



# CARDIOVASCULAR SCREENING IN YOUNG ATHLETES IN SARAJEVO CANTON

SENKA MESIHOVIĆ-DINAREVIĆ<sup>1\*</sup>, MEHMED KULIĆ<sup>2</sup>, AMIR KRESO<sup>3</sup>

<sup>1</sup> Pediatric Clinic, University of Sarajevo Clinics Centre, Patriotske lige 81,  
71 000 Sarajevo, Bosnia and Herzegovina

<sup>2</sup> Heart Center, University of Sarajevo Clinics Centre, Bolnička 25,  
71 000 Sarajevo, Bosnia and Herzegovina

<sup>3</sup> Sports Medicine Center Sarajevo Canton, Patriotske lige 36,  
71 000 Sarajevo, Bosnia and Herzegovina

\* Corresponding author

## ABSTRACT

Potential risk of sudden death during sports participation makes screening of competitive athletes of vital importance. Congenital cardiac anomalies and non-atherosclerotic, acquired myocardial conditions are primary causes underlying exercise-induced cardiac death in young patients. Since cardiovascular conditions are the leading causes of non-traumatic, exercise-induced cardiac events, cardiovascular screening preceding sports participation is mandatory. The objectives of this study were to determine prevalence of cardiac conditions through cardiovascular screening of young athletes and to establish preventive strategy. The study was conducted at the Sports Medicine Center of Sarajevo Canton and at the Pediatric Clinic of University of Sarajevo Clinics Centre in the period 2007-2009. The study was supported by Canton Sarajevo Ministry of Health and Ministry of sports, science and culture. The study targeted a group of 214 athletes, 8-18 years of age with average age being 15,26. The group was subdivided into five groups according to the age. After taking the anamnesis (family, personal and cardiological) patients were subjected to the measuring of body mass and height, blood pressure and heart rate and oxygen saturation, recording of 12-lead ECG, specialist examination (pediatrician, sports medicine specialist and cardiologist) and complete heart echocardiography. No examined athletes expressed subjective discomfort. Congenital cardiac anomalies were not diagnosed in any athlete. Also, cardiovascular abnormalities requiring additional evaluation, positive cardiac anamnesis, abnormal auscultatory findings, hypertension or abnormal ECG findings were not recognized in any patient. Moderate correlation was found among the left ventricle mass and heart rate ( $p < 0,05$ ). In order to minimize or even possibly prevent the risk of sudden cardiac death it is necessary to establish an adequate strategy of cardiovascular screening of young athletes.

KEY WORDS: cardiovascular screening, young athletes

## INTRODUCTION

In younger athletes, atherosclerotic conditions are rare causes of exercise-induced cardiac events. The occurrence of myocardial infarction in this age group ought to initiate investigation into non-atherosclerotic causes such as: coronary anomalies, vasculitis, drug abuse (including cocaine and possible anabolic steroids) or hereditary anomalies of lipid metabolism (1). The prevention of exercise-induced cardiac events is complicated because those events are rare. It heavily depends on the selective screening of the participants and detailed evaluation of symptomatic athletes prior to the authorization of their participation in sports (2). Physical activity is beneficial regarding numerous risk factors including triglycerides, high density lipoproteins (HDL), cholesterol, blood pressure, insulin sensitivity and body mass. Modern approach is to subject all the children and adolescents involved with sports clubs to the systematic evaluation once in six months which, in Sarajevo Canton, is performed by the Sports Medicine Center. Systematic evaluation include physical examination, body mass and height measuring (anthropometric body measures compared with reference values supply key information on child's growth and development, they reflect child's health and nutritive status), ECG, blood analysis, oxygen saturation, heart rate and blood pressure. Also, the athletes must meet certain physical requirements determined by the type of sports. Obviously, such systematic evaluation cannot identify children and adolescents with no apparent difficulties but who may have underlying congenital cardiac anomalies or myocardial conditions. Myocardium may be evaluated by ECG and provide an insight into an athletes health. In current era, all the sports demand extreme efforts. Accidents might ensue that are caused by a combination of extreme physical effort and underlying condition that remained undetected or not perceived. The objectives of this study were to determine prevalence of cardiac conditions through pediatric clinical, sports-medicine examinations and non-invasive tests that include echocardiography in children and adolescent athletes and to establish prevention and healthcare. The procedure includes evaluation of:

- heart morphology,
- heart haemodynamics,
- determination of heart ejection power,
- origins of coronary arteries.

Education of parents and sports workers on the prevention of coronary diseases is conducted simultaneously.

## MATERIAL AND METHODS

### *Patients*

The prospective study included 214 boys. The subjects' age ranged between 8 and 18. All the subjects were from the area of Sarajevo Canton. The inclusion criterion was active sports participation. The study protocol included taking the medical history (family, personal and cardiological) followed by specialist examinations conducted by three independent physicians: pediatrician, sports medicine specialist and pediatric cardiologist.

### *Methods*

Within the examination scope the following health services were provided:

1. measuring body mass (kg) and height (cm) using stadiometer and calibrated scale and determination of body mass index (BMI),
2. measuring blood pressure (mmHg), heart rate, oxygen saturation in % using digital sphygmomanometer and pulse oxymeter,
3. standard 12-lead ECG recording,
4. heart echocardiography was performed using Toshiba and GE apparatus, 3,5 MHz probes, with standard sections using M mod, B mod, CW Color Doppler technique. The analyzed parameters are presented in millimeters (mm) per body mass (BM) in kilograms (kg): LV end-diastolic diameter (EDD LV), LV end-systolic diameter (ESD LV), intraventricular septum diameter (S), LV posterior wall (LVPW), LV reduction fraction (RF) with supramitral flow (SMF).

Thus, the target group included children and adolescents who actively pursue sports activities within sports clubs. The methods of descriptive statistics were applied.

### *Statistics*

All statistical analyses were performed using MedCalc for Windows, version 11.2.1.0 (MedCalc Software, Mariakerke, Belgium). Means and standard deviations (SD) were calculated for all variables. Univariate relationship between left ventricular mass and BSA or pulse was assessed with Pearson correlation analysis. A value of  $p < 0,05$  was regarded as a statistically significant difference.

## RESULTS

The processed data pool pertained to 214 boys whose age ranged between 8 and 18 years. Average age was 15,06 years (SD 2,41). The group was divided into five subgroups according to body mass: G<sub>1</sub> (30-39 kg), G<sub>2</sub>

Variable	Group 1 (n=16)		Group 2 (n=32)		Group 3 (n=36)		Group 4 (n=62)		Group 5 (n=68)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Height (cm)	144,31	4,80	154,97	6,55	163,44	8,36	173,42	6,90	180,92	5,98
Weight (kg)	34,81	2,48	44,31	2,63	53,67	2,85	64,10	2,57	76,48	3,95
BSA (m <sup>2</sup> )	1,18	0,05	1,38	0,06	1,56	0,07	1,76	0,06	1,96	0,06
BMI (kg/m <sup>2</sup> )	16,73	1,17	18,52	1,62	20,19	1,77	21,39	1,62	23,43	1,84

TABLE 1. Anthropometric data for all the participants to the study

(40-49 kg), G3 (50-59 kg), G4 (60-69 kg) and G5 (70-79 kg). Anthropometric data is presented in Table 1.

Average blood pressure values were 111,86 (SD 8,25) mmHg for systolic and 68,99 (SD 9,50) mmHg for diastolic. Average heart rate was 66,49 (SD 13,45) beat/min. Both blood pressure values and hart rate were within reference range for the appropriate age. Auscultatory heart finding and cardiac anamnesis were negative in all the subjects as well as visual examination for syndromes including Marfan. ECG analysis showed the usual average values: PR interval was 145,98 (SD 31,88) msec, QRS complex was 106,21 (SD 13,07) msec and QTc was 405,55 (SD 21,03). The observed ECG values were concurrent with the range appropriate for this age group.

*Echocardiographic measurements*

Echocardiographic data analyzed for all the subject groups are presented in Table 2. The data include mean values and standard deviations for the following parameters: left ventricular diastolic diameter (LVDD), left ventricular systolic diameter (LVSD), interventricular septum diastolic thickness (IVSd), LV posterior wall diastolic thickness (LVPWd), left ventricular mass (LV Mass) and left ventricular index mass (LV Index Mass).

We analyzed correlation between left ventricle mass and body surface and established significant correlation at  $p < 0,05$  ( $r = 0,7058$ , 95% CI 0,6315-0,7673) (Chart 1). The results were simmilar in the analyses of correlation between left ventricle mass and high

( $p < 0,05$ ,  $r = 0,6622$ , 95% CI 0,5796-0,7314) and between left ventricle mass and body mass ( $p < 0,05$ ,  $r = 0,6987$ , 95% CI 0,6230-0,7615). Moderate correlation was established between left ventricle mass and heart rate  $p < 0,05$ ,  $r = -0,3923$ , 95% CI -0,5001 to -0,2725) (Chart 2).

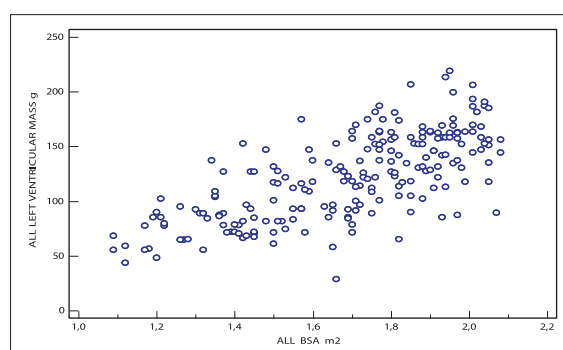


CHART 1. Correlation between left ventricular mass and body surface (all subjects).

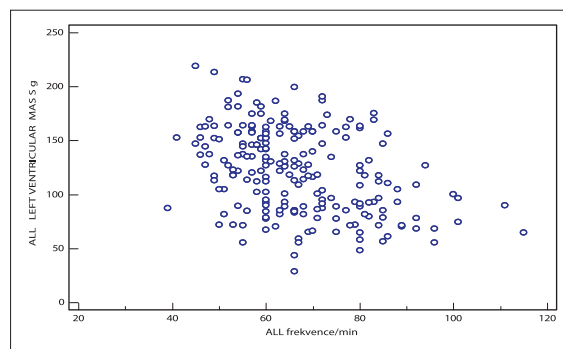


CHART 2. Correlation between left ventricular mass and heart rate (all subjects).

Variable	Group 1 (n=16)		Group 2 (n=32)		Group 3 (n=36)		Group 4 (n=62)		Group 5 (n=68)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
LVDD (mm)	38,69	4,81	43,25	3,50	42,78	5,98	45,98	4,77	48,75	4,00
LVSD (mm)	24,19	5,87	26,69	3,63	27,50	4,23	29,36	3,51	31,44	4,06
IVSd (mm)	6,75	0,86	6,94	1,37	7,92	1,32	8,79	1,54	8,79	1,50
LVPWd (mm)	6,81	0,91	7,28	1,73	7,86	1,33	8,36	1,18	9,25	1,26
LV Mass	71,60	17,55	91,58	24,31	104,55	31,09	129,14	32,49	152,52	28,76
LV Index Mass	60,41	13,52	66,26	16,92	66,79	18,74	73,36	17,87	77,81	14,45
BSA	1,18	0,05	1,38	0,06	1,56	0,07	1,76	0,06	1,96	0,06

TABLE 2. Echocardiographic data for all the subject groups

## DISCUSSION

Regular physical activity has proven beneficial in the prevention of atherosclerotic coronary disease, reduction of atherosclerotic risk factors, reduction of risk of acquired coronary conditions and improvement of exercising capacity in patients with stable angina pectoris, congestive heart failure and claudicating. There were no randomized, controlled studies that would directly test the hypothesis that exercising lead to the reduction in coronary heart disease (1). Exercise and loss of body mass may cause the reduction in low density lipoproteins (LDL) cholesterol and reduce decrease in values of HDL cholesterol produced by low fat diet (3). The mechanisms which influence the effect of exercise as well as the incidence of coronary heart disease (CHD) are not well defined. However, the identification of these mechanisms is important considering that they signify the importance of exercising in CHD reduction (2). Numerous possible mechanisms were identified: atherosclerotic risk factors, increase in parasympathetic tonus and risk of ventricular fibrillation, improvement in dilating capacity of coronary artery and endothelial function, reduced risk of coronary thrombosis and thrombocyte deposition (4-10). Congenital heart anomalies and non-atherosclerotic, acquired myocardial conditions are primary causes of exercise-induced cardiac death in young patients (11,12,13). Van Camp et al. reported (12) pathological findings in 136 highschool and university students who died during or within one hour following the sports participation. Cardiac diseases were responsible for approximately 100 death cases. The most frequently diagnosed cardiac diseases were: positive or possible hypertrophic cardiomyopathy (HCM) (56% cardiac cases), coronary artery anomalies (13%), myocarditis (7%), aortic stenosis (6%) and dilating cardiomyopathy (6%). The finding of HCM as a leading cause of exercise induced death and rare right ventricular dysplasia (12) is similar to the reports by other American authors (13). None of the listed anomalies were identified in our group of athletes. Also, revision of athletes' histories in Sarajevo Canton revealed no exercise-induced deaths over the last 10 years. Unlike Italian athletes series (11,15), the most frequent causes of exercise-induced death were right ventricular cardiomyopathy or right ventricular dysplasia. Incidence of major cardiovascular complications during exercise is low in young individuals because of low prevalence of cardiac abnormalities. Furthermore, an existent cardiac abnormality does not necessarily result in cardiac event. For example, the prevalence of echo-

cardiographic finding of LVH that is consistent with HCM is 1/500 or 0,2 % in American adolescents (16) but the incidence of exercise-induced sudden cardiac death (SCD) is much lower. This fact may be explained by self elimination of the affected individuals from sports, efficient screening program or genetic variation of these conditions. American Heart Association recommends the evaluation of personal and family anamnesis and physical examination for highschool students prior to sports participation as well as regular systematic examination once in four years (17). The examination includes visual inspections for signs of Marfan syndrome, blood pressure, auscultation in standing and sitting positions and by Valsalva maneuver. Routine ECG or echocardiographs are not recommended although extensive examinations are recommended in the cases with recognized cardiac symptoms. This document underlines the importance of the presence of a skilled coach with certificate in basic reanimation as well as additional personnel present in training sessions and during competition (18). In their study on 5615 highschool athletes Fuller et al. report on the significance of medical anamnesis, cardiac auscultation and ECG recording (19). In 10% athletes additional evaluation was required because of cardiovascular abnormalities that included: suggestive cardiac anamnesis (2%), abnormal auscultatory findings (3%), hypertension (0,3%) or abnormal ECG (2,6%). Further sports participation was discontinued for 22 athletes due to serious aortic insufficiency (n=1), serious hypertension (n=5), WPW findings (n=6), premature ventricular contractions (n=5), right branch block (n=4) and supraventricular tachycardia (n=1). The authors conclude that ECG screening does increase possibility for the detection cardiac abnormalities; however, most of the significant abnormalities may be detected by physical examination. In our study, cardiac anamnesis was negative in all the participants as well as auscultatory finding. We did not detect congenital cardiac anomalies, abnormal coronary arteries outflow, significant hypertension, WPW finding or supraventricular tachycardia. Incomplete right branch block was diagnosed in n=59 athletes (27,57%). Long-term physical activities lead to structural adjustments in the heart, for example increase in LV thickness, LV EDD diameter, LV mass and other features of "athletic heart". LV wall thickness is generally mild but rarely it may be significant and lead to the diagnosis of HCM. This is of fundamental importance since HCM is a leading cause of sudden death in young athletes. The distinction between physiological athlete heart

and HCM mainly depends on the finding whether the size of left ventricular hypertrophy (LVH) surpasses the expected response to exercise. Although the distinction may be established based on either ECG or echocardiographic finding in certain cases HCM has no diagnostic value and the diagnosis must be supported echocardiographically. Our echocardiographic measurements of relevant parameters: EDD, ESD, S, LVPW did not confirm/indicate incipient HCM in any of the subjects between 8 and 18 years of age. Italian experts underline the importance of routine echocardiograph (14). According to the national law passed in 1971 all the athletes must be subjected to the examination prior to the active sports participation. The physician responsible for the examination of athletes is legally accountable for medical events that may have been prevented (20,21). The basic examination includes evaluation of medical history, physical examination with ECG and step test. The athletes with abnormalities undergo 24h ECG monitoring, echocardiograph and formal stress test. Similar strategy is implemented in Sarajevo Canton since 1995. In 2007 the program was amended with echocardiography and spiroergometry with the intention of making them part of regular systematic examination. In the Italian study, of 33735 examined athletes, 3016 were examined echocardiographically while 621 athletes were removed from further sports participation (15). Among the disqualified athletes 58,7% had cardiac problems including 22 athletes with HCM. Among the disqualified athletes there were 49 deaths although none of those with HCM. The death rate is 1 in 62400 athletes. The authors compared the frequencies of HCM caused deaths in American and Italian athletes and concluded that low prevalence of HCM as a cause of death in the deceased athletes was the result of screening programme. There are no confirmed measures for the reduction of risk of exercise induced cardiac events in children. We support the recommendations of American heart association (AHA) for the screening of athletes which essentially include medical history evaluation and physical examination (17). A simple examination and cardiac auscultation may frequently reveal numerous conditions associated with exercise-induced sudden death syndrome. AHA does not endorse routine ECG or echocardiography because of high cost and frequent false positive findings. Possibly the most efficient strategy for the reduction of cardiac events in young athletes is careful exclusion of cardiac conditions in athletes who exhibit exertion-related symptoms. Many of the athletes who died during sports

participation exhibited symptoms but were never fully examined. Also, we underline the importance of basic reanimation training for athletic coaches and the others involved with athletes. When an athlete collapses those individuals are present and they may provide valuable assistance until the arrival of the professionals. Screening of athletes for cardiovascular conditions is an ambitious project which involves intrinsic difficulties and limitations related to the cost and sustainability. The program of athlete's screening involves numerous challenges beginning with organization, implementation, efficiency and financial demands. Preparticipation screening provides an opportunity for the prevention of sudden death in competitive athletes and it still remains disputable. Italian long-term preparticipation screening has been implemented for 30 years and it deserves to be mentioned because of its objectivity and the results. Italian program routinely includes standard ECG and it may identify or warn of most of cardiac events possibly responsible for sudden death in athletes including HCM, ARVC and DCM. Also, due to ECG their screening of trained athletes frequently leads to false positive findings, hence routine ECG frequently requires additional diagnostic procedures in order to exclude cardiac diseases. There is still no consensus regarding adequate strategies for the screening of young athletes. It involves possible implementation of national medical programme that targets millions of young athletes (approximately 25 million athletes in the USA, 6 million in Italy and 20,000 in Canton Sarajevo) with main intent of revealing wide spectrum of medical conditions. The costs of diagnostic tests performed during screening need to be taken into consideration. Possibility of false positive findings by ECG and echocardiography raises the whole range of legal claims that pertain to the removal of athletes from beneficial effects of physical activity. Therefore, AHA has issued recommendations with clear guidelines for this segment of sports medicine. In this prospective study of young athletes, the need for maintenance of basic education certificate on reanimation procedures for all sports' clubs coaches was instigated in cooperation with Red Cross Organization in Sarajevo Canton. Three physicians with different specialties identified no major differences in auscultatory heart examination, which stands for honest and professional approach. All the athletes of school and adolescent age ought to be examined by pediatrician, school medicine and sports medicine specialists. When indicated by basic physical examination, auscultation, vital parameters measures and standard ECG a visit to the

cardiologist should be recommended. In accordance with financial prospects, defibrillators for sports fields should be procured along with certified coaches, in

order to prevent sudden death in young athletes. Institution of national screening programme of young athletes for cardiovascular conditions should be planned.

## CONCLUSION

This study was the first organized cardiovascular screening of young athletes conducted in Bosnia and Herzegovina. The study included 214 young athletes. No significant anomalies with the potential to cause lethal outcome in young athletes were found. ECG failed to identify significant anomalies in heart rhythm. Also, deviations of blood pressure and heart rate from normal ranges for the relevant age were not established. Echocardiography did not reveal anomalies in LV wall thickness or EDD, ESD that may indicate possible HCM. Also, anomalies in coronary arteries outflow were not detected. Moderate correlation between left ventricular mass and heart rate was established ( $p < 0,05$ ). Institution of national screening programme of young athletes for cardiovascular conditions should be planned.

### *List of Abbreviations*

HDL	-	high density lipoproteins
ECG	-	electrocardiogram
BMI	-	body mass index
BM	-	body mass
LV	-	left ventricle
EDD	-	end-diastolic diameter
ESD	-	end-systolic diameter
LVPW	-	left ventricle posterior wall
RF	-	reduction fraction
SMF	-	supramitral flow
SD	-	standard deviation
BSA	-	body surface area
IVSd	-	interventricular septum diastolic thickness
LVPWd	-	left ventricle posterior wall diastolic thickness
LV index mass	-	left ventricle index mass
CHD	-	congenital heart disease
LDL	-	low density lipoproteins
HCM	-	hypertrophic cardiomyopathy
LVH	-	left ventricular hypertrophy
SCD	-	sudden cardiac death
AHA	-	American Heart Association
USA	-	United States of America
GE	-	General Electric
DCM	-	dilated cardiomyopathy
ARVC	-	arrhythmogenic right ventricle cardiomyopathy

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