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Analysis of the State of Energy Metabolism and Autonomic Nervous System of Children and Adolescents in the Aral Sea Region (Republic Of Karakalpakstan)

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Abstract
This work explains that, pupils from grades 1 through 11 at school No. 8 in the city of Nukus, the Republic of Karakalpakstan, had their minimum and maximum heart rates measured at 83.73±4.36 beats per minute (bpm) for boys and 79.32±2.26 beats per minute (bpm) for girls. They also had their systolic blood pressure measured at 85.16±4.15 beats per minute (bpm) for boys and 89.37±4.09 beats per minute (bpm) for girls. The Robinson index's minimum/maximum values for boys are 73.43±4.26/104.18±2.37, and 75.38±3.17/102.43±5.27 for girls, respectively. The mechanisms of energy exchange in the body were rated as "*excellent*" in the overall condition of boys and girls aged 7 to 10, and "*poor*" in the age range of 11 to 17 years. A minimum/maximum range of 23.18±1.05/42.32±1.24 was seen for the Kerdo index values in investigations including school children in grades 1-11. Contrarily, the autonomic nervous system in schoolchildren was entirely "*sympathetic*" meaning that the sympathetic nervous system was given primacy. For boys, this was 16.80±0.89 and for girls, it was 38.50±1.05.

Index Terms: heart rate, systolic/diastolic blood pressure, Robinson index, Kerdo index, sympathetictonia.

I. Introduction

Modern anthropogenic, technogenic, environmental, and socioeconomic factors have a significant impact on the stress-related functional activity of the human body, and as a result, it is theoretically and practically significant to continuously monitor the stage of physical development, particularly in children and adolescents [1, 2].

When characterizing heterochrony using indicators of the circulatory and respiratory systems in ontogeny, the objectivity of describing the state of the human body's growth and development was confirmed [3, 4].

This study aims to examine how the autonomic nervous system and energy exchange function of Aral Sea region schoolchildren.

II. Materials And Research Methods

The study was conducted among students of school No. 8 (grades 1-11) of the city of Nukus, Republic of Karakalpakstan. Nukus city (the capital of the Republic of Karakalpakstan) is located on the right bank of the AmuDarya River, borders the Kyzylkum desert from the south and east, the land area is 222 km^2, the population is 315,100 people, the canals Kyzketken (Doslyk), Anasay (Kattagar) flow through the city, the climate is temperate and it is located at a distance of ~172 km from the Aral Sea.

In research, blood pressure (millimeters of mercury (mmHg) was measured using the Korotkov method were measured on an OMRON 711 medical tonometer (model HEM-8712-CM2) (OMRON Healthcare Co LTD, China) [5].

At the same time, the student's blood pressure was recorded using a standard medical tonometer and stethoscope based on the measurement of systolic blood pressure and diastolic blood pressure in a sitting position in a chair, in the area of the wrist [6, 7] (Figure 1).

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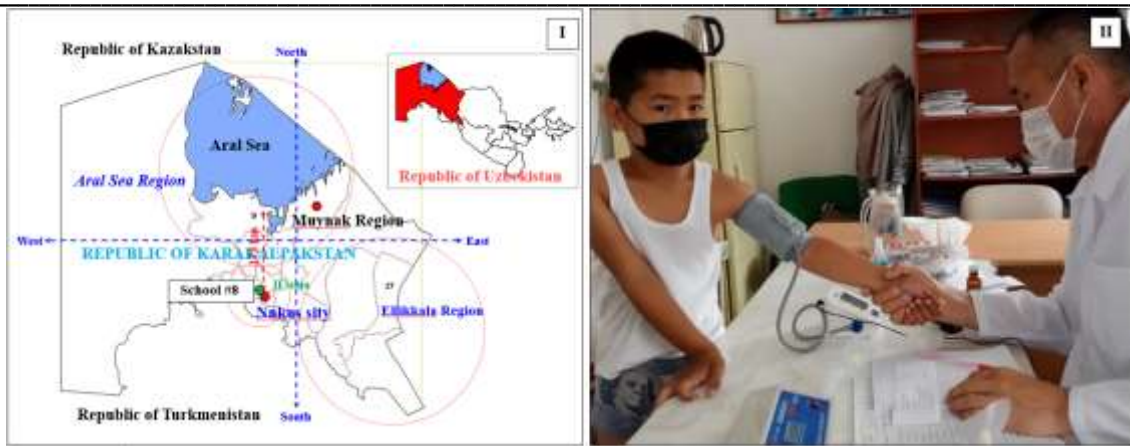
**Figure 1. I. Map of study areas (Nukus, Republic of Karakalpakstan).
II. The process of registering the functional activity of the cardiovascular system in school children.**

Heart rate (beats/min) was determined based on measuring the number of heart contractions by the tonometric method in a sitting position using a stethoscope (Ukraine) [6, 8].

In research, the Robinson index (*1*) was used to describe the processes of energy exchange in school children, and the Kerdo index (*2*) was used to assess the state of the autonomic nervous system [2]:

Robinson index=(HR×SBP)/100 (*conventional units/c.u.*)   (*1*)

Here, HR is the heart rate (beats per minute, or bpm); SBP is systolic blood pressure (mmHg).

According to research, a healthy person's body has a Robinson index of 85 on average, and in 69 cases, the body's energy exchange processes are "*great*", or "*good*", or "*medium*", 85-94, "*poor*", and >111 cases, it is "*extremely terrible*" [2, 7].

Kerdo index =[(1–(DABP/HR)]×100   (*c.u.*)   (*2*)

The experimental findings from the study were processed mathematically and statistically using specialized software programs in accordance with accepted practices using OriginPro v. 8.5 SR1 (EULA, USA) and Microsoft Excel 2007 (Microsoft, USA) [8, 9, 10, 11].

The experimental findings from these investigations are shown as M m outcomes of tests performed in n repetitions, where M is the arithmetic mean and m is the amount of the standard error (experiments were carried out 3-4 times in repetition; *n*=3-4)). Based on the Student's t-test, the degree of statistical significance between the experiment's results was determined, and was determined to be statistically significant at values of p<0.05 and p<0.01 [12].

Results And Discussion

It has been established that the impact of the external environment, particularly an unfavorable ecological environment, on the body of children and adolescents with a high level of sensitivity to the effects of endogenous and exogenous factors significantly affects both the current state of somatometric indicators and the dynamics of growth and development of the body in the future [13, 14, 15].

One of the rather sensitive systems in the human body's process of adapting to the effects of numerous factors is the way the cardiovascular system is functioning [16].

Heart rate (bpm) and blood pressure are indicators that offer a high level of information value (mmHg). Systolic blood pressure (SBP) is the highest blood pressure that can be measured while the left ventricle of the heart is contracting, or when the body is in systole. Diastolic blood pressure (DABP) is the lowest blood pressure that can be measured when the body is in diastole. [16, 17].

Studies have shown that students in grades 1 through 11 had an average heart rate that ranged from 83.73±4.36 for boys, 98.16±5.37 for girls. A total of 4.56 times per minute were recorded.

Also, the average systolic blood pressure in schoolchildren (grades 1-11) was 85.16±4.15, the maximum was 103.65±5.04 mm Hg in boys and 89.37±4 mm Hg. respectively, in girls 09 and 112.28±4.35 mm Hg (Table 1).

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Table 1

Heart rate (bpm) in children and adolescents and analysis of systolic blood pressure values (*M±m*)

#	Age (grade)	Heart rate (bpm)			Systolic blood pressure (mmHg)		
		Boys (*n*=170)	Girls (*n*=170)	Norm	Boys (*n*=170)	Girls (*n*=170)	Norm
1.	7 (1)	86.23±1.07	84.23±4.16	85-90	85.16±4.15*	89.50±3.14	87
2.	8 (2)	90.15±2.84	83.33±2.75	80-85	92.64±3.35*	91.32±4.27	88
3.	9 (3)	84.16±3.14	86.18±3.50	80-85	91.58±4.23	93.16±4.64	90
4.	10 (4)	83.73±4.36	79.32±2.26	78-85	95.17±5.40	94.39±5.12	91
5.	11 (5)	91.46±3.18 *	85.29±3.15	78-84	100.18±4.37 *	99.06±4.52	98
6.	12 (6)	90.12±2.79 *	89.30±4.57 *	75-82	105.41±3.19	100.67±5.34	103
7.	13 (7)	89.35±2.24 *	83.31±2.43 *	72-80	108.64±4.46	101.53±4.05 **	107
8.	14 (8)	95.27±4.45 **	80.20±3.53 **	65-75	116.75±4.87 *	89.37±4.09* *	109
9.	15 (9)	94.51±3.17 **	85.18±4.15 *	70-76	105.68±4.38 **	112.28±4.35	110
10.	16 (10)	93.72±4.28 **	86.54±3.42 **	68-72	102.43±5.26 **	105.24±5.16 *	113
11.	17 (11)	98.16±5.37 **	90.35±4.56 **	60-80	103.65±5.04 **	98.42±2.19* *	115

Note: * – according to the standard norm (control) group p<0,05, ** – p<0,01 (*n*=3-4).

In studies, the average values of the Robinson index among school children (grades 1-11) were minimal in boys 73.43±4.26, maximum 104.18±2.37 n.p., respectively, in girls – 75.38±3.17 and 102 s.p. amounted to 43±5.27 s.p. (Table 2).

However, based on the values of the Robinson index obtained in the studies, the energy exchange processes in the body were assessed as "good" in the general condition of boys and girls aged 7-10 years and "poor" in the age range of 11-17 years.

In following research the average values of the Kerdo index among students (grades 1–11) were found to be for boys minimum 23.18±1.05, 42.32±1.24 for the maximum and 16.80±0.89 for girls, respectively, it was found that it is 38.50. ±1.05. (Table 2).

Table 2
Analysis of the Kerdo index according to the Robinson index in children and adolescents
(*M±m*)

#	Age (grade)	Robinson index (*c.u.*)		Kerdo index (*c.u.*)	
		Boys (*n*=170)	Girls (*n*=170)	Boys (*n*=170)	Girls (*n*=170)
1.	7 (1)	73,43±4,26	75,38±3,17	39,54±2,06	38,25±1,27
2.	8 (2)	80,13±2,19	82,27±3,46	42,32±1,24	37,59±1,45
3.	9 (3)	77,07±3,35	80,29±4,26	37,03±2,12	38,50±1,05
4.	10 (4)	79,69±4,42	74,87±4,30	35,51±3,27	31,92±2,16
5.	11 (5)	91,63±5,18	84,49±5,12	34,39±2,23	29,65±1,07
6.	12 (6)	94,99±3,78	87,25±4,65	33,42±2,15	32,81±2,53
7.	13 (7)	97,06±4,27	84,58±3,15	31,73±1,48	26,78±2,04
8.	14 (8)	96,23±1,45	92,66±3,44	34,92±1,09	22,69±1,62
9.	15 (9)	97,51±4,06	95,64±5,73	34,39±1,36	27,21±1,04

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| 10. | 16 (10) | 97,98±5,38 | 96,16±4,26 | 23,18±1,05 | 16,80±0,89 |
| 11. | 17 (11) | 104,18±2,37 | 102,43±5,27 | 28,68±0,74 | 20,32±0,67 |

On the other hand, based on the examination of the Kerdo index values, it was found that the autonomic nervous system in the investigated schoolchildren (grades 7-11) is entirely in "*sympatheticatonia*" or that the sympathetic nervous system has primacy. neurological system.

Conclusion

Thus, according to the study, the average heart rate of students in grades 1 through 11 at school #8 in Nukus, the Republic of Karakalpakstan, was at least 83.73±4.36 beats per minute in boys and at most 98.16±5.37 beats per minute in girls, respectively. Systolic blood pressure in boys was on average minimal at 85.16±4.15 beats per minute and at most 103.65±5.04 beats per minute, while it was 89.37±4.09 beats per minute and 112.28±4.35 beat.

Thus, the lower the value of the Robinson index, the higher the maximum aerobic capacity of the body and, in turn, the state of somatic health [7].

The average values of the Robinson index are minimal 73.43±4.26, maximum 104.18±2.37 in boys, respectively 75.38±3.17 and 102.43±5.27 in girls . Obtained in studies of the Robinson index, the processes of energy exchange in the body were assessed as "*good*" in the general condition of boys and girls at 7-10 years old, and "*bad*" at 11 -17 years old.

Studies have shown that the values of the Kerdo index among schoolchildren (grades 1-11) averaged for boys at least 23.18±1.05, maximum 42.32±1.24, respectively, in girls 16.80±0.89 and 38.50±1.05 "*sympathetictonia*", the priority of the sympathetic nervous system was noted as well.

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