THE STUDY OF CERTAIN CARDIOVASCULAR MORPHOFUNCTIONAL PARAMETERS ON DIFFERENT GROUPS OF YOUNG ATHLETES

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Introduction

Earlier selection for sports determines adaptive phenomena in an organism found in an accentuated dynamics of growth and development – the junior athlete.

Theoretical Considerations

1. Morphofunctional particularities at puberty

Puberty brings quantitative accretions in the process of growth, development and maturation of organism.

The musculoskeletal, the cardiovascular, the respiratory, as well as the nervous system, modify their morphological and especially their functional parameters, in close relationship with the secretion of anterior pituitary hormones, hypothalamic, estrogens or androgens.

2. Human body’s adaptation to effort

The organism’s adaptation to sports’ effort is complex – the maximum effort belongs to the cardiovascular and respiratory systems, and this is why the cardiovascular functional evaluation during effort is needed, as well as the evaluation of the effort capacity for aerobic and anaerobic components.

3. Cardiovascular non-invasive functional explorations for athletes

Electrocardiography at rest and during effort, heart rate variability, and Doppler echocardiography indicate the diagnosis of health state.

On the other hand, all these noninvasive cardiovascular explorations can appreciate optimally, reproducibly, the impact of the sport effort on the organism.
**Personal Contributions**

*The AIM* of this research was to evaluate the physical development according to age for junior athletes, their health state and their capacity of performing the specific effort, as well as the degree of training required for the improvement of their biotype as performers.

**OBJECTIVES**

In order to reach the aim of this research we proposed the following objectives:

a) The assessment of the health state for the examined group members, by clinical exam and routine laboratory tests.

b) The assessment and evaluation of the morpho-anthropometric parameters for the groups of junior athletes studied.

c) The assessment of the cardiovascular functional parameters during specific effort, during training time and outside the training, by using noninvasive cardiovascular tests, such as ECG, Doppler echocardiography, and recording the diurnal and nocturnal heart rate variability.

d) The correlation study between the morpho-anthropometric and cardiovascular functional parameters for all studied groups.

e) The effort capacity and the training degree assessment for the athletes from the studied group.

**Material and Methods**

We studied a group of 100 junior athletes, with ages between 7-18 years, from which 77 are practicing sports games, with a mixed aerobic-anaerobic effort type, 11 are practicing martial arts with an aerobic-anaerobic effort type, predominantly anaerobic (non-lactic acidosis), and 12 are practicing athletics (speed and jumping tests) with an anaerobic type of effort (non-lactic acidosis). The athletes forming the mentioned group were monitored for 2 years through the medical data obtained at the time of the medical testing circuit, an examination that is performed twice-a-year in order to obtain the medical clearance for sports. The study was extended both during the training periods and outside them.

Anthropometric parameters examined:

- H (height);
- W (Weight);
- BMI (body mass index; BMI = W/H²);
- PT (thoracic perimeter: rest, inspiration, expiration);
- IE (Erismann harmony index; IE = PT – H/2) (3).

There have been recorded:
The electrocardiogram for the 12 classic derivations using the HEART SCREEN 112D device;
- The systolic BP and diastolic BP;
- The heart rate (4).
A Doppler echocardiography was performed using the SIEMENS ACUSON CV/70 device, thus obtaining:
- The cardiac cavity diameters;
- The cardiac volumes;
- The ejection fraction;
- The interventricular septum measurements;
- The left ventricular posterior wall measurement;
- The atrioventricular regurgitation measurement.

RESULTS AND DISCUSSIONS
While studying the anthropometric parameters, we have observed that:
- the average age for the studied group was 12 years old, H = 1.54 m, W = 46.95kg;
- BMI shows a proportion of 62.5% within normal limits, 32.5% below limit and 5% above limit.
The Erismann Index reflects a harmonious growth of thoraces at the examined group of athletes, adapted to specific effort.
The electrocardiogram has been within normal limits, correlated to the age of each athlete that participated in this study.
For 5% of athletes it has been observed the presence of BRD gr. 1 (right bundle branch block) without any pathological significance.
The echocardiographic study of cardiac parameters, has underlined:
- telediastolic diameter 41.45 mm;
- telesystolic diameter 23.45 mm;
- ejection fraction of 68.50 %;
- interventricular septum of 7.04 mm;
- left ventricle posterior wall of 6.15 mm.
By studying these cardiac morphofunctional parameters we have noticed a good adaptation to specific effort, the parameters being similar to those of the control group.
The cardiac volumes were significantly statistically correlated (r = 0.78) with the ejection fraction, which was normal at all athletes.
It can be observed a statistically significant correlation between the anthropometric parameters and the cardiac morphofunctional ones.
The HRV parameters were recorded using a Zymed type ECG Holter, at the Medical Clinic of the University Hospital C.F.R., the human subjects being monitored for 24 hours. The following values were obtained:

- Min HR – minimum value of the heart rate;
- Avg HR – average value of the heart rate;
- Max HR – maximum value of the heart rate;
- SDNN – standard deviation for all RR intervals;
- RMSSD – square root of the average of quadratic differentials between successive RR intervals;
- QT interval analysis;
- ST segment analysis;

The recordings were performed during a period of 24 hours, nocturnal and diurnal, while the human subjects did not participate to training or competitions.

**Conclusions**

1. This study included a group of junior athletes, with ages between 7 and 18 years, from which 77 are practicing sports with mixed aerobic–anaerobic effort, 11 are practicing martial arts, with aerobic–anaerobic type effort being predominantly anaerobic (non-lactic acidosis), and 12 are practicing athletics (speed and jumping) with anaerobic effort (non-lactic acidosis). In the groups of athletes, the males were predominant for the age group 11-15, and as effort type the sports games were predominant (aerobic–anaerobic mixed effort).

2. The groups of junior athletes were studied thoroughly clinically and paraclinically, by assessing the anthropometric and cardiovascular morphofunctional parameters.

3. The assessment of the anthropometric parameters (height, weight, chest perimeter, thoracic perimeter, nutritional indexes, and harmony indexes) of the three groups of athletes showed an increase (statistically significant) with the age group. There were no significant statistically differences between the three groups of athletes (junior athletes are in the primary or secondary selection period and there were no changes of the morpho-type depending on the type of effort).

4. It would be interesting to emphasize that the determination of the thoracic perimeter at rest for inspiration–expiration and of the Erismann index had good values, but that can be improved, in order to obtain a good thoracic elasticity and a harmonious development of the thorax.
5. The study of cardiovascular morphofunctional parameters was performed by determining the systolic BP (blood pressure), the diastolic BP, the heart rate, the Schellong test, the electrocardiogram, and the Doppler echocardiogram.

6. The measurement of systolic BP and diastolic BP, and of the heart rate 4 hours prior to competition showed an increase of 22% for systolic BP, and of 20% respectively (athletics, sports games), and an increase for diastolic BP of 11%, and of 10% respectively (athletics, sports games), changes that could be explained by sympathetic stimulation determined by the stress before the competition. These changes were completely reversible after 48 hours.

7. SDNN values representing HRV parameters calculated in correlation to time domain, reported to age group, sex and effort type, were higher in boys than girls, and also at the 16-18 years age group compared with the 10-15 years. The results obtained show a higher stability of cardiovascular regulation systems in the 16-18 years age group, where physical and psychological development is more advanced. The lower values in girls are due to the fact that for girls the endocrine changes at puberty start earlier and become stable towards 16-18 years of age.

8. The recording of the heart rates during 24 hours have reconfirmed the influence of the circadian rhythm with a diurnal sympathetic predominance, and a nocturnal parasympathetic predominance, so higher values of heart rates were obtained during the day in all the studied subgroups.

9. At the echocardiographic test the following parameters were determined (VSD (VTDVS) = left ventricle telediastolic diameter; VSS (VTSVS) = left ventricle telesystolic diameter; AD = right atrium diameter; VD = right ventricle diameter; FE = ejection fraction = stroke volume / telediastolic volume; SIV = interventricular septum size; PPVS = left ventricle posterior wall size) and they were compared with those for a control group of 40 children with the same ages, but which are not practicing any performance sports. The echocardiographic parameters were similar to the control group, with the exception of the left ventricle telediastolic diameter, that was 6% larger, and the ejection fraction that was 5% higher than the one for the control group. This shows a good adaptation of the junior athletes’ heart to the specific effort.

10. The anthropometric and cardiovascular parameters studied for the group of 100 athletes showed no significant differences related the effort type, because the junior athletes are in the primary and secondary selection period when the performer biotype is not definitive for the specific type of effort.
We also note that the studied groups included individuals that did not have performances of national or international level. Depending on age groups, there were observed differences of these parameters for the athletes groups.

11. The assessment of the fitness condition (Ruffier test), of the effort capacity (Astrand test) showed an age correlated fitness condition, and the mean value shows the need for a better physical condition, in general. The Astrand test (steptest) determined for some athletes showed a good aerobic effort capacity (72% from the ideal value) with the possibility of improvement concordant with the training and competition stages.

12. We would like to emphasize that we noticed a statistical significant correlation between the anthropometric parameters (height, weight, bust, thoracic perimeter, nutrition indexes, and harmony indexes) and the age group for all three athletes groups. An important aspect is the fact that the left ventricle telesystolic and teledyastolic diameters were statistically correlated with the height and the thoracic perimeter. The increases in height and thoracic perimeters, with the increase in age, are concordant with the increase in cardiac diameter.

13. The specific effort in performance sport improves these parameters.

The final conclusion of thesis:

a. In this research a complex study of clinical and paraclinical anthropometric and cardiovascular morphofunctional parameters was realized for groups of junior athletes that are practicing athletics, martial arts and sports games – a type of study that is not commonly mentioned in the literature.

b. The study performed showed a good harmonious physical development of the junior athletes and an effort capacity adequate to the type of effort, elements that are needed for realization of the biological model for the performers in the specific sport tests.

c. The analysis of the heart rate variability over a 24 hours period (Holter monitoring) for the athlete groups with different type of effort, allowed the assessment of the harmonious physical development, of the cardiovascular system, of the nervous system, and also the assessment of the physiological mechanisms of cardiovascular system’s regulation. This study is not yet mentioned in literature.

It is important to emphasize that the anthropometric parameters were correlated statistically significant with those cardiovascular morphofunctional, these correlations constituting the original part of this thesis.
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