Review Article

What significance do the results of the study "morphological evolution in Cuban sporting population, 1970-2014" have?

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¿Qué trascendencia tienen los resultados del estudio "evolución morfológica de la población deportiva cubana, 1970-2014"?

Que significado têm os resultados do estudo "evolução morfológica da população esportiva cubana, 1970-2014"?

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ABSTRACT: The Anthropological Research "Morphological evolution in the Cuban sporting population in the period 1970-2010. Implications for its kinanthropometric evaluation" won the Annual Award of Sciences, Technology, Innovation and Environment of the INDER "José Yánez Ordaz" (2019) and Annual Award of the National Commission of Scientific Degree for Best Doctoral Thesis in the Category of Education Sciences (2020) ; however, the scope of this result for the Cuban sports movement has not been sufficiently socialized in the community of Physical Culture Sciences as it has happened in the National Network of Sports Medicine. The focus of this paper was to contribute to understanding of the morphological evolution of the Cuban athletic population and its consequences. A historical analysis was carried out, based on the antecedents of the anthropometric studies of athletes in Cuba, which constituted the "Normal Science"; subsequently, the theoretical support that led to the investigation were exposed; then, the results achieved and their impact on the practice of Cuban Kinanthropometry today were described. The results found represent a paradigm shift in the practice of Kinanthropometry within the framework of Biomedical Control of Training in national teams.

Key words: physical culture, sport medicine, sport sciences, Kinanthropometry.

RESUMEN: La investigación antropológica "Evolución morfológica en la población deportiva cubana en el período 1970-2010. Implicaciones para su evaluación cineantropométrica "alcanzó el Premio Anual de Ciencias, Tecnología, Innovación y Medio Ambiente del INDER "José Yánez Ordaz" (2019) y el Premio Anual de la Comisión Nacional de Grado Científico por Mejor Tesis Doctoral en la Categoría de Ciencias de la Educación (2020) ; sin embargo, el alcance de este resultado para el movimiento deportivo cubano no ha sido lo suficientemente socializado en la comunidad de las Ciencias de la Cultura Física como si ha ocurrido en la Red Nacional de Medicina del Deporte. El objetivo del presente trabajo fue contribuir a la comprensión de la evolución morfológica de la población deportiva cubana y sus consecuencias. Se realizó un análisis histórico, basado en los antecedentes de los estudios antropométricos de deportistas en Cuba, lo que constituyó la "Ciencia Normal"; posteriormente se expusieron los sustentos teóricos que llevaron a realizar la investigación; luego, se describieron los resultados alcanzados y su repercusión para la praxis de la Cineantropometría cubana en la actualidad. Los resultados encontrados suponen un cambio de paradigma en la praxis de la Cineantropometría en el marco del Control Biomédico del Entrenamiento en las selecciones nacionales.

Palabra clave: cultura física, medicina del deporte, ciencias del deporte, cineantropometría.

RESUMO: Pesquisa antropológica "Evolução morfológica da população esportiva cubana no período 1970-2010. Implicações para sua avaliação cineantropométrica "foi agraciado com o Prêmio Anual de Ciência, Tecnologia, Inovação e Meio Ambiente do INDER "José Yánez Ordaz" (2019) e o Prêmio Anual da Comissão Nacional de Grau Científico para Melhor Tese de Doutorado na Categoria de Ciências da Educação (2020); no entanto, o alcance deste resultado para o movimento esportivo cubano não foi suficientemente socializado na comunidade de Ciências da Cultura Física como tem sido na Rede Nacional de Medicina Esportiva. O objetivo deste trabalho foi contribuir para a compreensão da evolução morfológica da população esportiva cubana e suas consequências. Realizou-se uma análise histórica, com base nos antecedentes dos estudos antropométricos de atletas em Cuba, que constituíam a "Ciência Normal"; posteriormente, foram expostos os fundamentos teóricos que conduziram a investigação; em seguida, foram descritos os resultados alcançados e sua repercussão para a práxis da cineantropometria cubana hoje. Os resultados encontrados representam uma mudança de paradigma na prática da Cineantropometria no âmbito do Controle do Treinamento Biomédico nas equipes nacionais.

Palavras-chave: cultura física, medicina esportiva, ciências do esporte, cineantropometria.

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INTRODUCTION

In Cuba, Kinanthropometry had a vertiginous development with respect to other countries, reaching its maximum prominence in the 1980s (Carvajal, 2017). At this stage there were several contributions that were fundamental for the development of this science at the national level. In general terms, the main contributions were the following: constitution of the anthropometric profile of the most successful Cuban athletes (Rodríguez et al., 1986); establishment of reference values for the study of body composition (Rodríguez, 1987); development of various algorithms for monitoring body composition adaptations during preparation (Rodríguez et al., 1989; Rodríguez et al., 1991).

The generalizations of many of these experiences were available for the Cuban athletes' fitness process, in view of the 1987 Pan American Games in Indianapolis, and later for the competitive cycle of the 1992 Barcelona Olympic Games (Rodríguez, 1987). The procedures used in the national teams were not only restricted to national teams, but also extended to the evaluation of youth and first-class athletes from the entire national network of Sports Medicine, in some cases, up to the present time.

Despite the fact that the aforementioned contributions defined the status of "normal science" for Kinanthropometry in Cuba for several decades, Rodríguez and colleagues made the following statement: "the working methods obtained and proposed will not be rigid in the course of time. The coefficients may vary as the reference values differ, due to the behavior dynamics of the body composition of our population of high-performance athletes. This will change in time and space depending on the modifications of a number of factors, among others, the selection, training, competitions, sport rules, environmental conditions and the secular trend of the growth and development of the Cuban population, in general. (Rodríguez, 1989, p. 25)".

In 1999 the Branch Project "Medical Control of Training in Laboratory and Field Conditions" was created at the Institute of Sports Medicine (IMD), at the request of the High Performance Directorate of the National Institute of Sports, Physical Education and Recreation (INDER). Some of the tasks of the project were: perfection of laboratory tests, by introducing methodologies according to the demands of sport at an international level; obtaining new reference values; while, in most sports, the morphofunctional characterization of the athletic population was one of the main demands made by sports coaches and medical doctors (González, 2006; Almenares, 2014).

During the morphofunctional characterization of athletic population, the first evidence of its morphological evolution appeared. These results were reported by Espinosa (2005), Rubio (2007), Carvajal et al. (2008) and Sánchez (2010) in an academic publication and a series of master's theses supervised by researchers from the Department of Kinanthropometry.

Based on the growing evidence on the changes in the physical structure of the Cuban athletes, the researchers of the aforementioned institution, taking into account the need to find solutions according to the current needs of the Biomedical Control of the athlete's preparation, gave the task of generating databases with historical information in order to contrast this possible paradigm shift in the practice of Kinanthropometry assessment of sport training in Cuba. This is how Anthropological Research "Morphological evolution in the Cuban sporting population in the period 1970-2010. Implications for its kinanthropometric evaluation" emerged to answer: What are the implications of morphological evolution for the kinanthropometric evaluation of Cuban sporting population?

Once completed, the investigation was recipient of two national awards; however, the scope of this result for the Cuban sports movement has not been sufficiently socialized in the community of Physical Culture Sciences as it has happened in the National Network of Sports Medicine. It won the Annual Award of Sciences, Technology, Innovation and Environment of the INDER "José Yánez Ordaz" 2019 (Redacción JIT, 2019) and Annual Award of the National Commission of Scientific Degree for Best Doctoral Thesis in the Category of Education Sciences of the year 2020 (González, 2021).

The focus of this paper is to contribute to understanding of the morphological evolution of the Cuban athletic population and its consequences, based on the results of the Research Project "Morphological evolution in the Cuban sporting population in the period 1970-2010. Implications for its kinanthropometric evaluation"

THEORETICAL SUPPORT OF THE MORPHOLOGICAL EVOLUTION IN THE CUBAN SPORTING POPULATION

From the pyramidal system of Cuban sports development

According to Pancorbo (2002), for a long time the Cuban pyramid model was composed of the following strata: 1) massive school sports areas where around 300,000 children participated, 2) special school sports areas where the level of participation only included 26.6 % of the initial total, 3) Provincial Schools for Sports Initiation where only 5.3% of the total reached, 4) Schools for Athletic Improvement where only 1.6% reached, and National Centers for adult and youth teams where only they made up 0.6% of the total that started in massive sports areas.

The pyramidal model of Cuban high performance sports complies with the Darwinian postulates of the

theory of natural selection in its social application, since the elements of the Darwinian system present in its pyramidal system are: a highly variable population, represented by all, without distinction of social classes, racial groups and religious tendencies with the possibility of competing for a place; an environment where resources are scarce and there is no availability for all in a massive way as one advances in the pyramid of high performance (enrollment, skills, medicines, food, specialized medical attention, clothing); selective pressures that result in the adaptation of those who survive (being consistent with the statutes of the social system they represent and resisting multi-million dollar offers); transmission of successful characteristics to future members of this population, where not only physical characteristics are spread, but also a value system within which the training system, diet, patriotic values, biocultural inheritance, among other factors were inherited (Old, 2009).

Since the end of the eighties, the Cuban pyramid model has been constantly shaking, as the continuous migrations of athletes, scarce resources for training, talent theft, offers of multimillion-dollar income, are among the factors that have made to break a structure that today has lost intermediate links such as the Pre-EIDE (previous step of the Schools for Initiation into Scholastic Sport) and the High Schools of Athletic Perfection. On the other hand, the massive participation during the national championships has been limited, and the number of enrollments in the youth and senior national teams has been reduced, which has resulted in the escape of a morphological variability that favored that at the top the best phenotypically gifted will arrive through the sports reserves.

This phenomenon, in turn, has favored the change of perception that parents and their own talents have towards the practice of sports, many try to seek their future by practicing sports in which Cuba is considered a world power, thus guaranteeing, greater competition number, income and a decent retirement income as an internationally awarded athlete. An example of this phenomenon, at a biological level, is justified by the fact that the average height of Cuban basketball players has not changed significantly since the 1970s (Rubio,2007), although it has changed internationally (Sedeaud et al.,2014). On the other hand, the average volleyball player has increased his stature significantly, despite the significant emigration of the best players from Cuba since the beginning of the 21st century (Carvajal and Serviat, 2014).

Under these conditions, the original elements of the Darwinian system, present in the social field of Cuban sport, have undergone some modifications today. The new elements are: A highly variable population, represented by an increasing number of competitors, without distinction of social classes, racial groups and religious tendencies, with the possibility of competing for places in a smaller number of prioritized sports than in past decades (loss of interest in the practice of some sports and increasing increase in the practice of others); an environment where resources are more scarce and there is less availability for all as one advances in the high performance pyramid (disappearance of intermediate links of the pyramid and concentration of quality, expressed in reduction of enrollment in sports schools, an increasingly strict biological medical control); increased selective pressure (increased motivation due to salary stimulation, multi-million dollar offers, globalization); transmission of the successful characteristics to the future members of this population, where not only the new physical characteristics that disadvantage a few sports are spread, but also a value system within which more modern training systems will be inherited, feeding mode, among other factors.

A clear example of this problem is constituted by baseball player: Cuba is losing its talented athletes surprisingly and without warning. Since 1991, more than 300 Cuban baseball players defected from Cuba and in just the past 3.5 years, 5 of those players "signed contracts worth a combined $287 million" (Zaworska, 2017). Under the influence of baseball player's defection, Cuban talents with great physical potential continue appearing. The morphological evolution has occurred favoring players of greater absolute size, responding to the increasingly growing professionalization of the sports.

Based on the trends described at the international level

At the beginning of the 20th century, Norton and colleagues made the following statement: "the evolution of body types in the athlete has often been ignored, and it was instrumental in setting most of the current records" (Norton et al., 2000, p.225).

When these authors joined by a line the data related to the physical characteristics of the elite athletes who competed between 1925 and 2000, each sport and / or modality evidenced a different pattern of change. According to these authors, in the first decades of the 20th century, most sports showed physical characteristics close to each other, but from that moment on, the physical characteristics that favored scouts and coaches caused a radical change that dispersed the physical in all directions, looking like the pattern shown for galaxies according to the expansion model of the universe (Epstein,2014).

For a significant group of authors, the "expanding universe" of sporting bodies showed that athletes of short absolute height remained the same size or were smaller and smaller, while athletes of greater absolute height showed increasing height (Norton and Olds, 2001; Norton et al.,2000; Olds,2009; Sedeaud et al.,2014).

According to Olds (2009) this has occurred as a consequence of the increasingly marked morphological specialization, where the athletes of the same sport increasingly resemble each other in their characteristics, while they differ substantially from the athletes of other sports, a kind of "big bang" of sporting physiques.

The "expanding universe" of sporting bodies has its support in the philosophical ideas of Jean-Baptiste de Lamarck (1744-1829), this naturalist was the one who exposed that circumstances create the need, that need creates habits, habits produce modifications as a result of the use or disuse of a certain organ and the means of nature are in charge of fixing these modifications (Birx,2009).

According to Norton and Olds (2001) the fundamental postulate of the evolutionary ideas of Charles Robert Darwin (1809-1882) "only the most capable survive" represent a fundamental challenge for morphological evolution in the athlete, this being one of the reasons why athletes act in accordance with the Olympic slogan "faster, higher, stronger".

The first compilation was made by Tanner et al. (1964), who evaluated a group of athletes participating in the Rome Olympic Games, showing that the sprinters were about 4cm taller and 7kg heavier, and 400m runners differed by about 8cm and 10kg, middle-distance 4cm and 4kg, long-distance 4cm and 1kg, and marathon 4cm and 0kg in height and weight to those studied in the 1920s (Kohlrausch et al., 1930). The comparison of jumpers was just as interesting; in 1960 jumpers were 8-10cm taller and 10kg heavier, while throwers were 8-10cm taller and 25kg heavier.

Most of the publications on the subject 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 (Norton et al., 2000; Norton y Olds, 2001; Sands et al.,1012; Charles y Bejan, 2014; Sedeaud et al.,2014)

The group of authors who have reported adaptive changes between generations for somatotype, body fat, muscle mass, among other aspects of the physical structure, such as the diameter of the pelvis and shoulders, is more limited (Olds, 2001; Cŭk et al.,2007; Carvajal et al.,2008; Lozovina et al.,2012; Carvajal and Serviat, 2014; Burdukiewicz et al.,2019; Han et al.,2020; Carvajal et al., 2021).

Olds (2001) reported a considerable decrease for the endomorphy, mesomorphy and ectomorphy of rugby players that significantly affected the change of the somatotype to make it considerably more mesomorphic and less endomorphic and ectomorphic, these being in correspondence with the evolution of the game.

Carvajal et al. (2008) found marked differences for the somatotype and body composition of Cuban athletes, related to weight-height trends at the international level. The changes were substantial in competitive art sports and in the active body substance index of a significant number of sports.

Given the limited amount of existing research at the international level, which involves the quantification of the components of body composition and somatotype (Olds, 2001; Cŭk et al.,2007; Carvajal et al.,2008; Lozovina et al.,2012; Carvajal and Serviat, 2014; Queiroga et al., 2019; Carvajal et al., 2021), and taking into account that these are national in nature and involve different methodologies, there is insufficient evidence to establish to what extent the compartments associated with body composition or the components of the anthropometric somatotype have been modified at the international level.

In the world, as of 2000, 90.2% of the research articles on this topic were published; but 60.8% were published in the period from 2011 to 2020 (Figure 1). The specialized literature has approached the morphological evolution of international athletes from the anthropological-epidemiological paradigms (Norton and Olds, 2001; Borms, 2003; Danuvio, 2008), since its impact on performance (Norton et al., 2000; Olds, 2001; Olds, 2009; Sedeaud et al., 2014), but the fact of knowing how this phenomenon has had impact on the practice of the biomedical control of the preparation of a particular medical-sports system has not deserved serious consideration.

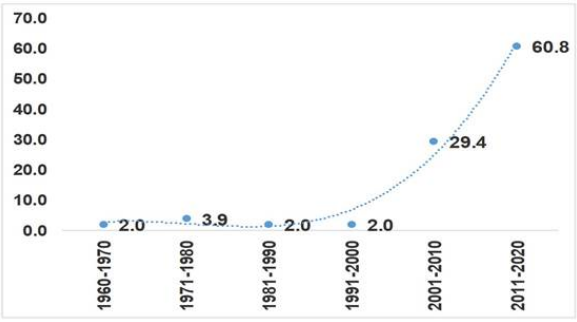

Figure 1. Evolution of the percentage of articles (n = 51) on the morphological evolution of international athletes according to the domains http://www.ncbi.nlm.nih.gov/pubmed/ ,https://scielo.org/es/ , https://scholar.google.es/schhp?hl=es, and manual search.

PARADIGM SHIFT IN KINANTHROPOMETRIC CONTROL OF PREPARATION OF THE CUBAN ATHLETES

According to Norton and Olds: "a number of social factors both drive and are driven by the search for athletes of increasingly rare morphology. These include globalization and international recruitment, greater financial and social incentives, and the use of special training methods and artificial growth stimuli" (Norton and Olds, 2001, p.763).

In Cuba, for the initial stage of the project "Medical Control of Training in Laboratory and Field Conditions", after the period 1991-1998, notable events had occurred:

The Cuban population had faced a period of intense socioeconomic transformations that influenced the development of the pyramidal model of high-performance sports (Chappell,2004; López et al., 2005);

Professionalization in high performance began in sports such as volleyball, handball, athletics, baseball, among others;

Professionalization benefited athletes with the growth of financial and social incentives, which had an impact on the preference for the choice of some sports that have more incentives, as happened internationally (Berthelot et al., 2015); and

Many sports had changed their regulations impacting the training methodology and talent selection methods at the international level (Berthelot et al., 2015).

In the specialized literature it is described that in periods of socioeconomic transformations disadvantageous changes occur at a morphological and / or physiological level (Saint-Onge et al., 2008; Berthelot et al., 2010). However, the increasingly intensive selection processes reduce the variation associated with these large social differences.

Checking any of the assumptions attributable to the impact of morphological evolution, supported by natural selection in the social field of sport in Cuba, and / or influenced by the international trends previously described, would cause a change in the practice of Kinanthropometry in Cuba. A first approach to the subject was supported by a study published in the Revista Española de Antropología Biológica during 2008. In this pilot study, Carvajal et al (2008) found marked differences for the somatotype and body composition of Cuban athletes, related to the tendencies of weight-stature within the Cuban sporting population, being the first existing research on the subject to date in Cuba. The changes were substantial in artistic and rhythmic gymnasts, volleyball and baseball players, while weight, height and active body substance index were the indicators that changed the most in a significant group of sports.

This first study led to a broader investigation where the evolution of body composition and somatotype of Cuban athletes in the last 45 years was analyzed. It was found that the body composition of 4096 athletes, grouped into 24 disciplines, fundamentally changed at the expense of fat-free mass, as a result of the increase in weight and height with relatively constant adiposity in many sports disciplines. The changes mentioned reinforced the appearance of an increasingly linear anthropometric profile with more discrete endomorphy levels and an emphasis on musculoskeletal development; This typology became more accentuated in the female sex where there was a significant change in the somatotype frequencies (Carvajal, 2018).

Many of the results found in the course of this long investigation will be presented below:

Athletes who competed by body weight category (wrestling, boxing and judo) maintained the same anthropometric characteristics in the period from 1970 to 2015. This was due to the competitive restrictions imposed on body weight in these athletes (Carvajal, 2018);

The super-heavy categories of these sports were those that showed anthropometric changes, but at some point they maintained these characteristics for 20 years or more, due to the appearance of Olympic multi-medalists in boxing, judo, wrestling, judo who are international references in talent selection (Carvajal, 2018; Carvajal et al.,2021);

Sports with greater professionalization, such as volleyball and baseball, showed more sustained anthropometric changes over time. In volleyball, the stature change was 1.8 and 2.2cm / decade for males and females respectively; in baseball, the change for body weight was 4kg / decade (Carvajal y Serviat, 2014; Carvajal, 2018);

When the sporting success was sustained for long periods of time, not important anthropometric changes were found; but when this was not, the anthropometric selection operated in favor of changes of these characteristics in volleyball players (Carvajal et al., 2015);

Not all sports had the morphological optimization processes according to international athletes. Some have been found since the 1970s within currents standards, while others lack popularity, resources, and the necessary professionalism (Carvajal, 2018).

In general, the body weight of baseball players (pitchers, out fielders), throwing modalities (javelin, shot put, hammer), tennis, fencing, water polo, basketball and boating increased at a rate of 1.5kg / decade in males; while rhythmic gymnastics and the super heavy category of wrestling decreased this substantially (Carvajal, 2018); and in male athletes, swimming, javelin, shot and hammer athletes, super heavy wrestlers, baseball pitchers, water polo, and tennis players increased their stature at a rate greater than 1.2cm / decade since 1970 until 2010. On the other hand, the athletes of shot put, discus and javelin, long jump, volleyball, fencing and basketball players had an increase in stature of more than 1.3 cm / decade in the same period (Carvajal, 2018).

The results of research carried out in the last 20 years led to the introduction of new reference values, accompanied by more discriminating methodologies of changes in body composition due to the

effect of training (Carvajal et al.,2018a); new consensus documents and guidelines for the evaluation of the current athlete were also introduced (Carvajal et al.,2018b). In the same way, the theoretical foundations of the findings were exposed in a series of literary works and scientific articles (Carvajal, 2021).

Practical significance of research

The practical significance of the research proposed by the authors was that established by Carter (1982), once the dissemination of the results of the Anthropological project of the Montreal 1976 Olympic Games was concluded, in the decade after its development, common for all large-scale anthropometric studies of athletes. Its scope is in the following aspects:

Diagnostic elements of greater precision are available, which can lead to better sporting results that are treasured not only for the athlete but also for the country.

The new instrument can be used by trainers, medical doctors, physiologists, kinesiologists, anthropologists, geneticists, nutritionists and biomechanics in the evaluation of the athlete, for the control of the biological response to training, as well as for the modeling of prototypes.

It is a tool that has great simplicity in its application and interpretation, which allows medical doctors and trainers to carry out a systematic evaluation of the kinanthropometric profile and influence the factors that affect it.

The knowledge of the trend in the physique and the form of the elite athlete's alerts teachers, coaches and talent recruiters, about the body type that may be successful later, so that training, recruitment and selection strategies can be adapted to the needs of the future.

CONCLUSIONS

The paper presents the scientific novelty, theoretical and practical significance of the work entitled "Morphological evolution in the Cuban sports population in the period 1970-2010. Implications for its kinanthropometric evaluation" through the description of the research project, its antecedents and main results. The results found imply a paradigm shift in the practice of Kinanthropometry within the context of Biomedical Control of Training in national teams, since the anthropometric changes found implied the introduction of a new consensus document, supported by new reference values.

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