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Brief Article

Assessment of the nutritional and vascular state in students and high-performance baseball athletes

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ARTICLE INFORMATION

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Acronyms
ASI: arterial stiffness index
PTT: pulse transit time
RI: reflection index

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ABSTRACT

Introduction: The assessment of the vascular state is one of the pillars in the prevention of cardiovascular diseases in elite athletes, as well as in the general population. The reflection indexes and the arterial stiffness of the pulse wave are objective elements that favor this assessment.
Objective: To characterize the high-performance baseball athletes from the anthropometric-nutritional and vascular points of view.
Method: A cross-sectional study was conducted in 28 individuals, between January and March 2016: 14 high-performance baseball athletes, youth categories (age: $\bar{\chi}$=18.2±1.4), and 14 medical students (age: $\bar{\chi}$=18.1±1.7). An anthropometric-nutritional assessment was performed and the reflection indexes as well as the arterial stiffness pulse waves were determined by the polygraph PowerLab® (ADInstruments), of the Laboratory for Basic Biomedical Sciences at the University of Medical Sciences of Santiago de Cuba.
Results: Significant increases were found in the height (p=0.001), weight (p <0.001), body mass index (p=0.003) and blood pressure of the athletes regarding the students. Although there is no significant difference among the reflection index values (p=0.085), an increase of the arterial stiffness index (p=0.02) was observed in the students ($\bar{\chi}$=6.1) with respect to the athletes ($\bar{\chi}$= 5.6).
Conclusions: There was an increase in the blood pressure and nutritional state in athletes compared to those of students, in contrast to the lower arterial stiffness in athletes. This suggests that in this type of high-performance activity, physiological protective mechanisms operate against cardiovascular diseases.
Key words: Athletes, Baseball, Athletic performance, Reflection index, Arterial stiffness index, Nutrition assessment

Evaluación del estado nutricional y vascular en estudiantes y atletas de beisbol de alto rendimiento

RESUMEN

Introducción: La evaluación del estado vascular es uno de los pilares en la prevención de las enfermedades cardiovasculares en atletas de elite y en la población general. Los índices de reflexión y rigidez arterial de la onda de pulso constituyen

elementos objetivos que favorecen su evaluación.
Objetivo: Caracterizar desde los puntos de vista antropométrico-nutricional y vascular a deportistas de beisbol de alto rendimiento.
Método: Se realizó un estudio analítico transversal, entre enero y marzo de 2016, en 28 sujetos: 14 atletas de beisbol de alto rendimiento, categoría juvenil (edad: $\bar{\chi}$= 18,2±1,4), y 14 estudiantes de medicina (edad: $\bar{\chi}$=18,1±1,7). Se realizó una evaluación antropométrico-nutricional y se determinaron los índices de reflexión y rigidez arterial de las ondas del pulso mediante el polígrafo PowerLab® (ADInstruments) del Laboratorio de Ciencias Básicas Biomédicas de la Universidad de Ciencias Médicas de Santiago de Cuba.
Resultados: Se encontraron incrementos significativos en la talla (p=0,001), el peso (p<0,001), el índice de masa corporal (p=0,003) y en las presiones arteriales de los deportistas con respecto a los estudiantes. A pesar de no existir diferencias significativas entre los valores del índice de reflexión (p=0,085), se observó un incremento de los valores del de rigidez arterial (p=0,02) en los estudiantes ($\bar{\chi}$=6,1) respecto a los deportistas ($\bar{\chi}$=5,6).
Conclusiones: Existió un aumento la presión arterial y el estado nutricional en los atletas comparado con los estudiantes, que contrasta con la menor rigidez arterial en los atletas. Lo que sugiere que en este tipo de actividad de alto rendimiento operan mecanismos fisiológicos protectores contra las enfermedades cardiovasculares.
Palabras clave: Atletas, Beisbol, Rendimiento atlético, Índice de reflexión, Índice de rigidez arterial, Evaluación nutricional

INTRODUCTION

Cardiovascular diseases are currently the leading cause of death worldwide. Due to the fact that nowadays it is possible to slow the progression of this vascular disease with the use of pharmacological agents and changes in lifestyle, the discovery of markers to characterize it better, by identifying the presence of arterial disease, can facilitate a more appropriate and early intervention on the affected individuals[1].

The assessment of the arterial pulse has always been an important part of the clinical examination. Since ancient times, it was recognized that changes in the pulse behavior were indicators of disease[2]. Recently, thanks to the development of new technologies, it has been possible to assess its morphology's indicators, as important risk markers for the cardiovascular disease. Within these indicators, the reflection index (RI) and arterial stiffness index (ASI) have gained wide acceptance. The first relates to the vascular tone and the second to the stiffness of large arteries.

The greater the age, the greater the ASI value[3], what is explained because age, environmental changes, and the association to classical cardiovascular risk factors and genetic factors (specific polymorphic variants of fibrillin-1, of type I receptors of angiotensin II and endothelin receptor)[4] are responsible for structural and functional changes in the arterial wall[5].

The mechanisms of degeneration and rupture of elastic fibers, with collagen replacement, intimal hypertrophy, necrosis of the smooth muscle of the middle layer and fibrosis and inflammation phenomena lead to a process of wall adaptation, through which certain physical properties, such as distensibility and capacitance, suffer a regressive process that generates a decrease in arterial elasticity and, therefore, increased rigidity, which influences the course of cardiovascular disease[6-8].

The ASI refers to the modified arterial resistance when there are changes in pressure/flow in each cardiac cycle. Conventionally, arterial stiffness is designed as a determinant of the systolic blood pressure, of the pulse –or differential– and, to a lesser extent, ventricular afterload. However, in recent decades, it has been shown that the clinical significance of arterial stiffness is not limited to its role as a determinant of hemodynamics conditions[9], but also:

1. Independent predictor of cardiovascular risk[10-12], additive and complementary to other global risk indices, such as the Framingham[13].
2. Predictor of cardiovascular mortality and any cause of mortality[14-16].
3. Useful in the individual cardiovascular risk strati-

fication and reclassifying risk[17,18].

4. Changeable from the therapeutic point of view and, if improves, it is associated with better prognosis (in specific subpopulations)[19].
5. Biomarker of arterial health state, being an indicator of "accumulated blood damage", unlike other variables such as blood pressure, glycaemia and blood lipids, which can be controlled within a few weeks of treatment, without this constituting better arterial changes (for example, atherosclerotic lesions, increased arterial stiffness)[12,20].

The physical activity and particularly sport activities are, since a long time, considered part of a healthy lifestyle[21]. Continued training or exercise induces a series of physiological and morphological and functional adaptations on the cardiovascular system that may vary depending on the influence of several factors[22-24]; nevertheless, there are controversies about the effects of physical exercise of strength and high-performance sports, as there is a tendency to argue that these activities lead to an increase of the ASI and decreased the elasticity of the vessels[25-28]; but on the other hand, it is argued that, to the multiple benefits associated with physical activity in reducing cardiovascular mortality, must be added the fact that high-performance sports do not increase the rigidity of the vessels and improve body composition[29,30]; thus, the increased cardiac activity is associated with a better arterial activity and endothelial function[31].

This alludes the need to know the changes in the vascular condition, associated with high-performance sports. Therefore, it was decided to conduct this research, aiming to characterize the nutritional and vascular state in medical students and high performance baseball athletes.

METHOD

A cross-sectional observational study was conducted on a sample of 28 individuals (14 athletes [Age: $\bar{\chi}$=18.2±1.4 years] belonging to the provincial youth high-performance baseball team of Santiago de Cuba, in the pre-competitive stage, who were matched, by age and sex, with 14 medical students [Age: $\bar{\chi}$=18.1±1.7 years]), in the Laboratory for Basic Biomedical Sciences, Faculty of Medicine Nº 1, at the University of Medical Sciences of Santiago de Cuba, in the period from January to March 2016.

Techniques and procedures for measuring and recording the variables

Each measurement was recorded by the same person, to minimize errors in methodology, at the place for body measurements of the mentioned Laboratory for Basic Biomedical Sciences.

Variables

Variables as height, weight, body mass index, body surface area, arterial pressures as systolic, diastolic and medium, pulse pressure, and the arterial stiffness and reflection indexes were evaluated.

Anthropometric measures

Measuring height and weight was performed using Soehnle Personal Scales with an accuracy of 0.1 cm. The size was defined as the distance between the highest point of the head to the heel; the volunteers placed standing upright in the anatomical position and head in Frankfort plane. The body mass index was calculated (weight in kg divided by the square of height in meters), and for the estimation of the body surface area (BSA) the Mosteller[32] formula was used:

$$BSA = \sqrt{\frac{\text{weight (kg)} * \text{height (cm)}}{3600}}$$

Physiological records

At the beginning of the session records, the pulse wave in the morning (08:30-12:00 hours), the individuals were lying on a comfortable couch, placed in a room with controlled temperature between 24 and 27 degrees Celsius and dim light. Under these conditions, they were allowed to relax for 10-15 minutes to achieve a better adaptation to the place's conditions. One tonometer transducer was placed on the middle phalanx of the right forelimb, to record the pulse wave for 5 minutes; then the blood pressure was taken with calibrated and certified sphygmomanometer and stethoscope.

The computer tonometry sensor of the Powerlab® device was digitized at a sampling rate of 1000 samples/second (1 kHz) in the LabChart® software package 2012, both from Australian production of the ADInstruments company. This software package allows the tabulation and export of records to the programming package Matlab 2016b® of the MathWork Company.

An algorithm for detecting points of clinical interest of the pulse wave[33] was used, which calculated the first derivative of the filtered signals and separated the systolic and diastolic points and the bottom of each interval of the pulse wave. Thus, the transit time of the pulse was found between the systolic and diastolic peak (PTT, Pulse Transit Time) and corresponding amplitudes with the systolic and diastolic peak (**Figure**), besides a threshold where the PTT was at the physiological limits. In the figure itself, the formulas to calculate the RI and ASI were exposed, where «a» is the diastolic amplitude and «b» the systolic.

The obtained data (RI, ASI and PTT) were exported to a CVS (comma-separated values) file to be processed with the statistical package SPSS.

Statistical analysis of the data

There was used the SPSS 22.0, through which the data of the variables are presented as mean values ($\bar{\chi}$) and standard deviation (SD), to which, a non-parametric statistical analysis was conducted with a Mann-Whitney U test for independent samples, with a significance level of $p<0.05$.

Bioethical parameters

All research participants agreed and showed their agreement by signing the informed consent model. The study met the ethical criteria in accordance with institutional policy and the principles of Helsinki.

RESULTS

In **Table 1** can be observed the average values of the nutritional state indicators in medical students and high-performance athletes, with a significant increase in size ($\bar{\chi}$=180; p=0.001), weight ($\bar{\chi}$=82.9; p< 0,0001), body mass index ($\bar{\chi}$=25.2 p=0.003) and the area of body surface ($\bar{\chi}$=2.03; p=0.0001) in athletes with respect to students.

In **Table 2** are displayed the average values of the vascular state indicators in both groups, where a significant increase is observed in the blood pressures, systolic ($\bar{\chi}$=119.2; p=0.02), diastolic ($\bar{\chi}$=80; p= 0.03) and medium ($\bar{\chi}$=93; p= 0.04), in athletes with regard to students. Although there are no significant differences be-tween the values of the pulse pressure (p=0.07) and the RI (p=0.085), a significant increase of the ASI's average values was observed in students regarding athletes ($\bar{\chi}$: 6.1 vs. 5.6; p=0.02).

DISCUSSION

In this study, the characteristics of nutritional and vascular states in high-performance athletes and medical students were compared. The findings of the

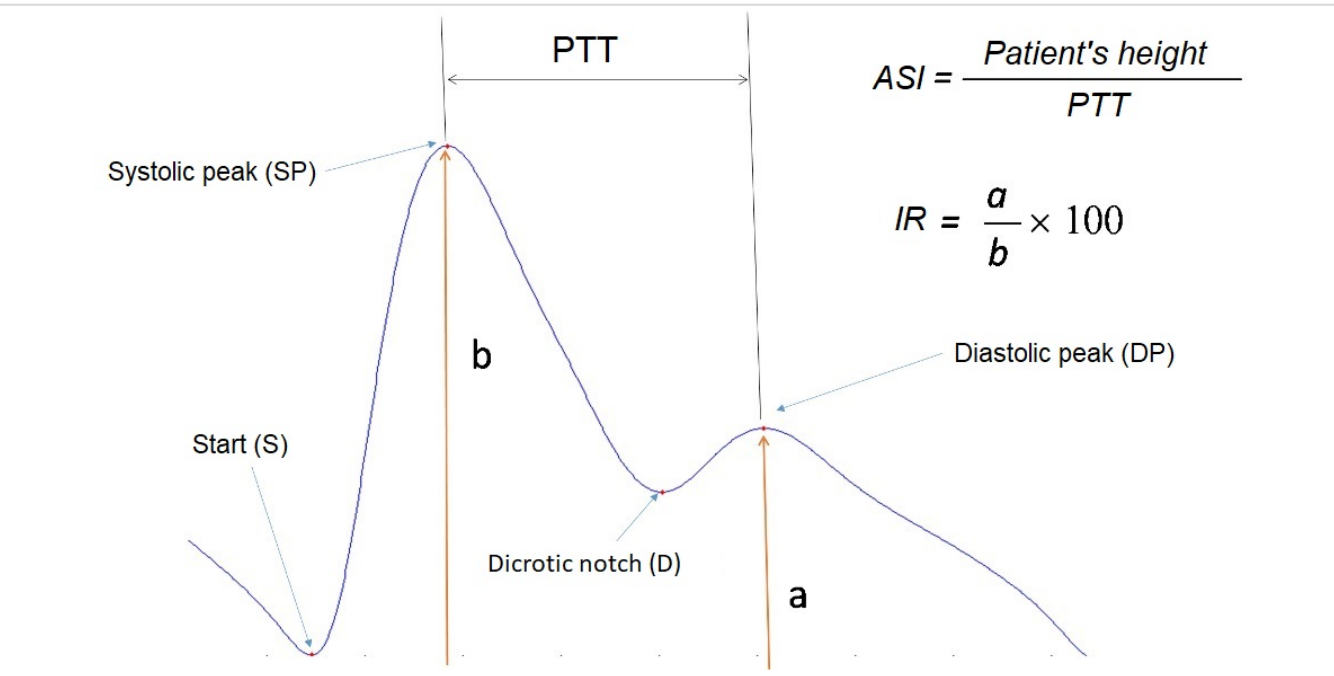

Figure. Calculation of the reflection and arterial stiffness indices from the contour of the pulse wave.

anthropometric evaluation reaffirm the distinctive characteristics of the athletes, as the anthropometric changes are known to be associated with high-performance sports, that make it possible to differentiate this population group of the non-sportive population, which are due to trophic effects of exercise on growth and development of individuals[34].

These trophic and metabolic changes associated with sport are accompanied by circulatory hemodynamic changes for maintaining a consistent blood flow according to the tissue needs of the human body [23,24,35,36]. Although the increase in blood pressure is associated with increased arterial stiffness and reflection indices in the general population[1-4,8], associated with aging, atherosclerosis and cardiovascular disease[9-17]; in athletes, a physiological phenomenon of increased blood pressure values takes place, because they have a larger body surface area leading to an increased basal metabolism and, hence, greater cardiac output, a variable which is dependent on the blood pressure.

The Ohm's law, applied to the understanding of the interactions between pressure, flow and arterial resistance, allows to know that the blood flow is directly proportional to the pressure difference, but inversely proportional to its resistance; thus, decreasing arterial stiffness found in high-performance athletes, in this study, is one of the compensatory mechanisms against increased blood pressure and the cardiac output, which protects athletes from cardiovascular diseases[37,38].

Table 1. Differences in indicators of the nutritional state in medical students and high-performance athletes.

Variables	Students		Athletes		Significance
	Mean	SE	Mean	SD	
Height (cm)	172	6,7	180	5,9	**0,001**
Weight (kg)	62,6	10,2	82,9	11,6	**<0,0001**
BMI (kg/m^2)	21,2	3,6	25,2	2,9	**0,003**
BSA (kg/m^2)	1,72	0,15	2,03	0,16	**0,0001**

BMI, body mass index; BSA, body surface area; SD, standard deviation.

Table 2. Differences in indicators of the vascular state in medical students and high-performance athletes.

Variables	Students		Athletes		Significance
	Mean	SE	Mean	SD	
Systolic BP (mmHg)	108,7	10,5	119,2	12	**0,02**
Diastolic BP (mmHg)	75,2	7	80	3,9	**0,03**
Medium BP (mmHg)	86,4	7,7	93	6,0	**0,04**
PP (mmHg)	33,4	6,3	39,2	9,9	0,07
ASI (m/s)	6,1	0,4	5,6	0,3	**0,02**
RI (%)	55,5	11,4	62,5	9,1	0,085

ASI, arterial stiffness index; BP, blood pressure; PP, pulse pressure; RI, reflection index ; SD, standard deviation.

CONCLUSIONS

There was found increased blood pressure and better nutritional state in athletes, compared with students, in contrast to the decrease in arterial stiffness in high-performance athletes; this suggests that in the high-performance activity, protective physiological mechanisms operate against cardiovascular diseases.

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