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Methodological alternative for the physical preparation of referees for competitions at high altitude

[*Alternativa metodológica para la preparación física del árbitro ante competencias en zona alta*]

[*Alternativa metodológica para a preparação física do árbitro antes das competições na zona alta*]

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ABSTRACT

Introduction: high altitude training is always a current problem for sport, due to the diversity of modifications it generates in the human organism. In the case of soccer refereeing, it also generates it in this professional, due to the specific characteristics of their functions.

Objective: to design a methodological alternative for the physical preparation of referees for competitions at high altitude.

Materials and methods: a non-experimental and descriptive research with a single measurement, typical of transversal studies, was carried out. Theoretical, empirical and mathematical statistical methods and techniques were used.

Results: the results obtained by means of the nominal group technique show the level of relevance of the alternative presented.

Conclusions: the need to implement methodological proposals to transform the current situation of high-altitude soccer refereeing is evident.

Keywords: soccer, refereeing, methodological alternative, high altitude

RESUMEN

Introducción: el entrenamiento de altura siempre es una problémica actual para el deporte, por la diversidad de modificaciones que genera en el organismo humano. En el caso del arbitraje del fútbol, también lo genera en este profesional, por las características específicas de sus funciones.

Objetivo: diseñar una alternativa metodológica para la preparación física del árbitro ante competencias en zona alta.

Materiales y métodos: se realiza una investigación no experimental y descriptiva con medición única, típica de los estudios transversales. Para el mismo se utilizan métodos y técnicas tanto teóricos, como empíricos y matemáticos estadísticos.

Resultados: los resultados obtenidos mediante la técnica de grupo nominal evidencian el nivel de pertinencia de la alternativa presentada.

Conclusiones: se evidencia la necesidad de instrumentar propuestas metodológicas que transformen la situación actual del arbitraje del fútbol en altura.

Palabras clave: fútbol, arbitraje, alternativa metodológica, altura.

RESUMO

Introdução: o treinamento em altitude é sempre um problema atual para o esporte, devido à diversidade de modificações que gera no organismo humano. No caso da arbitragem de futebol, também gera isso neste profissional, pelas características específicas de suas funções.

Objetivo: desenhar uma alternativa metodológica para a preparação física do árbitro para competições na zona alta.

Materiais e métodos: realiza-se uma pesquisa não experimental e descritiva com uma única medida, típica de estudos transversais. Para isso, são utilizados métodos e técnicas matemáticas teóricas, empíricas e estatísticas.

Resultados: os resultados obtidos através da técnica de agrupamento nominal mostram o nível de relevância da alternativa apresentada.

Conclusões: é evidente a necessidade de implementar propostas metodológicas que transformem a situação atual da arbitragem do futebol de alta altitude.

Palavras-chave: futebol, arbitragem, alternativa metodológica, altura.

INTRODUCTION

The human organism, when facing altitude, presents different modifications in the respiratory, cardiovascular and endocrine systems. This can cause alterations in the functionality of the gesture to be performed in this scenario.

Among the main modifications of the organism when facing altitude are the following:

- Increased respiratory rate: To compensate for the reduce availability of oxygen, the body tends to increase the respiratory rate, which means that people breathe faster.
- Increased red blood cells production: The body can increase the production of red blood cells to transport more oxygen to the tissues. This process is known as erythropoiesis.

- Increased hemoglobin concentration: Hemoglobin is the protein in red blood cells that transports oxygen. At high altitudes, it can increase hemoglobin concentration to improve oxygen transport.
- Increased capillary density: More blood capillaries can develop in the tissues to improve oxygen supply to the cells.
- Increased oxygen efficiency: At the cellular level, the body can become more efficient in the use of oxygen, optimizing metabolic processes.
- Increased alveolar ventilation: The pulmonary alveoli may increase in number and size to improve the efficiency of gas exchange.

That is why this topic has been of interest to the sports scientific community. Because in several countries that have geographical diversity in their territories such as the highlands, coast and Amazon, in the particular case of Ecuador. They demand both players and referees to be in constant exchange with altitude.

Several authors such as (Soñén, Miguel, Azze, and de La Fuente, 2021; Jaramillo, 2022; Chanatasig, 2022; Yang, 2022). All of them have focused on substantiating and justifying the need to implement research in this area of sports sciences.

That is why the physical preparation of soccer referees is essential. They, like the players, must spend 90 minutes or more running during the match. Reason why adequate physical condition is required.

However, the above is required even more when they perform their functions at high altitude terrain. That is why the topic chosen for this research is current and novel and solves a current problem in Ecuadorian sports arbitration.

The Fédération Internationale de Football Association (French for `International Association Football Federation'; abbreviated as FIFA) considers that referees who compete at sea level follow numerous strategies to perform in games where there is altitude. One of the measures is to arrive at the place of the match a few hours before playing, although it is not a sufficient measure to achieve good acclimatization.

However, physical preparation plays a fundamental role in achieving an adequate performance at altitude.

The physical preparation of referees who work at altitude is essential to get them into physical fit, taking advantage of their natural aptitudes and developing their physical qualities through systematic and gradual exercises that allow the body to adapt to a specific work at altitude and obtain the maximum physical performance possible to face the refereeing of 90 or more minutes.

Several researchers such as (Castillo, López and Alonso, 2021), consider that in order to achieve an adequate performance at altitude, referees must perform physical preparation exercises aimed at developing all physical qualities, such as strength, endurance, speed, flexibility, necessary for the practice of any sport; as well as the development of all muscle groups, all organic functions, energy systems and varied movements.

Other authors (Alvarado, Cevallos and Calero, 2022; Faicán, 2022) have systematized that for correct physical preparation for referees working at altitude, exercises should be performed to increase the physiological values of their cardiovascular system and are modified by obtaining patterns in its heart rate, maximum oxygen consumption, heart rate and respiratory rate that allow the body to work with a lower energy cost.

On the other hand, (Acevedo, and Guzmán, 2020) reflect on the importance of performing exercises for the respiratory system. These should be oriented for referees at altitude in three fundamental directions. These are:

- Increase pulmonary ventilation so that the organism can better oxygenate the blood.
- Increase the depth of each breath.
- Increase vital capacity.

Aspects that are shared in the present investigation. Because they are in accordance with the main alterations of the human organism when facing some kind of altitude.

Researchers such as (Letrado, Martínez and Zamora, 2020). They propose a group of fundamental strategies for the work at altitude of soccer referees. Due to the demands that this demands to the human organism, these are summarized in:

Simulated altitude training:

- Performing training in a simulated altitude environment, such as hyperbaric chambers or altitude tents, can help the body gradually adapt to the lower oxygen pressure conditions.

Cardiovascular training:

- Include regular cardiovascular training, such as running, cycling or swimming, to improve cardiovascular capacity and oxygen transport efficiency.

Resistance training:

- Incorporate resistance exercises, such as weight lifting or resistance band training, to strengthen muscles and improve overall endurance.
- High intensity intervals.
- Include high-intensity intervals in training to improve the body's ability to handle oxygen deprivation and promote physiological adaptations.

Exercise at intermediate altitudes:

- Performing training sessions at intermediate altitudes before reaching higher altitudes can facilitate gradual acclimatization.

Gradual increase in altitude:

- If possible, gradually increase the altitude of your workouts to allow for progressive acclimatization. This can be done by climbing mountains or choosing higher altitude hiking routes over time.

Balance diet:

- Maintaining a balanced diet rich in iron and other essential nutrients can help in the production of red blood cells and improve oxygen-carrying capacity.

Iron and vitamin B12 supplements:

- In some cases, iron and vitamin B12 supplements may be beneficial, especially if there are nutritional deficiencies that could affect red blood cell production.
- The topicality and novelty of the previously valued authors is recognized. However, in theirs proposals do not specify how to carry out a methodological plan of physical preparation for soccer referees who work at high altitude. That is why in a diagnosis made to referees of the first division of Ecuadorian soccer who have worked at high altitude with the application of a survey, a group of limitations that hinder this topic were identified. This can be summarized as follows:
- There is a lack of methodological tools to guide soccer referees in their physical preparation for high altitude matches.
- It was found that there are several cardiovascular and respiratory alterations in referees during high altitude matches that are not adequately treated in their preparation.
- Little knowledge of the referees on what physical exercises to perform as a means of preparation for high altitude matches.

The following research problem is identified: How to contribute to the physical preparation of soccer referees who perform at high altitude?

The objective is to design a methodological alternative for the physical preparation of the soccer referee for competitions at high altitude.

MATERIALS AND METHODS

For the present research, the mixed paradigm is assumed, since it takes aspects of qualitative and quantitative research, due to the nature of the topic studied.

That is why, at first, elements of the qualitative modality are taken. It allowed the collection of different research related to the physical preparation of soccer referees who work at high altitude and its consequences, observing the current situation in which they are exposed, it was used for the interpretation of data from the consultation to the members of the nominal group.

Quantitative modality: It allowed the results of the research instruments to be expressed in number, since it was oriented towards the collection of data and the use of statistics by using the quantification of the criteria of the members of the nominal group as a consensus technique. For this purpose, a Likert scale is created with three categories: very adequate (3); somewhat adequate (2) and not adequate (1).

A cross-sectional design was carried out. This type of non-experimental design is used because it allows data collection at a given moment in the research. In this case, only the members of the nominal group were consulted, and they had to approve their assessment by consensus.

The methods and techniques used in the research are described below. These were contextualized to the research nature of the subject analyzed and to the objectives pursued by this research.

Theoretical

Analytical-synthetic: it allowed to carry out a study on the theoretical and methodological foundations that support the methodological alternative for the physical preparation of the referee for competitions at high altitude. It was used for the systematization, generalization and concretization of the processed information.

Inductive-deductive: it made it possible to make inferences and generalizations about the referee's physical preparation for competitions at high altitude, as well as the interpretation of the data obtained, from which new logical conclusions are deduced.

Empirical

Survey: this is used in the initial stage of the research to carry out the exploratory diagnosis and identify insufficiencies in the subject under investigation.

Nominal group: it was taken into account as a consensus technique to theoretically evaluate the alternative presented and thus determine its level of relevance in correspondence with the criteria of the Likert scale designed.

Mathematical statistics

Statistical analyzes were performed with SPSS v. 20 software. (SPSS Inc , Chicago, IL, United States). Data relating to descriptive statistics will be presented by frequency distribution and percentage analysis.

RESULTS AND DISCUSSION

Summary of the main aspects of the methodological alternative for the physical preparation of the referee for competitions at high altitude

The alternative is a scientific result that allows solving the problems that arise as an expression of a social need, the transformation because it is flexible, dynamic and encouraging based on an existing theory and taking into account direct practical experience, produces new knowledge and therefore, should transform the social reality.

Being consistent with what was previously stated in this research, we assume what was stated by (Montejo, 2017), which states that:

> … "an alternative can be considered a methodology, but it differs from it, because it is opposed to other possible previous solutions to the problem analyzed, having a specific character, that is, it is not systematically presented in practice, so it does not reach a certain degree of generality" (p.38)

Therefore, the alternative is a scientific result that allows solving the problems that arise as an expression of a social need, the transformation as it is flexible, dynamic and incentivizing from an existing theory and taking into account the direct practical experience, produces new knowledge.

The elaborated alternative has the following qualities:

- Systemic: it contains different parts interrelated to each other, they work harmoniously and each one reinforces the existence of the other.
- Open: it facilitates the annexation of other elements and the assumption of changes for its improvement.
- Flexible: it responds to an anti-dogmatic dynamic and with a level of decentralization that supports the creative initiative of those who apply it.

Structure of the methodological alternative. Contextualized from (Montejo, 2017)

Stage I. Diagnosis

This stage involves the planning and implementation of the organizational actions necessary to carry out the diagnosis by the executor. This requires the design and assurance of such diagnosis as a practical process. This stage leads to the development of four actions:

1. Objective of the diagnosis.
2. Content of the diagnosis.
3. Application of the diagnosis.
4. Information processing.

Stage II. Elaboration

Actions to be taken at this stage:

- Analysis of the physiological fundamentals of physical exercise and its role in the physical preparation of soccer referees working at high-altitude matches.
- Inclusion of indications and recommendations for their correct performance.
- Elaboration of a compendium of physical exercises for the physical preparation of soccer referees working at high-altitude matches.
- Evaluation of the alternative by means of the nominal group.

Stage III. Implementation

For the implementation of the methodological alternative, two (2) workshops are proposed at first, based on the criterion that the "workshop" is a form of organization of the teaching-learning process, which has been developed by some Cuban and Latin American authors for initial and continuous training.

Actions to be taken at this stage:

- Design workshops to prepare referees.
- Elaborate the implementation schedule.

Example of a workshop:

Workshop No. 1. (Framing Workshop).

Topic: main characteristics of the physical preparation of referees working at high altitude.

Objective: to familiarize participants with the need to work towards an adequate physical preparation of referees working at altitude.

Development:

We then proceed with the course framework (clear and precise explanation of the operating rules, objectives and agenda).

To following question will be asked to initiate the discussion:

What are the characteristics of working at high altitude?

What are the main exercises to be performed for the physical preparation of referees working at altitude?

Examples of some of the physical exercises included in the methodological alternative

Physical exercises for the cardiovascular system:

- Running or jogging: improves cardiovascular endurance and lung capacity.
- Cycling: helps strengthen the legs and improve cardiovascular endurance.
- Swimming: A low-impact cardiovascular exercise that also works many muscle groups.

High Intensity Interval Training (HIIT):

- Incorporate short, high-intensity intervals followed by rest periods. This improves the body's ability to use oxygen more efficiently.
- Perform physical activity such as hiking and climbing.
- Walking uphill and climbing on steep terrain helps to get used to the altitude conditions and strengthens the legs and lungs.

Resistance training:

- Weight lifting: strengthens muscles and improves endurance.
- Resistance band training: Provides additional resistance during exercises, strengthening specific muscles.

Breathing exercises:

- Deep breathing training: Improves lung capacity and helps in adaptation to lower oxygen pressure.
- Qi -gong exercises to improve breathing.

Circuit training:

- Combine different exercises to work on strength, endurance and cardiovascular capacity in an efficient way.

Core Training:

- Strengthening core muscles improves posture and stability, which is especially important on uneven terrain.

Stairs:

- Climbing and descending stairs is an effective exercise to strengthen the legs and improve cardiovascular capacity.

Stage IV. Evaluation

Once the alternative has been implemented, it is evaluated, analyzing whether the objectives of the stages of the alternative were met, how the system of actions influenced it and whether there is any variation in the expected results, in order to take measures for change. All of which is part of the flexibility that the alternative and the planned actions must have.

At this stage, the control is performed and is revealed at each moment of the previous stages, allowing the regulation and readjustment in each of them and the transit through the different moments and the culmination of the alternative.

Nominal group results

There are several authors who propose that the nominal group technique is an ideal way to determine the relevance of research proposals. This study assumes the procedures of Carrascosa *et al.* (2022). Which will be described below.

The nominal group was made up of ten specialists, selected on the basis of their work functions, years of experience in physical preparation for soccer referees working at high altitude and also related to the research topic. The distribution of the members of the nominal group is presented (Table 1).

Table 1. *- Distribution of nominal group members*

Qualification	Specialty	Quantity
Licensed	Physical activity and sport pedagogy	5
Magister	Physical activity and sport pedagogy	3
Doctor of Science (PhD)	Physical Culture Sciences	2

Procedure followed in the nominal group

A meeting is held with those involved where the authors of the research present the content stages of the alternative, explain them and describe how each one of them works. Then a discussion is held where the members give their opinion on the matter and the modifications that are understood to be pertinent are then made.

The instrument was applied in two moments, the first for the group members to provide their assessment through questions on the elements asked, and the second moment shows the unified arguments of the opinions given in the previous evaluation round, so that they can examine the aspects of the problem in more detail and issue an assessment.

Results

The results of the nominal group are presented below. For this purpose, each of the criteria that were submitted for evaluation by the members are analyzed. The results are shown in Figure 1 of this research (Figure 1).

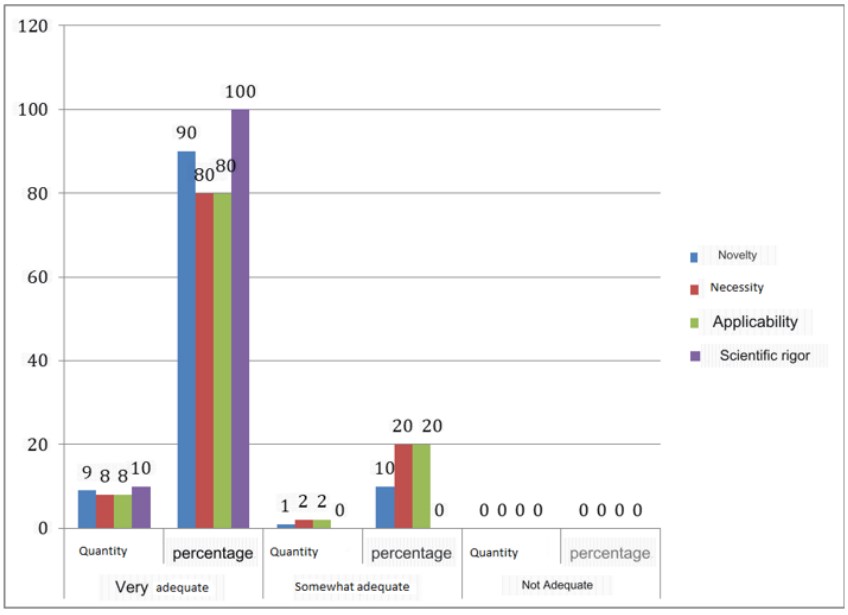

Fig.1. *- Results of the nominal group assessments*

When evaluating the first indicator referred to the novelty of the methodological alternative for the physical preparation of the referee for competitions at high altitude, nine of the members of the group (90 %) gave it the category of Very adequate. Only one (10 %) gave it the category of Somewhat adequate. It is worth mentioning that none of them stated that the alternative was Not adequate.

The necessity indicator had similar results. Eight, for 80%, assigned it the category Very adecuate. While only two for 20 % valued it as Somewhat adequate. The category Not adecuate was not found with any score.

The applicability indicator had the same results as the previous one. This denotes that there is an important relationship between the necessity and the applicability of the methodological alternative for the physical preparation of the referee for competitions at high altitude. This makes it evident that this topic solves a problem of current sports practice.

The indicator scientific rigor was the one with the highest score, since 100% of the group members by consensus considered that each of the stages, actions, exercises and workshops of the methodological alternative were elaborated under scientific rigor. This aspect gives validity to the proposal developed in this research.

Based on the criteria expressed by the members of the nominal group, it can be stated that the proposal presented can be applied to the physical training of referees working at high altitude. Since there was consensus among the members of the group and since these professionals are knowledgeable and experienced in the subject, it can be stated that the methodological alternative developed is relevant.

Validation of the study

Table 2. *- Pearson correlation results*

		Novelty	Necessity	Applicability	Rigor
Novelty	Pearson correlation	1	.667 *	.667 *	.667 *
	Sig. (bilateral)	-	.005	.005	.005
	N	10	10	10	10
Necessity	Pearson correlation	.667 *	1	1,000 **	.667 *
	Sig. (bilateral)	.005	-	,000	.005
	N	10	10	10	10
Applicability	Pearson correlation	.667 *	1,000 **	1	.667 *
	Sig. (bilateral)	.005	,000	-	.005
	N	10	10	10	10
Rigor	Pearson correlation	.667 *	.667 *	.667 *	. b
	Sig. (bilateral)	.005	.005	.005	-
	N	10	10	10	10

Correlations

**. Correlation is significant at the 0.05 level (bilateral).*

***. Correlation is significant at the 0.01 level (bilateral).*

b. It cannot be calculated because at least one variable is constant.

Source*: processed with SPSS v 20 for Windows*

As shown in table 2. The correlation matrix of each of the four indicators subjected to evaluation, shows a high level of correlation, since p is equal to or less than 0.05. Which shows that the results obtained were significant, aspects that confirm the validity of the research developed (Table 2).

The researchers (Da Silva, Fernández, and Fernández Pérez, 2008), these authors only focused on assessing the level of physical fitness and body composition of the referees of the Federaç¥o Paranaense de Futebol (FPF) in English: Football Association of Paraná state. The sample consisted of 224 FPF referees, all male. The results are very valuable and their timeliness and novelty are recognized. The main difference between this research and those presented below is that it does not create specific bases for referees working at high altitude.

It is necessary to mention that (Solís, Cruz, and Plaza, 2020) delved into the development of resistance in professional soccer referees. Their research focused on analyzing the physical preparation and sports injuries in the members of the Referees Association, for

which the problem was known little treated through exploratory research, then the behavior was described in the context of performance. These results served as a basis to support this research. However, the main difference lies in the methodological organization by stages of physical preparation for soccer referees working at altitude.

On the other hand, (Escobar et al., 2020), links physical preparation with soccer refereeing decision making. This research proposes some of the exercises very similar to those presented in this research. However, this study did not take into account the auxiliary sport as an essential means for the training of the cardiovascular system. Aspects that were included in our proposal were swimming and cycling, just to mention two examples.

The study by (Ortega, 2023), in this research describes the anthropometric profile and physical condition of Colombian soccer referees to establish training plans with scientific and methodological criteria. However, it does not use altitude training, nor its evaluation of the same. These are essential aspects due to the transformations they cause in the human organism.

CONCLUSIONS

The theoretical and methodological foundations systematized during the research process show the importance of the physical preparation of the soccer referee for competitions at high altitude.

In order to solve the problem, a methodological alternative was designed for the physical preparation of the soccer referee for competitions at high altitude, containing stages, actions, preparation workshops and physical exercises for high altitude.

The results obtained in the implementation of the nominal group corroborate the relevance of the methodological alternative for the physical preparation of the soccer referee for competitions at high altitude.

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***Author contribution statement*:**

The authors have participated in the redaction of the manuscript and the documentary review.