was applied as a measure that determines the ordinal association between the measures stated as part of the research analysis indicators. and adequate agreement was considered if the value of the statistic was ≥ 0.5 .

RESULTS AND DISCUSSION

Table 1 shows the results achieved in the ratings issued by the specialists consulted and the average values recorded for each analysis indicator are described in the last row (Table 1).



Table 1. - Results in the analysis indicators

No	IRA	IRC	IVO2máx	CR	NRE
1	4	3	4	4	4
2	5	4	4	5	4
3	5	3	5	5	5
4	5	4	5	5	4
5	4	3	4	4	4
6	4	2	4	4	5
7	5	3	5	5	3
8	5	2	5	5	4
9	5	3	4	4	5
10	5	4	5	5	4
11	4	4	4	4	3
12	5	3	5	5	4
13	4	4	4	4	3
Media	4,62	3,23	4,46	4,54	4,00

In the indicator that showed the criteria of the 13 specialists on the importance of aerobic endurance in soccer training (IRA), the average score reached the highest figure in the study (4.62), obtaining a qualification between high and very high in terms of level of importance for the sports training management process.

As discussed in the introductory section, the enhancement of aerobic endurance in the sports training management process applied to soccer was considered highly used in planned modeling and included the control of the athlete's preparation; in this sense, authors such as Arroyo *et al.* (2019) and Cruz *et al.* (2017) studied the modeling of endurance in its different variants to optimize the preparation of the athlete by delimiting how and when to train endurance in the soccer player, an (Alfano, 2018), aspect that allowed to deduce that aerobic endurance in soccer was a determining capacity, as defined Sánchez-Cañas *et al.* (2017).

In the case of the IRC indicator that delimited the importance of aerobic endurance in relation to the rest of the physical capacities applied to soccer, the consulted specialists qualified the variable with the lowest average score achieved in the research (3.23). Although aerobic capacity is considered determinant in soccer (Arroyo *et al.*, 2019; Sánchez-Cañas *et al.*, 2017), there are other components of the athlete's preparation that are also determinants such as speed (Arroyo *et al.*, 2019), strength capacity (Zghal *et al.*, 2019) and motor coordination (Carchipulla Enríquez, 2021); and taking other components into account would include technical-tactical performance, (Silva & Ayala, 2021; Morocho-Bonifaz, 2022) and the psychological preparation of the player, (Jaramillo, 2022) among others, since performance depends on variables interrelated regardless of the sport analyzed, as expressed by Mon-D *et al.* (2019).



Given the above, it could be understood that although the specialists consulted considered the aerobic capacity (IRA) to be important, other components of the preparation, such as those mentioned above, are equally important in the management process and in the specialists' consideration of the development of the aerobic capacity was determinant, but under various assumptions other components of the preparation can be much more determinant in the performance of the soccer player.

In the case of the "IVO2máx" indicator, the specialists consulted considered its inclusion in the process of directing sports training in soccer as positive, said indicator reached an average score of 4.46 (high).

The VO2máx is the indicator par excellence to measure the aerobic power of the organism (Medina *et al.*, 2001; Gill, 2020a) and a quantitative value that appears expressed in numerous applied researches; therefore, it was considered the basis for establishing correlations between it (VO2max) and recovery in soccer players (CR). In this sense, the specialists expressed through their qualifications a mean in the average score for the CR indicator of 4.54 (between high and very high), evaluated as the second indicator with the highest score in the present investigation. This correlation became evident in the international literature, for example in the study by Gill (2020b), the alteration in VO2max was demonstrated after almost two months of detraining.

Finally, the NRE indicator that specified the need to improve aerobic endurance in Ecuadorian soccer reached an average score of 4 (high), an aspect that shows the importance in the process of directing sports training, since aerobic endurance is determinant in the sports performance of the soccer player. The aforementioned indicator justified a need in the practical environment of Ecuadorian soccer players and served as a foundation for taking future actions that lead to the improvement of maximum oxygen consumption, a strategy that the author of this research must support from the point of view of from the point of view of the practical contribution, a recurring theme in postgraduate studies and prospective action to be developed in the near future.

Table 2 showed the results achieved by Kendall's *W* coefficient, expressed in a value of 0.527, which constituted an acceptable value in the agreement of the specialists when qualifying each analysis indicator, an aspect that demonstrated the reliability in the evaluations issued by each specialist with an adequate degree of reliability (Table 2) and (Table 3).

Table 2. - Kendall's W coefficient

Rangos	
	Rango promedio
IRA	3,81
IRC	1,58
IVO2máx	3,46
CR	3,65
NRE	2,50



Table 3. - Test statistics

N	13
W de Kendall^a	,527
Chi-cuadrado	27,409
gl	4
Sig. asintótica	,000

a. Kendall's coefficient of agreement

CONCLUSIONS

With an acceptable degree of concordance, the research demonstrated the high theoretical importance given by a group of specialists consulted to establish the link between VO₂max and the recovery capacity of soccer players, as well as the importance of aerobic endurance in soccer training. and therefore, the importance of VO₂max as a directly related indicator. In relation to the above, there is a need as a recommendation of the research, to design development strategies to enhance the aerobic endurance capacity in Ecuadorian soccer from practice, for which the present research constituted a theoretical base that will support prospective actions in the immediate future.

THANKS

To the AFIDESA Research Group, from the University of the Armed Forces-ESPE.

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Conflict of interests:

The authors declare not to have any interest conflicts.

Authors' contribution:

The authors have participated in the writing of the work and analysis of the documents



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