CARDIOVASCULAR SYSTEM ADAPTIVE ABILITIES IN YOUNG PEOPLE

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Keywords: cardiovascular system; adaptation; risk factor; Kerdo index; obesity.
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Relevance. Cardiovascular diseases are increasing dramatically in young people and have a leading cause of death worldwide.

Aim. The study aimed to assess the adaptive and compensatory mechanisms of the cardiovascular system and identify the most significant risk factors for cardiovascular disease development in young people.

Materials and methods. The study included 29 volunteers; we have divided them into two groups according to the adaptation potential (AP) values. The first group (n=16) AP values were before 2,6 (satisfactory adaptation), the second group (n=13) AP values were 2,6 and (tension of adaptation mechanisms, unsatisfactory adaptation). The age of the both groups participants was the same ranged from 18-25 years (median 21,0). All the participants have been measured their Heart rate (HR), blood pressure (BP), height (H), weight (W), waist, and hip. We calculated adaptation potential (AP) of the cardiovascular system (CVS) (R.M. Baevsky et al., 1987), body mass index (BMI). We collected information on lifestyle risk factors: tobacco smoking, factors related to unhealthy diet (low frequency of fruits, vegetables and high frequency of fatty food), lack of physical activity and emotional stress (PA) through specially created and standardised in-person interviews using electronic and paper questionnaires. The Pearson $\chi2$ test ("Statistica 7") was chosen for mathematical analysis.

Results. Among the entire sample, pathological deviations of the adaptive potential in young people are revealed in 44.8% Analysis of the hemodynamic characteristics and adaptational abilities of CVS in young persons showed that the Group 1 persons with normal adaptation potential of CVS had levels of the SBP, DBP and HR lower than persons of Group 2. The study of the degree of influence on the CCC of the autonomic nervous system with the calculation of the Kerdo index showed that in group 1 there was a predominance of the parasympathetic system in the regulation of the work of the heart and vascular tone, in group 2 an increase in the role of sympathetic influences was recorded. In both groups, individuals with hyperactivation of SNS / PNS were identified, but in group 2 there were more of them by 80%. The assessment of unmodifiable risk factors in young people has shown an important role for gender. In group 1, the gender distribution was 50.0% women, 50.0% men, in group 2 women accounted for 7.7%, men - 92.3% (p <0.015). The study of the significance of the genetic predisposition to the development of

CVD showed that 38% of the participants in group 1 and 31% of the participants in group 2 have close relatives with this pathology. The study of the anthropometric data of the participants revealed the correlation between the increase in BMI and violations of the adaptive abilities of the CVS. In group 2, normal BMI values were in 42.2%, overweight - in 42.2%, obesity - in 7.6%. In group 1, all participants had a normal BMI. Differences between groups were significant (p <0.01). Statistical analysis of CVD risk factors such as smoking, physical inactivity, heredity, dietary habits in young people and evaluation of the percentage distribution of participants according to these characteristics did not reveal statistical differences between groups. Significant differences between the groups were registered in terms of gender, BMI, and emotional stress, which indicates their particular importance in young people in reducing the adaptive and compensatory potential of CVS and the development of CVD.

Conclusion. Pathological deviations of the adaptive potential in young people are accompanied by the prevalence of sympathetic influences in the regulation of CVS functions and are revealed in 44.8%, which indicates the relevance of identifying the most significant CVD risk factors in order to prevent them. In reducing the adaptive compensatory potential of CVS and the development of CVD in young people, the factors of gender, excess weight, and emotional stress are the most significant.

Relevance. Cardiovascular diseases are increasing dramatically in young people and have a leading cause of death worldwide [1, 7]. The CVD includes; heart failure, atrial fibrillation, chronic kidney disease, heart valve diseases, aortic syndromes, and dementia, in addition to coronary heart disease (CHD) and stroke. Typically, coronary heart disease is sudden with no previous signs and clinically silent with unclear risks only when considering the family history of this disease. Modified risk factors usually depend on the insurance status of the person, the family income above the poverty line, having a usual source of health care, and the presence of comorbid conditions. Hypertension and diabetes mellitus are the main avoidable risk factors, besides daily stress, smoking, low physical activity, obesity, and the lifestyle regime, together, are the start point for CVD development [2, 6]. Physical inactivity was found to be partially associated with an increased risk of CVD [3]. Probably, physical inactivity increases the opportunity for the development of chronic anxiety, particularly general anxiety disorder, which consequently increases the risk of CVD [5]. However, the potential risk factors continue beyond the immune system to include inflammation and clonal hematopoiesis [4]. Furthermore, obesity and dyslipidemia are directly associated with CVD, especially visceral obesity and high low-density lipoprotein cholesterol fraction. Anxiety has a higher potential risk for CVD since it plays a key role in developing the primary clues of CVD such as obesity. The study aimed to assess the adaptive and compensatory mechanisms of the cardiovascular system and identify the most significant risk factors for cardiovascular disease development in young people.

Research methods and materials. The study included 29 volunteers; we have divided them into two groups according to the adaptation potential (AP) values. The first group (n=16) AP values were before 2,6 (satisfactory adaptation), the second group (n=13) AP values were 2,6 and (tension of adaptation mechanisms, unsatisfactory adaptation). The age of the both groups participants was the same ranged from 18-25 years (median 21,0). All the participants have been measured their Heart rate (HR), blood pressure (BP), height

(H), weight (W), waist, and hip. We collected information on lifestyle risk factors: tobacco smoking, factors related to unhealthy diet (low frequency of fruits, vegetables and high frequency of fatty food), lack of physical activity and emotional stress (PA) through specially created and standardised in-person interviews using electronic and paper questionnaires. The Pearson $\chi2$ test ("Statistica 7") was chosen for mathematical analysis.

Results and their discutions. The analysis show that among all the variants of pathological deviation of adaptation in young people, 44.8% (13) are detected, which shows the relevance of the most significant risk factors for CVD in order to prevent them. Distribution of participants into groups, taking into account the values of AP CCC. A decrease in the adaptive poten
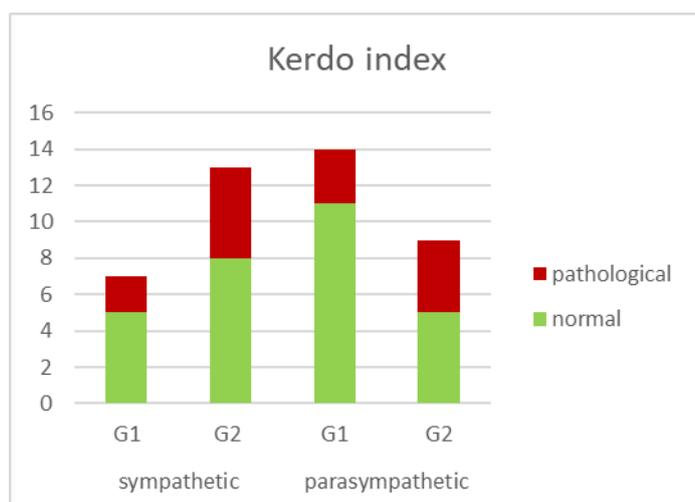
Fig. 1- Kerdo index of young persons with different adaptational abilities of CVS.
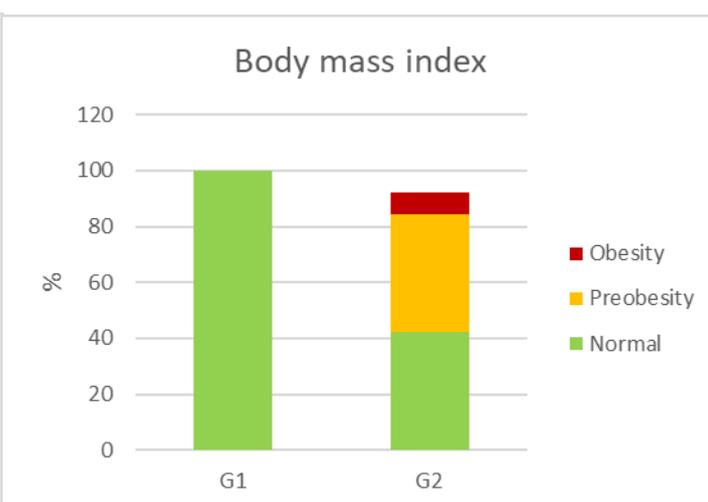
Fig. 2- BMI of young persons with different adaptational abilities of CVS.

tial is accompanied by a slight shift in the indicators of microhemodynamic homeostasis within their so-called normal values, the tension of regulatory systems increases, and the "payment for adaptation" increases. The impairment of adaptation as a result of overstrain and depletion of regulatory mechanisms in the elderly is characterized by a sharp drop in the reserve capacity of the heart. At a young age there is even an increase in the level of the circulatory system. This has been shown in our studies as well. Analysis of the hemodynamic characteristics and adaptive capabilities of CVS in young people showed that the levels of SBP, DBP and heart rate in persons of group 1 with normal adaptive potential of CVS are lower than in persons of group 2. 11.3% this indicator in group 2. The heart rate in the 1st group was lower by 12.5%, in the 2nd group. The study of the degree of influence on the CCC of the autonomic nervous system with a calculated index, which in group 1 showed the prevalence of the parasympathetic system in the regulation of the heart and vascular tone, in group 2 an increase in the role of sympathetic influences was recorded. Individuals with hyperactivation of SNS / PNS were identified in the groups, but in group 2 there were more of them by 80% (Fig. 1).

Assessment of unmodifiable risk factors in young people showed a role for gender. In group 1 the gender distribution was 50.0% women, 50.0% men, in group 2 women ac-

counted for 7.7%, men - 92.3%. This difference is statistically significant (p <0.015). The study of the significance of the genetic predisposition to the development of CVD showed that 38% of the participants in group 1 and 31% of the participants in group 2 have close relatives with this pathology.

The study of the anthropometric data of the participants revealed the correlation between the increase in BMI and violations of the adaptive abilities of the CVS. In group 2, normal BMI values were in 42.2%, overweight - in 42.2%, obesity - in 7.6%. In group 1, all participants had a normal BMI. Differences between groups were significant (p <0.01) (Fig. 2).

The assessment of risk factors with an appropriate lifestyle showed the following results (Table 1).

Tabl. 1. CVD risk factors in young people.

Factor	Index		G1 (n=16)	G2 (n=13)	χ2 test	p
Gender	M		50% (8)	92.3% (12)	5.998	<0.015
	F		50% (8)	7.7% (1)		
Fast food	>1t/wk		68.8% (11)	53.8% (7)	NS	
	<1t/wk		31.3% (5)	46.2% (6)		
Vegetables	>1t/wk		100% (16)	100% (13)	NS	
	<1t/wk		0% (0)	0% (0)		
Smoking	Yes		25.0% (4)	53.8% (7)	NS	
	No		75.0% (12)	46.2% (6)		
Physical activity	≥ 50 min/d		88% (14)	77% (10)	NS	
	≤50 min/d		13% (2)	23% (3)		
Genetic predisposition	AH	No	63% (10)	69% (9)	NS	
		Yes	38% (6)	31% (4)		
	DM	No	44% (7)	62% (8)	NS	
		Yes	56% (9)	38% (5)		
BMI	Median (min; max)		21.76(18.46; 24.50)	25.15(19.52; 33.42)		
	Normal		100 % (16)	42.2 % (6)	11.357	<0.01
	Overweight		0% (0)	42.2 % (6)		
	Obesity		0% (0)	7.6 % (1)		
w/h ratio	Median (min; max)		0.79 (0.68; 0.83)	0.81 (0.73; 0.92)		
	Normal		100 % (16)	92.4 % (12)	NS	
	Increase		0% (0)	7.6 (1)		
PAS	Median (min; max)		47(26;63)	37.5(21; 71)		
	Low		6.3% (1)	38.4% (5)	6.192	<0.05
	Middle		31.3% (5)	38.4% (5)		
	High		62.5 % (10)	23.2% (3)		
SAS	Median (min; max)		43(24; 68)	34.5(23; 60)		
	Low		6.3% (1)	23.1% (3)	NS	
	Middle		37.5% (6)	46.2% (6)		
	High		56.3% (9)	30.7 % (4)		

NS - not significant difference between groups

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In young people, hypodenamia was observed in 13% of the participants in group 1, 23% in group 2. In the studied groups of smoking, 25.0 % and 53.8% of participants in groups 1 and 2 were found to have vegetables at least once a week. Fatty foods are consumed more than once a week by 68.8% of participants in group 1 and 53.8% of participants in group 2 (p> 0.05). Evaluation of emotional stress by the level of situational and personal anxiety showed that this factor was most significant in the individuals in group 1 (LT was 47 (26; 63) - a high level, in group 2 this indicator was 37.5 (21.71)) - a moderate level.

Comparison of the results of both groups indicates a maladaptation of the cardiovascular system even at rest in the second group, probably due to excess weight and smoking, as well as the risk of low physical activity and stress. Six out in seven smokers of the second group had mechanisms of adaptation to stress, and 14% had a failure of adaptation mechanisms. However, only one in seven smokers has 50 minutes of physical activity a day. Five out of six participants have relatives with arterial hypertension and / or diabetes who have developed tension in adaptation mechanisms, and only 17% have failure in adaptation mechanisms. Interestingly, at the time of data collection and survey of participants in the first group, 10 (62.5%) participants had a severe degree of anxiety, 5 (31.3%) had moderate values, and only one had a low anxiety scale, while hypodenamia 0% developed problems with adaptive capacity. Whereas in the second group, 3 (23.2%) out of 13 participants had a severe anxiety scale and 5 (38.4 %) had a moderate anxiety scale; at the same time 5 (38.4%) had low values, while 92% of them had adaptation voltage and 8% had unsatisfactory adaptation values. However, this variation does not exclude the negative role of anxiety in the development of cardiovascular diseases. This is probably the specificity of adolescence. It should be noted that anxiety is part of the risk factors and the ratio of risk factors, which is probably corrected by the body. For example, high vegetable intake or physical activity offset anxiety by correcting the metabolism of the cardiovascular system, especially the molecules released by the endothelium (nitric oxide, endothelin, etc.).

Statistical analysis of indicators of CVD risk factors such as smoking, physical inactivity, heredity, dietary habits in young people and the assessment of the percentage distribution of participants according to these characteristics did not reveal statistical differences between the groups. Significant differences between the groups were registered in terms of gender, BMI, and emotional stress, which indicates their particular importance in young people in reducing the adaptive and compensatory potential of CVS and the development of CVD.

Conclusions: pathological deviations of the adaptive potential in young people are revealed in 44.8%, which indicates the relevance of identifying the most significant risk factors for CVD in order to prevent them. Pathological deviations of the adaptive potential in young people are accompanied by the prevalence of sympathetic influences in the regulation of the functions of the CVS. In reducing the adaptive compensatory potential of CVS and the development of CVD in young people, the factors of gender, excess weight, and emotional stress are the most significant.

Literature
1. Benjamin E. E. J. [и др.]. Heart Disease and Stroke Statistics—2019 Update: A Report From

the American Heart Association // Circulation. 2019. № 10 (139). C. e56–e528.

2. Choi S. [и др.]. Association of Obesity or Weight Change With Coronary Heart Disease Among Young Adults in South Korea // JAMA Internal Medicine. 2018. № 8 (178). C. 1060.

3. Chomistek A. K. [и др.]. Physical Activity and Incident Cardiovascular Disease in Women: Is the Relation Modified by Level of Global Cardiovascular Risk? // Journal of the American Heart Association. 2018. № 12 (7).

4. Libby P. [и др.]. Atherosclerosis // Nature Reviews Disease Primers. 2019. № 1 (5). C. 56.

5. Reiner I. C. [и др.]. The association of chronic anxiousness with cardiovascular disease and mortality in the community: results from the Gutenberg Health Study // Scientific Reports. 2020. № 1 (10). C. 12436.

6. Srour B. [и др.]. Ultra-processed food intake and risk of cardiovascular disease: prospective cohort study (NutriNet-Santé). // BMJ (Clinical research ed.). 2019. (365). C. l1451.

7. Cardiovascular diseases (CVDs) [Электронный ресурс]. URL: https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds) (дата обращения: 16.04.2021).