Ciencia y Deporte

Methodology for the evaluation of morphological optimization in school category boxers

[*Metodología para la evaluación de la optimización morfológica en boxeadores de categoría escolar*]

[*Metodologia para Avaliação da Otimização Morfológica em Pugilistas emIdade Escolar*]

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ABSTRACT

Introduction: This article was written after identifying theoretical, methodological, and practical shortcomings in the process of sports medical monitoring of school-age boxers. This is compounded by existing research that does not integrate anthropometric,

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biomedical, and physical indicators into the monitoring process, hindering a more accurate assessment of morphological optimization.

Objective: To develop a methodology, based on a theoretical framework for the medical monitoring of sports training, that allows for the evaluation of morphological optimization in school-age boxers at the Granma Sports Initiation School.

Materials and methods: At the theoretical level, the structural-functional, systematic, analytical-synthetic, and hypothetical-deductive methods were used. At the empirical level, the methods employed included observation, document analysis, surveys, expert judgment (Delphi method), and an experimental approach using a pre-test and post-test for the same group. Descriptive statistics included percentage analysis, mean, and standard deviation. Inferential statistics were used to compare the results obtained in the pedagogical tests where quantitative variables were observed, using the Wilcoxon signed-rank test and the Student's t-test, with SPSS version 25.

Results: The study examines the development of variables related to morphological optimization and indicators specific to sports medicine monitoring during the training process. This is achieved through the implementation of a methodology organized in stages that lead to an evaluation of morphological optimization, after being theoretically validated by a group of experts.

Conclusions: The proposed methodology contributed to the improvement of the morphological efficiency index, with the majority of the evaluated boxers falling into the excellent, acceptable, and moderate levels, where only two athletes showed stagnation.

Keywords: evaluation; boxer shorts; index; efficiency.

RESUMEN

Introducción: el presente artículo se realizó a partir de detectar insuficiencias teórico-metodológicas y prácticas en el proceso del control médico deportivo en boxeadores de categoría escolar, unido a las investigaciones realizadas que no incluyen durante los

controles indicadores antropométricos, biomédicos y físicos de forma integrada que permita realizar una evaluación más acertada de la optimización morfológica.

Objetivo: elaborar una metodología, sustentada en una concepción teórica del control médico del entrenamiento deportivo, que permita la evaluación de la optimización morfológica en boxeadores de categoría escolar de la Escuela de Iniciación Deportiva de Granma.

Materiales y métodos: del nivel teórico, el sistémico estructural funcional, el analítico sintético, el hipotético-deductivo, y dentro del nivel empírico, la observación, el análisis de documentos, la encuesta, el criterio de expertos (Delphi), el experimental mediante un pretest y un postest para un mismo grupo, de la estadística descriptiva, el análisis porcentual, la media y la desviación estándar. La estadística inferencial en la comparación de los resultados obtenidos en los test pedagógicos donde se observaron variables cuantitativas, mediante la prueba de hipótesis de Wilcoxon y la prueba T de Student, del paquete estadístico SPSS, versión 25.

Resultados: se estudia el desarrollo de variables relacionadas con la optimización morfológica e indicadores propios del control médico deportivo durante el proceso de entrenamiento a partir de la puesta en práctica de una metodología organizada en etapas que conducen al logro de una evaluación de la optimización morfológica, luego de ser validada teóricamente por el grupo de expertos.

Conclusiones: la metodología propuesta, contribuyó al progreso del índice de eficiencia morfológica, con la mayor ubicación de los boxeadores evaluados entre los niveles de excelente, aceptable y moderada, donde solo dos atetas mostraron estancamiento

Palabras clave: evaluación; boxeadores; índice; eficiencia.

RESUMO

Introdução: Este artigo foi escrito após a identificação de lacunas teóricas, metodológicas e práticas no processo de monitoramento médico esportivo de boxeadores em idade escolar. Essa lacuna é agravada pela ausência de integração de indicadores

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antropométricos, biomédicos e físicos no processo de monitoramento, o que dificulta uma avaliação mais precisa da otimização morfológica.

Objetivo: Desenvolver uma metodologia, fundamentada em um referencial teórico para o monitoramento médico do treinamento esportivo, que permita a avaliação da otimização morfológica em boxeadores em idade escolar da Escola de Iniciação Esportiva Granma.

Materiais e métodos: No âmbito teórico, a metodologia empregada foi sistêmico-estrutural-funcional, analítico-sintética e hipotético-dedutiva. No âmbito empírico, os métodos incluíram observação, análise documental, questionários, avaliação por especialistas (método Delphi) e uma abordagem experimental com pré-teste e pós-teste para o mesmo grupo. As estatísticas descritivas incluíram análise percentual, média e desvio padrão. Estatísticas inferenciais foram utilizadas para comparar os resultados obtidos nos testes pedagógicos onde variáveis quantitativas foram observadas, utilizando o teste de Wilcoxon para postos sinalizados e o teste t de Student, com o pacote estatístico SPSS, versão 25.

Resultados: Estudou-se o desenvolvimento de variáveis relacionadas à otimização morfológica e indicadores específicos para o monitoramento em medicina esportiva durante o processo de treinamento. Isso se baseou na implementação de uma metodologia organizada em etapas que levam à obtenção de uma avaliação da otimização morfológica, após ser validada teoricamente por um grupo de especialistas.

Conclusões: A metodologia proposta contribuiu para a melhoria do índice de eficiência morfológica, com a maioria dos boxeadores avaliados enquadrando-se nos níveis excelente, aceitável e moderado, onde apenas dois atletas apresentaram estagnação.

Palavras-chave: avaliação; boxeadores; índice; eficiência.

INTRODUCTION

In recent decades, combat sports have gained considerable popularity and recognition worldwide, with boxing standing out as one of the most widely practiced. This discipline not only offers a competitive environment but also promotes the physical and mental

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development of its practitioners. In particular, school boxing has emerged as a conducive environment for fostering essential skills in young people, such as discipline, concentration, and teamwork (Martínez & Rojas, 2021). However, participation in this sport entails significant challenges that require careful attention, especially regarding the health and safety of young athletes.

Therefore, medical monitoring in the training of school-age boxers has become increasingly important. As more young people become involved in boxing, the requirement for regular medical checkups becomes essential to prevent short- and long-term injuries. Boxers, being adolescents in critical stages of development, are particularly vulnerable to problems related to physical overload and injuries; therefore, it is essential to implement monitoring programs that ensure training is safe and effective, allowing young athletes to focus on their technical progress without compromising their health (Sullivan, 2020).

In this context, morphological optimization plays a fundamental role. The term "morphological optimization" refers to the culmination of a body shape and composition after having undergone a process of natural selection through successive generations, as well as adaptation to the training demands of the current generation (Norton and Olds 2001; Lozovina and Lozovina 2008).

This concept refers to the adjustment and improvement of an athlete's physical characteristics, ensuring they align with the specific demands of boxing. Morphological optimization not only has a positive impact on athletic performance but also contributes to better technique and strategy in the ring (Orozco & Martínez, 2023). For school-aged boxers, this approach can translate into greater effectiveness in their movements, improved endurance, and a reduced risk of injury.

Currently, combining medical monitoring with morphological optimization programs is emerging as a necessary and valuable strategy for the sustainable development of young boxers. By adopting an evidence-based approach that considers both health and performance, more well-rounded and resilient athletes can be developed (Reyes, 2023).

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Furthermore, this practice addresses the growing concern within the sports community for the well-being of young people, underscoring the need to implement appropriate protocols at all levels of sports training.

Therefore, the evaluation of morphological optimization in school-age boxers is a topic of great relevance today. It not only contributes to improved athletic performance but also ensures the health and safety of young athletes. When this area is explored in greater depth, it becomes clear that school boxing, supported by adequate medical monitoring and a focus on physical optimization, can be a powerful tool in the comprehensive development of young athletes. Morphological optimization in sports has its roots in the first somatotype studies developed in the 1940s, with a constitutional classification of the human body into three categories: endomorph (predominance of fat), mesomorph (muscularity), and ectomorph (linearity). Although the original model has been criticized for its deterministic approach, it laid the groundwork for subsequent research linking body morphology to athletic performance.

In this regard, one of the earliest studies on the topic was conducted on university athletes (Polednak 1975). This author compared data from two cohorts of Harvard college athletes collected over a period of five decades (1850-1899) and concluded that the samples constituted by the 1860-1869 and 1890-1899 birth cohorts were significantly different and that differential selection for body size in these athletes can explain the differences in the magnitude of secular evolution when analyzing a specific sport.

Ross and Carter's (1984) studies examined secular acceleration in male athletes attending the Olympics, in track and field events, from 1928 to 1976 and showed that proportional weight increased dramatically in discus, shot put, and hammer throwers.

An analysis of publications related to the topic showed that they assumed weight and body mass index as a measure of body composition in athletes, while height was assumed as an indirect measure of the evolution of body segments, considering that weight and height are the most representative variables of morphology and explain the increase in strength, speed, power and better biomechanics during performance.

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On the other hand, Slimani *et al.* (2017) conducted a review concluding that elite boxers share specific morphological characteristics, such as a low percentage of body fat (between 8% and 12%) and a balanced muscle distribution between upper and lower extremities. These attributes not only improve punching power but also recovery capacity between rounds, reinforcing the idea that body optimization should be accompanied by personalized physiological training, since variables such as maximum oxygen consumption (VO_2 max) and anaerobic endurance vary according to the athlete's morphological profile.

At the national level, studies were conducted in the 1980s that contributed to the development of kinanthropometry (Carvajal (2017). In general terms, the main contributions were the following: the establishment of the anthropometric profile of the most successful Cuban athletes, the establishment of reference values for the study of body composition, and the development of various algorithms for monitoring body composition adaptations during training.

Subsequently, changes were made to the working methods with the purpose of perfecting the morphological evolution of the Cuban sports population, where marked differences were found for the somatotype and body composition of Cuban athletes, related to weight-staturic trends, which constituted the first existing research on the subject in the national context.

Other research has shown that the processes of morphological optimization, based on talent selection and successive adaptation to training demands, have brought about changes in the physical structure and body composition of Cuban athletes, as well as their evolution and morphological optimization over the decades.

Studies conducted in the province of Granma have focused on anthropometric indicators from different disciplines that comprise the sports groups Arzuaga and Vega (2017), and other isolated works on estimating the range of anthropometric characteristics in various macro cycles of preparation of school athletes from the Eide of Granma, including combat sports, but there is no evidence of research that addresses the study of

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anthropometric, biomedical and physical indicators in an integrated way that allows for a more accurate evaluation of morphological optimization in boxers of the school category.

From all these approaches, the problematic situation of this research is derived, expressed in the absence of integration of morphological, biomedical and physical indicators with an impact on the evaluation of morphological optimization in school category boxers, resulting from the contradiction between the current evaluative process of body composition, referred to in a traditional approach and the need to integrate morphological, biomedical and physical indicators that allow the evaluation of morphological optimization within the framework of medical control of sports training in school category boxers.

Therefore, the scientific problem of the present research consists of: How to favor the evaluation of morphological optimization, during the medical control process of sports training in boxers of the school category in the Sports Initiation School in the province of Granma?

Consequently, the object of study is defined as the Medical Control of Sports Training in school-age boxers. To address the problem, the following objective was established: To develop a methodology, based on a theoretical conception of the medical control of sports training, that allows the evaluation of morphological optimization in school category boxers from the Sports Initiation School of Granma.

MATERIALS AND METHODS

In the research, theoretical methods were used that allowed the essential relationships of the research object not directly observable to be revealed, in the stages of problem formulation, hypothesis and analysis of results, establishing a logic of discovery through which the data obtained were transformed into empirical generalizations, while the

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empirical methods fulfilled the function of revealing and explaining the characteristics of the research object, as well as participation in the search for initial empirical information and in the collection of information for the achievement of the objectives.

Among the theoretical level methods used were the systemic structural functional, the analytical synthetic, and the hypothetical-deductive; and among the empirical level methods and techniques, observation, document analysis, survey, expert criteria, and the experimental method through a pre-experiment using a pretest and a posttest for the same group; among the mathematical statistics, descriptive statistics, percentage analysis, the mean, and the standard deviation.

Descriptive statistics, to collect, order, analyze, interpret and represent a set of data, in order to appropriately describe its characteristics, based on the arithmetic mean, standard deviation, empirical frequency distribution and percentage distribution.

Inferential statistics, to test the hypothesis, estimate parameters and compare the results obtained in the different pedagogical and biomedical tests where quantitative variables were observed, the Wilcoxon test available in the SPSS statistical package, version 25, was applied with a significance level of $\alpha = 0,05$.

The research was conducted between September 2023 and July 2024. The sample consisted of 13 male boxers in the school-age category who participated in the National School Games. These athletes were drawn from a population of 43, with an average age of 13.6 years and an average of five years of sports experience. The coaches working with this age group have 15 years of experience and are university graduates with degrees in Physical Culture. The group underwent a pre-test before the experimental stimulus or treatment. All participants belonged to the Pedro Batista Fonseca School of Sports Initiation in Bayamo, Granma.

In the factual analysis carried out based on the problems faced, and supported by the review of regulatory documents, interviews, surveys and observation of training sessions, the following shortcomings were detected:

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- The research conducted is usually based on small samples or elite athletes, which limits the generalizability of the findings, with a lack of multidisciplinary approaches that integrate morphological, biomedical and physical aspects.

- Insufficient contextualization and systematization of the evaluation of morphological optimization within the framework of medical control of training in school category boxers.

- The process of evaluating anthropometric characteristics is directed towards general characterization, and not towards integrated indicators that enable the evaluation of morphological optimization, which are essential to assess the response to training demands.

- The regulatory documents lack an organizational analysis for the evaluation of morphological optimization in school-level combat sports, limiting their integration into the medical control of sports training.

The study was structured according to the methodological approach taken, the dimensions and indicators during sports medical control, the integration of the morphological, biomedical and physical capacities of the school category boxer and their impact on the morphological efficiency index.

The evaluation of morphological optimization in school-age boxers refers to the comprehensive analysis of the physical and structural characteristics of the athletes' bodies, considering how these fit the specific requirements of boxing in this category. It involves identifying the degree to which body composition and physical development contribute to athletic performance, allowing us to determine if the boxers have an adequate and balanced physical profile for their performance in the school-age category.

The evaluation of morphological optimization was carried out by measuring the following indicators:

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Morphological dimension: weight, height, % of fat: IAKS, active body mass and the sum of six skin folds (triceps, subscapular, suprailiac, abdominal, medial thigh and calf).

Biomedical dimension: hemoglobin and caloric intake.

Physical dimension: endurance in 1000 meters, speed 30 meters, jump ability through the *Sargent test* modified by Lewis and push-ups for upper limb strength.

Each of these indicators was measured following standardized protocols and will be compared with the values considered optimal for the school category in the context of boxing, thus allowing the determination of the level of morphological optimization in each athlete.

optimization in school-aged boxers is determined using the Morphological Efficiency Index, which integrates morphological, biomedical, and physical characteristics. To obtain the Morphological Efficiency Index, the value for each of the dimensions described above is determined and then summed to obtain a total value. This value reflects the integration of the school-aged boxer's morphological, biomedical, and physical capabilities; a higher index indicates better morphological optimization and, potentially, improved performance in the sport.

The construction of the assessment scales for the dimensions and the Morphological Efficiency Index was based on the calculation of the standardized z-score. The corresponding *z- score* represents the number of standard deviations that a given value is from the mean of the set of observations. The calculation of standardized z-scores makes no assumptions about the distribution of the data.

In evaluating the progress of the morphological dimension between the start of general physical preparation and the end of specific physical preparation, changes ≥10% were considered high efficiency, 5% to 9.9% acceptable efficiency, and <5% no relevant changes. (International Society for the Advancement of Kinanthropometry , Gómez-Landero *et al.* , 2020; Inder, 2023). For the progress of the biomedical dimension between

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the start and end of preparation, an increase of ≥8% was considered metabolically optimal (Cuban Institute of Sports Medicine, IMD Cuba, 2023).

Regarding the physical dimension, progress between the start of general physical preparation and the end of special physical preparation was assessed: an increase of ≥12% as high performance; increases of 6% to 11.9% are related to acceptable performance; an increase <6% is associated with low progress AIBA (2023).

For the evaluation of IEM progress between the beginning and end of the preparatory period, the percentage of changes determines the degree of optimization, where a change ≥ 15% is considered excellent optimization (comprehensive improvement in all dimensions), between 10 and 14.9% significant optimization (progress in 2/3 dimensions, without critical setbacks), 5 to 9.9% moderate optimization (improvement in at least one dimension, others stable), -4.9 to +4.9% stagnation (no relevant changes), and ≤ -5% regression (worsening in ≥1 dimension; requires immediate intervention).

the structure of the theoretical conception of sports medical control and the methodology for the evaluation of morphological optimization in school-age boxers was designed . This allowed the establishment of a hierarchy and relationships between its components, giving it a systemic character in all its dimensions, which facilitated the coherence and integrity of the methodology and its foundation.

RESULTS AND DISCUSSION

In the first stage of the investigation, the most current references regarding sports medical control in school category boxers were determined, seen from the understanding of different forms of evaluation, indicators, medical tests, physical tests, which allowed to delimit the advantages of the evaluation of morphological optimization and its inclusion within the control in school category boxers.

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It was determined that the investigations have been framed within studies on the kinanthropometric characteristics in various macrocycles of preparation of school athletes, including combat sports, but there is no evidence of research that addresses the study of anthropometric, biomedical and physical indicators in an integrated way that allows for a more accurate assessment of morphological optimization in boxers of the school category.

The application of the structural and functional systemic method as a logical method that accompanies the modeling, allowed the design of a theoretical conception of the sports medical control process, as well as the methodology for the evaluation of morphological optimization, modeling the object by determining its components, as well as the interrelation between them, determining on the one hand the structure and hierarchy of each component, and on the other hand, its dynamics and functioning.

The results obtained laid the foundation for designing a methodology to assess morphological optimization in school-aged boxers, essential for supporting their holistic development and athletic performance. This process is based on sound theoretical approaches that consider the growth and specific needs of young athletes. Furthermore, validated tools are used to ensure the reliability and comparability of the data obtained, thus enabling a more precise analysis of each boxer's progress in the school-aged category.

Furthermore, the methodology is applied in a personalized way, recognizing that each athlete has unique characteristics that require an individualized approach; it has clear practical applications for sports doctors, coaches and other professionals, allowing direct translations into training recommendations, thus promoting healthy and sustainable development in school boxers.

The proposed methodology was designed to address the need for accurate assessment, control, and monitoring of morphological optimization in school-age boxers in the province of Granma. It integrates the approaches of Patton (2020) and Kemmis *et al.* (2022), combining evaluative flexibility with the active participation of stakeholders.

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This approach is justified by the dynamic nature of training for school-age boxers, where variables such as biomedical aspects, body composition, and physical performance require continuous monitoring. The proposed scientific outcome has the following characteristics.

Instructive: It is a tool for professional development and improvement of the work of sports physicians; it provides a novel approach to morphological optimization within the medical control of sports training.

Integrative: the structuring of the methodology is facilitated by the integration of the contents that make it possible to carry out the evaluation of morphological optimization, in relation to sports training, the medical control of sports training and the indicators that guide the comprehensive programs of preparation of the Cuban athlete.

Flexible: the contents and indicators declared in the methodology are not rigid, as they can be adjusted to the characteristics of the sports groups.

Systematic: When selecting the content of the methodology structure, the objective was taken into account, as well as its internal relationships as a system, which supports the logical order of the stages in its functionality and meets the following characteristics:

Hierarchy: the components of the methodology are ordered according to a principle, from which it is established which are the components and which are the stages;

Adaptability: the property of the methodology to modify its components, stages, or characteristics according to the changes that the context undergoes; integration: a change that occurs in any of its components produces changes in the others and in the methodology as a whole.

To verify the practical feasibility of the methodology, it was submitted to expert review using the Delphi variant. A total of 30 subjects were intentionally selected from Cuban specialists with publications on the topic, identified in the SCOPUS (ScienceDirect), EBESCO, and Scielo databases. Selection criteria included, firstly, professional

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experience related to the research topic, studies conducted that were relevant to the topic, academic degree, teaching rank, position held, and years of experience working in the field of sports science; and secondly, a demonstrated *competence coefficient.* of 0.8 or more (high), determined from the administration to each potential expert of an instrument to evaluate it.

The minimum optimal number of experts was determined using a probabilistic method and assuming a binomial probability law , where M is the number of experts to be selected, i is the level of precision achieved (it is recommended between 0.14 and 0.5), p is the estimated proportion of the error and k is a constant whose value is associated with the $M = p(1-p)k/i2$ selected confidence level (1-).α

The calculation was based on an error of 5% (p=0.5), an i value of 0.25 and a confidence level of 95%, for which k is equal to 3.84:

Finally, among those who showed a high competence coefficient, the 30 with the highest coefficient were selected, with the following characteristics:

- Doctors in Physical Culture and Sports Sciences: 15 (50%).
- Specialists for high performance: 8 (26.6%).
- Master of Science: 5 (16.6%).
- Graduates in Physical Culture: 2 (6.6%).
- Average professional experience: more than twenty years.

The group of experts was responsible for evaluating the proposed methodology specifically in five fundamental steps.

1. Internal structural coherence.
2. Content quality.
3. Functionality as a practical tool.
4. Contributions to the process (objectivity and scientificity).
5. Applicability in the current context of the provinces.

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Table 1. - Cumulative frequencies of evaluations, by aspect

Steps	Assessment				
	Very sure	TRUE	Moderately TRUE	Not entirely true	Uncertain
1	17	30	30	30	30
2	14	30	30	30	30
3	18	30	30	30	30
4	18	30	30	30	30
5	15	30	30	30	30
Total	82	150	150	150	150

The results of applying the Delphi prospective method allowed not only the improvement of the initial proposed solution to the problem, developed by the author of this thesis, but also an expert assessment of the quality, relevance and effectiveness of said proposal, prior to its application in practice (Table 1).

Thus, the experts generally agreed that the final proposal met the necessary characteristics to fulfill the objectives for which it was built, which is due to the fact that all the statements relating to the aspects evaluated were valued as very true (internal structural coherence, quality of content, applicability in the current context of the provinces, contributions to the process of objectivity and scientificity, and functionality as a practical instrument).

The proposed methodology was implemented during the macrocycle that began in September 2023 and ended in July 2024, where a pre-test (initial diagnosis) and a post-test were applied . Analyzing the health status diagnosis of the boxers in the school category, it can be observed that nine athletes, representing 69.2%, are apparently healthy; three present scoliosis of the spine (23.1%); and one athlete, representing 7.7%, has bronchial asthma. Therefore, it is confirmed that there is no pathology or health condition that would prevent the start of the sports preparation process.

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Analysis of the indicators by dimensions and the morphological efficiency index before starting the methodology (initial test)

Morphological dimension (IPFG)

With regard to the evaluation of the morphological dimension, it is observed that ten athletes, for 76.9%, present an acceptable morphology; two, for 15.4%, moderate morphology, while, in one athlete, for 7.7%, an excellent morphology was found.

Regarding its specific indicators:

Regarding body weight, seven athletes (53.8%) are above average, while six (46.2%) are below average. As for height, seven athletes (53.8%) are above average, while six (46.2%) are below average. Regarding body fat percentage, six athletes (46.2%) have figures above average, while seven (53.8%) have results below average.

Regarding IAKS, five athletes (38.5%) scored above the average, while eight athletes (61.5%) scored below the average for this indicator. With respect to active body mass and the sum of skinfold thicknesses, both indicators showed six athletes above the average (46.2%) and seven athletes below the average (53.8%) for both indicators.

Biomedical Dimension (IPFG)

In the evaluation of the biomedical dimension, it can be seen that ten athletes, for 76.9%, show acceptable optimization and three athletes, for 23.1%, show moderate optimization.

Regarding its specific indicators:

Regarding hemoglobin levels, ten athletes (76.9%) had levels below the established optimal values for school-age boxers, while three (23.1%) had optimal levels for the sport. Of the total sample, six (46.2%) had levels below the average, and seven (53.8%) had levels above the average. In terms of caloric intake, all 13 athletes (100%) received

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less than the established standard for school-age boxers: 2028 kcal, representing 58% of the recommended intake for this stage.

Physical Dimension (IPFG)

Regarding the evaluation of the physical dimension to the IPFG, it is shown that ten athletes, for 76.9%, present an acceptable optimization; two athletes, for 15.4%, show a moderate optimization and one athlete, for 7.7%, exhibits a low optimization in their physical performance.

Regarding its specific indicators:

Regarding the Sargent test modified by Lewis, seven athletes (53.8%) showed results at or above the average, while six (46.2%) were below the average. In terms of 30-meter sprint speed, seven athletes (53.8%) showed results above the average, while six (46.2%) were below the average.

Regarding 1000-meter endurance, nine athletes (69.2%) showed above-average results, while four (30.8%) scored below average. In the upper body strength assessment using 30-second push-ups, ten athletes (76.9%) scored at or above average, while three athletes (23.1%) scored below average.

Analysis of the indicators by dimensions after applying the methodology (final test)

Morphological dimension (FPFE)

The results of the measurement of the indicators for the evaluation of the morphological dimension at the end of the special physical preparation, show that 11 athletes, for 84.6%, show an acceptable morphological optimization, while two athletes representing 15.4% obtained an optimal optimization in terms of their physical structure.

Regarding its specific indicators :

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Regarding body weight, six athletes (46.2%) are above average, while seven (53.8%) are below average. As for height, seven athletes (53.8%) are above average, while six (46.2%) are below average. Regarding body fat percentage, six athletes (46.2%) have figures above average, while seven (53.8%) have results below average.

Regarding IAKS, seven athletes (53.8%) scored above the average, while six athletes (46.2%) scored below the average for this indicator. With respect to active body mass and the sum of skinfold thicknesses, both indicators showed six athletes above the average (46.2%) and seven athletes below the average (53.8%) for both indicators.

Biomedical Dimension (FPFE)

In the evaluation of the biomedical dimension at the end of the special physical preparation (FPFE), it is observed that in eight athletes, for 61.5%, an acceptable optimization was found and in five athletes, representing 38.5%, an optimal optimization is observed from a metabolic point of view.

Regarding its specific indicators:

Regarding hemoglobin levels, eight athletes (61.5%) had levels below the established optimal values for school-age boxers, while five (38.5%) had levels within the optimal range for the sport. Of the total sample, six (46.2%) had levels below the average, and seven (53.8%) had levels above the average. In terms of caloric intake, all 13 athletes (100%) received less than the established standard for school-age boxers: 2236 kcal, representing 63.9% of the norms established for this stage .

Dimension (FPFE)

The indicators for the evaluation of the physical dimension at the end of the special physical preparation (FPFE) reflect that the ten athletes, for 76.9%, are in the acceptable optimization range, while three athletes representing 23.1% obtained optimal optimization in relation to their physical performance.

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Regarding its specific indicators:

Regarding the Sargent test modified by Lewis, seven athletes (53.8%) scored at or above the average, while six (46.2%) scored below the average. As for the 30-meter sprint, four athletes (30.8%) scored above the average, while nine (69.2%) scored below the average.

Regarding 1000-meter endurance, three athletes (23.1%) showed above-average results, while ten athletes (76.9%) scored below average. In the upper body strength assessment using 30-second push-ups, ten athletes (76.9%) scored at or above average, while three athletes (23.1%) scored below average .

According to these data, it is observed that the values denote an increase in the results by dimensions after applying the methodology for the evaluation of morphological optimization in school category boxers (Figure 1).
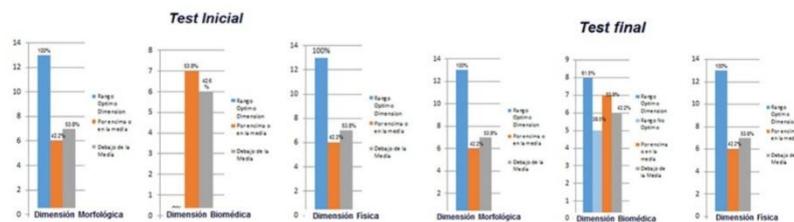

Fig. 1. - *Status of evaluation of dimensions and indicators by athletes*

Progress in the dimensions and in the IEM

Analyzing the percentage of progress in the morphological dimension, it was observed that one athlete (7.7%) was evaluated with high morphological efficiency; five (38.5%) with acceptable morphological efficiency; and seven (53.8%) with no relevant changes in their morphology. Of the total sample, five athletes (38.5%) achieved a percentage of progress at the end of the training period above the average, and eight (61.5%)

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performed below the average. Overall, the group average showed acceptable morphological efficiency.

The percentage of progress in the biomedical dimension showed that three athletes (23.0%) were evaluated as metabolically optimal; four (30.8%) showed partial changes; and six (46.2%) showed no significant changes. The group average showed partial metabolic modifications.

Regarding progress in the physical dimension, eight athletes (61.5%) were assessed as having high performance, one (7.7%) as having acceptable performance, and four (30.8%) as having low progress. Of the total sample, six athletes (46.2%) showed a percentage of progress in the physical dimension above the average, and seven athletes (53.8%) showed values below the average. Overall, the group average demonstrated high performance from a physical standpoint.

Analyzing the progress of the overall morphological efficiency index, it was observed that one athlete (7.7%) showed excellent optimization, four (30.8%) showed acceptable optimization, six (46.1%) showed moderate optimization, and two athletes (15.4%) showed stagnation in the progress of the morphological efficiency index at the end of the preparation period. Of the total sample, six athletes (46.2%) showed a percentage of progress in the overall morphological efficiency index above the average, and seven athletes (53.8%) showed values below the average. The overall average for the group showed moderate morphological optimization with 8.8% progress. (Figure 2).
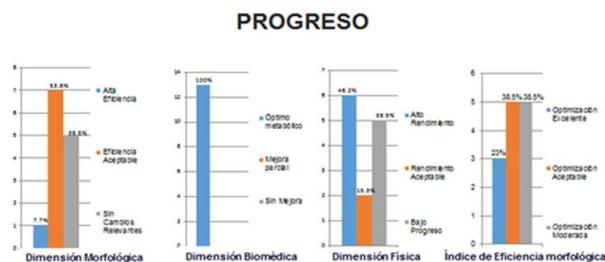

Fig. 2. - Progress in dimensions and in the IEM

In the analysis of the morphological dimension's behavior using the Student's t-test , a significance was found : p = 0.010 (significant , p < 0.05), with an increase in the mean; the effect size was 0.84 , considered large , indicating a significant and considerable difference in the means. The confidence interval (95%) is observed from 0.237 to 1.443, so the average difference is in that range, without crossing zero, confirming that the change is statistically significant and the power The statistic was 88.6 %, so there is a high probability of detecting the real difference if it exists.

The biomedical dimension was tested using the Student's t-test, which yielded a significant result: p = 0.000 (highly significant), with an increase in the mean. The effect size was 2.18, considered very large , indicating a very important difference. The confidence interval ranged from 1.577 to 2.783, showing that the mean difference is clearly significant, and the statistical power was 100%, reflecting the test's ability to detect the difference.

For its part, the dimension The physical hypothesis was verified using the Wilcoxon signed-rank test (non-parametric), where a significance of p = 0.001 (highly significant) was found, with an increase in the mean; the effect size was 3.76, very large , indicating a highly significant difference. The confidence interval was from 0.583 to ∞, where the upper limit cannot be precisely defined, but both limits show a significant difference, and the statistical power was 100%, demonstrating reliability.

To determine the behavior of the morphological efficiency index, the following was applied: the The t-test (Student's test) showed a significance level of p = 0.001 (highly significant), indicating an increase in the mean. The effect size is 2.62, considered very large , indicating a significant difference. The confidence interval is: from 4,069 to 6,515, which expresses that the average difference is between these values and is statistically significant and the power is observed at 100% which demonstrates that the reliability of this test is high.

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Therefore, it can be stated that:

The differences found in all dimensions and the efficiency index are highly statistically significant and have large to very large effects, especially in the biomedical, physical dimensions and the morphological efficiency index.

CONCLUSIONS

Based on the reflections derived from the development of the investigative actions aimed at providing an answer to the problem and the objective, it is concluded that:

The most current references regarding trends in sports medical control allowed us to find that the pedagogical integration of medical tests, laboratory tests and field tests constitute a way for the medical control of sports training and the morphological optimization in school category boxers.

It was determined that there are limitations on the morphological evaluation in school category boxers at the Eide in the province of Granma, and that the contents in the normative documents present limitations in the information about the indicators and their use by the coaches.

was implemented , designed from a theoretical framework for the medical monitoring of sports training in school-age boxers. This methodology, through the pedagogical integration of medical tests, systematizes the laws, principles, methods, and procedures related to the morphological efficiency index. Its practical application was organized into successive and interconnected stages, allowing for the evaluation of morphological optimization.

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