# Investigation Of The Functional State Of The Cardiorespiratory System In Children From Various Regions Of The Southern Aral Sea Region

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***Abstract: The article discusses the results of a study of the features of the functional state of the cardiorespiratory system in children in the conditions of the Southern Aral Sea region. The study of the patency of various parts of the tracheobronchial tree showed that boys tend to increase bronchial patency with age. The increase in bronchial patency with the age of children with insignificant differences in the value of the vital capacity of the lungs can be attributed to the regional features of the external respiration system. It has been established that there is a relationship between physical development and functional characteristics of the circulatory system in children born and living in the South Aral Sea region. The data obtained suggest that the circulatory system in children is very sensitive to adverse environmental factors in the Southern Aral Sea region, thereby reducing their adaptive capacity and contributing to the formation of conditions for the development of diseases.***

***Keywords: Southern Priaralie, cardiorespiratory system, children’s population, physical development, external respiration, blood circulation, environmental factors.***

## 1. INTRODUCTION

The preservation of the adaptive potential of the organism under conditions of intense influence of various anthropogenic factors is one of the central problems of ecology and physiology. Individual adaptation is a process that develops in the course of life, as a result of which the body acquires resistance to environmental factors and gets the opportunity to live in conditions previously unsuitable for life.

Today, many researchers [1, 2, 10.] have shown that along with genetic factors, environmental factors have a great influence on the development of the child’s body. The scientific significance of studies devoted to the problem of the physical development of children has especially increased in recent years [7, 10, 14.]. The acceleration process has significantly slowed down or even stopped, in connection with which there is a need for new scientific research. According to numerous data, indicators of physical development and health of certain groups of the child population over the past two decades have acquired a negative trend [7, 11, 13.]. At the same time, the specification of the situation in terms of timely and reliable information about the state of physical development of children and adolescents is constantly necessary for the organization of preventive work.

The functional characteristics of the body of children, who are still immature in the physiological and mental terms and therefore the most susceptible to various exogenous influences, are of great interest from the ecological and physiological positions and are necessary for making a reasonable forecast of the functional reserves of the body and the health of the population of the Republic of Karakalpakstan in the current ecological situation. The formation of the ecological situation in the South Aral Sea region could not but affect the functional state of the cardiorespiratory system.

## 2. MATERIAL AND METHODS

The surveyed contingent consisted of groups of children aged 6 to 10 years. Geographically, all subjects were divided into 3 groups in accordance with their place of permanent residence. The functional state of the organism of children was assessed by the results of the study of the function of external respiration (VC) by the method of spirometry; cardiovascular system (heart rate, blood pressure). The functions of external respiration were investigated by the pneumotachometry method on the device “Polyanalizer - PA5-02”. The parameters of external respiration were assessed in a state of relative rest, in a sitting position. In the course of the study, the absolute values of the indicators of external respiration and their relation to the average statistical norm, expressed as a percentage, were determined: FVC - vital capacity of the lungs (l); FEF 75 - large bronchial patency (l / sec); FEF 50 - middle bronchus patency (l / sec); FEF 25 - patency of small bronchi (l / sec).

The evaluation of the obtained research results and their mathematical processing were carried out according to the methods recommended in biological research [9] and using the Microsoft Excel analysis package. Statistical methods used in the processing of the obtained material included the determination of the reliability of the materials obtained by the Student’s t-criterion (the lower confidence limit was taken to be a significance level of 95% ($p < 0.05$)); carrying out a correlation analysis of the indicators of the compared groups, with the determination of the correlation coefficient R by the Pearson method (the correlation was considered significant when the coefficient was 0.7 or more) [9].

The analysis of the heart rate of children makes it possible to determine the activity of the divisions of the autonomic nervous system (ANS) in the regulation of the cardiovascular system and to assess the degree of tension in the regulatory systems. The trend towards an increase in pathological deviations in blood pressure in children puts the problem of studying the circulatory system in a number of urgent problems of modern human physiology. Statistical analysis of heart rate is a research method recognized in applied and special physiology. It is based on the developments of R.M. Baevsky and others. [3, 5], Which were originally intended to predict the state of a person in space flight, complex operator activities, etc. Currently, this method is used to determine the type of regulation of cardiac activity.

## 3. RESULTS AND DISCUSSION

The respiratory system is border line and is in direct contact with the external environment and is one of the first to respond to changes in external conditions, pollution of the surface air layer. The main purpose of breathing is the delivery of oxygen to the tissues and the removal of carbon dioxide formed as a result of oxidative processes. In accordance with the generally accepted concept of P.K. Anokhin’s respiratory system is a complex of formations that includes central (regulatory) and peripheral (perceiving) nerve components and working apparatus, functionally combined into a single system, the final effect of which is to maintain the relative constancy of the gas composition of blood and body tissues.

Studies of the function of external respiration provide essential information about the state of the adaptive mechanisms of the child's body. In response to a change in the quality of atmospheric air on the part of external respiration, bronchial patency first of all changes. By the level of bronchial patency, the state of adaptive changes is judged. Such relative indicators as the vital capacity of the lungs in assessing physical development simultaneously characterize the functional capabilities of the organism [6, 11, 15.].

In the course of the study, we found that in a child’s body there are two important periods of development of the external respiration system: at 6-7 years old - there is a significant decrease in bronchial resistance, which leads to an increase in the volume of inhalation and exhalation, and 8-10 years - a period of intensive increase in volume lungs. The general patterns of development of the functions of external respiration, its reserve and adaptive capabilities in the ontogenesis of children have been studied by specialists in many ways [1, 2, 5, 6.].

So, we note that according to experts, at the age of 8-12 years, there is a smooth maturation of the morphological structures of the lungs. However, between 8-9 years of age, the lengthening of the bronchial tree prevails over its expansion. As a result, the decrease in the dynamic resistance of the airways slows down, and there is no dynamics of tracheobronchial resistance [2]. The greatest growth and development of the respiratory system occurs during puberty [5]. By the beginning of puberty, the total volume of the lungs increases 10 times, and by its ring - 20 times compared with those of a newborn. The cartilage of the bronchi in children is soft, flexible and easily springy. Elastic fibers are relatively poorly developed. The mucous membrane of the bronchi is rich in blood vessels, but relatively dry. According to N.A. Skoblina (2008), the final branching of the bronchial tree (segmental, subsegmental and terminal bronchi, bronchioles, alveolar passages) ends by the age of 7 [13].

The results obtained on the functional indicators of the body of children 6-10 years old indicate that in the process of development of children, indicators of vital capacity of the lungs (VC) tend to increase (Table 1). The vital capacity of the lungs in a 5-7 year old child is 1200 ml in boys and 850 ml in girls. At 8-10 years old, this figure is respectively 2000 ml and 1700 ml. [16].

**Table 1**
**Age dynamics of indicators of the function of external respiration in children living in the region of the Southern Aral Sea region (M + m)**

| Age | gender | FVC | PEF | FEF-75 | FEF-50 | FEF-25 |
|---|---|---|---|---|---|---|
| 6 | b | 1,90+0,07 | 3,11+0,1 | 3,28+0,1 | 2,40+0,1 | 1,16+0,03 |
| | g | 1,60+0,04 | 3,76+0,2 | 3,34+0,2 | 2,36+0,2 | 1,23+0,1 |
| 7 | b | 1,93+0,02 | 3,25+0,1 | 3,39+0,1 | 2,47+0,1 | 1,24+0,02 |
| | g | 1,62+0,08 | 3,86+0,2 | 3,48+0,2 | 2,49+0,2 | 1,31+0,1 |
| 8 | b | 1,94+0,08 | 3,77+0,1 | 3,33+0,1 | 2,50+0,1 | 1,26+0,07 |
| | g | 1,72+0,08 | 4,06+0,2 | 3,53+0,2 | 2,54+0,2 | 1,36+0,1 |
| 9 | b | 2,18+0,08 | 4,49+0,2 | 3,78+0,2 | 2,56+0,1 | 1,33+0,07 |
| | g | 1,85+0,06 | 4,24+0,1 | 3,86+0,1 | 2,68+0,1 | 1,42+0,1 |
| 10 | b | 2,34+0,07 | 4,91+0,2 | 4,23+0,1 | 3,01+0,1 | 1,54+0,1 |
| | g | 2,07+0,07 | 5,17+0,1 | 4,31+0,2 | 3,29+0,2 | 1,76+0,01 |

**Note:** g - girls, b - boys, FVC - vital capacity (l); FEF 75 - large bronchial patency (l / sec); FEF 50 - middle bronchus patency (l / sec); FEF 25 - permeability of small bronchi (l / sec), PEF - maximum expiratory flow rate (l / sec).

So, in boys at 6 and 7 years old, the vital capacity of the lungs (FVC) was 1.90 + 0.07 l and 1.93 + 0.02 l, respectively. The greatest increase in FVC is observed in children aged 9 and 10 years, in boys, the FVC indicator was 2.18 + 0.08 and 2.34 + 0.07 L ($p < 0.001$), respectively.

According to the analysis carried out, it is observed that in girls aged 6 and 7 years, the FVC indicators were 1.60 + 0.04 and 1.62 + 0.08 liters, respectively. The greatest increase in FVC is observed in girls aged 9 and 10 years, the absolute FVC values were 1.85 + 0.06 and 2.07 + 0.07 L ($p < 0.001$), respectively. In girls aged 10 years, FVC was significantly higher - 2.07 + 0.07 L ($p < 0.001$) than in girls of 6 years old and not significantly higher than in girls of 8 years old ($p > 0.05$).

The study of the patency of various parts of the tracheobronchial tree showed that boys tend to increase bronchial patency with age. In boys aged 9 and 10, the patency of large bronchi (FEF-75) was 3.78 + 0.2 and 4.23 + 0.1 l / s, respectively, versus 3.33 + 0.1 and 3.33 + 0 , 1 l / s ($p < 0.001$) in boys 7 and 8 years old (respectively). In girls aged 9 and 10 years, the absolute FEF-75 indicators were significantly increased to 4.31 + 0.2 l / s versus 3.48 + 0.2 and 3.53 + 0.2 l / s, respectively in girls 7 and 8 years old ($p < 0.001$).

The absolute indicator of the patency of the middle bronchi (FEF-50) in boys 9 and 10 years old was significantly higher, respectively - 2.56 + 0.1 and 3.01 + 0.1 l / s, than in boys 7 and 8 years old ($p < 0.001$ ) and 6 years ($p < 0.01$). In girls, the average bronchus FEF-50 was, respectively, 3.29 + 0.2 (10 years) ($p < 0.001$), 2.68 + 0.1 (9 years) ($p < 0.001$) and 2.36 + 0, 2 (6 years) ($p < 0.05$).

Note that the absolute indices of the patency of small bronchi (FEF-25) in boys aged 9 and 10 were also significantly higher, respectively, 1.33 + 0.07 and 1.54 + 0.1 l / s. than in boys 6-8 years old ($p < 0.05$). As for girls, at the age of 9-10, the small bronchial patency indices (FEF-

25) were significantly increased, respectively, to 1.42 ± 0.1 and 1.76 ± 0.01 l / s (p <0.001) than in girls 7-8 years old and significantly against 1.23 ± 0.1 l / s in girls aged 6 years (p <0.001). The absolute indicators of maximum expiratory flow rate (PEF) in boys increased with age. The greatest increase in PEF was observed in boys aged 9 and 10 years, respectively 4.49 ± 0.2 and 4.91 ± 0.2 l / s versus 3.25 ± 0.1 and 3.77 ± 0.1 l / s at the age of 7 and 8, respectively. A significant increase in the absolute PEF was observed in girls 9 and 10 years old (4.24 ± 0.1 and 5.17 ± 0.1 l / s, respectively) (p <0.01).

The studies carried out by the pneumotachography method in the examined children revealed the following results. It was shown that in boys aged 6-7 years, the vital capacity of the lungs averaged 1.90±0.07 liters, which corresponds to 92% of the proper values. VC values in boys aged 8-10 years were significantly lower (p <0.05) than the proper values of this indicator for persons of the corresponding sex and age (8-10 years). In girls aged 6 and 7 years, VC was reduced relative to the proper values (86%) and more pronounced than in boys, which is statistically significant (p <0.05).

On the basis of the provisions of the theory of adaptation and functional systems, it can be considered that different levels of functioning of the organism correspond to different levels of severity. There is also a different degree of stress on the compensatory mechanisms. All this is reflected in the mathematical indicators of sinus heart rate, which was the basis for the cardiointervalographic characteristics of the severity of the condition in various pathologies (neurocirculatory dystonia, rhythm and conduction disturbances and hypertension) and as a predisposing factor (atherosclerosis, ischemic heart disease) in children.

Each age period must have a clear idea of the cardiointervalogram indices of healthy children of different age groups. It is known that each age period of childhood is characterized by anatomical and physiological features, which are also reflected in the sinus heart rate. Based on the analysis of the structure of the sinus heart rate, it is possible to obtain information about the current interaction of the links in the control of heart activity, to judge the nature of the protective and adaptive reactions of the body. In other words, the indicators reflecting the nature of the sinus heart rate can be considered as integral parameters of reactivity, primarily, of autonomic homeokinesis, as one of its most important links. Table 1 shows the normative data of indicators of cardiointevalography (CIG) of healthy children in the age aspect, adopted in pediatrics [1, 2, 8.]. It is known that already in the early age period (1-3 years) there is the lowest level of body functioning with the highest degree of tension of compensatory mechanisms, high activity of the sympathetic link of the autonomic nervous system and the central circuit of heart rate regulation.

Table 1

CIG normative indicators of healthy children (M + -m)

| Indicators of CIG | Age groups | | | | |
|---|---|---|---|---|---|
| | 1-3 years | 4-7 years old | 8-10 years old | 11-13 years old | 14-15 years old |
| Mo, sec | 0,58± 0,02 | 0,62±0,03 | 0,72±0,03 | 0,73±0,02 | 0,74+0,02 |
| DX, sec | 0,23+0,04 | 0,23±0,05 | 0,28±0,02 | 0,27±0,02 | 0,38+0,04 |
| AMo, % | 28,0±2,5 | 27,0±1,0 | 16,0±0,9 | 23,0±1,5 | 18,0±1,0 |
| IN, | 134,0±17,7 | 94,0±15,0 | 57,0±11,0 | 82,0±10,0 | 39,0±6,6 |

| | | | | | |
|---|---|---|---|---|---|
| conventional units | | | | | |

Such regulations are imperfect and fraught with the danger of overstrain and failure of adaptation with the development of a pathological process. Apparently, this is one of the reasons for the susceptibility of young children to various diseases. The data obtained in the course of our study are presented in Tables 2 - 5.

Table 2
Cardiac rhythmogram indicators at rest in boys 6-7 years old

| Indicators | Number of examined | Statistical characteristics | | | | |
|---|---|---|---|---|---|---|
| | | Min | Max | M | m. | δ |
| Mo, sec | 106 | 0.6500 | 1.2000 | 0.8833 | 0.04781 | 0.1656 |
| AMo, % | 106 | 19.000 | 52.000 | 32.0833 | 2.9910 | 10.3612 |
| DX, sec | 106 | 0.1700 | 0.5100 | 0.3492 | 0.03100 | 0.1074 |
| IN, conventional units | 106 | 68.540 | 125.460 | 96.386 | 3.2800 | 5.7699 |

Table 3
Indicators of a cardiac rhythmogram at rest in girls 6-7 years old

| Indicators | Number of examined | Statistical characteristics | | | | |
|---|---|---|---|---|---|---|
| | | Min | Max | M | m. | δ |
| Mo, sec | 108 | 0.6300 | 1.1940 | 0.8531 | 0.04682 | 0.1454 |
| AMo, % | 108 | 18.070 | 51.000 | 31.0933 | 2.8810 | 10.2679 |
| DX, sec | 108 | 0.1670 | 0.50720 | 0.3251 | 0.03080 | 0.1041 |
| IN, conventional units | 108 | 67.540 | 120.460 | 92.156 | 3.4610 | 5.8229 |

Table 4
Indicators of a cardiac rhythmogram at rest in boys 8-10 years old

| Indicators | Number of examined | Statistical characteristics | | | | |
|---|---|---|---|---|---|---|
| | N | Min | Max | M | m. | δ |
| Mo, sec | 161 | 0.7600 | 0.96800 | 0.8673 | 0.05481 | 0.1558 |
| AMo,% | 161 | 20.040 | 74.000 | 42.0533 | 3.8916 | 16.4612 |
| DX, sec | 161 | 0.1620 | 0.6900 | 0.2500 | 0.04230 | 0.6184 |
| IN, conventional units | 161 | 38.638 | 64.120 | 59.344 | 2.5710 | 6.1324 |

Table 5
Indicators of a cardiac rhythmogram at rest in girls 8-10 years old

| Indicators | Number of examined | Statistical characteristics | | | | |
|---|---|---|---|---|---|---|
| | N | Min | Max | M | m. | δ |
| Mo, sec | 159 | 0.6000 | 0.9600 | 0.7381 | 0.02637 | 0.1055 |
| AMo, % | 159 | 23.000 | 82.000 | 44.0000 | 4.49907 | 17.9963 |
| DX, sec | 159 | 0.1000 | 0.4600 | 0.1844 | 0.02347 | 0.0939 |
| IN, conventional units | 159 | 42.420 | 65.720 | 63.164 | 2.5810 | 6.0624 |

For boys aged 6-7 years, the average value of Mo is 0.88 sec, for girls 0.85 sec. Indicators of the amplitude of the AMo fashion in boys is 32.08%, in girls 31.09%, which is slightly higher than the norm (27.0 ± 1.0%). The DX indicator at a rate of 0.23 ± 0.25 sec for boys of this age group was 0.35 sec, for girls 0.32. which is also above the norm. All this gives reason to believe that children of this age period have the most pronounced sinus arrhythmia, which is apparently associated with the predominance of vagal-cholinergic influences on the activity of the heart. Note that all these changes occurred against the background of an increase in the R-R intervals (meaning the average values of these indicators) with the age of the subjects.
On the basis of the analysis, it was found that in the age group of 8-10 years, the standard deviation of the mean value of the interval Mo is 0.14 ± 0.6 units for boys, 0.05 ± 0.005 units for girls. Indicators of the value of the R-R interval fashion in boys was 0.88 ± 0.04 sec., while in girls it was slightly lower than 0.73 ± 0.02 sec. At the same time, the amplitude of the AMo mode in boys was slightly low (32.0%) than in girls of the same age group (44.0%).

## 4. CONCLUSION

In short, the general trend demonstrates a relative stabilization of age-related R-R changes in both boys and girls. At the same time, the gradient of the R-R intervals change in girls was lower than this indicator than in boys (the R-R gradient of girls - 0.05 seconds, boys - 0.09 seconds), by almost 50%, and the gradients of changes in cardiac rhythmogram indicators prevailed in boys. However, taking into account the high pollution of the surface layer of the atmosphere in the South Aral Sea region, the increase in bronchial patency revealed in children was regarded by us as an undesirable reaction and one of the factors contributing to the development of bronchopulmonary pathology. An increase in the patency of the bronchi in conditions of dustiness of the surface air layer is physiologically irrational. The persistence of this reaction in the future can lead to various pathological changes in the bronchopulmonary apparatus, which partially explains the growth of bronchopulmonary pathology in the child population in the South Aral Sea region.
The data obtained are consistent with the results of the research of specialists and suggest that the circulatory system in children reacts very sensitively to unfavorable environmental factors in the Southern Aral Sea region, thereby reducing their adaptive capabilities and contributing to the formation of conditions for the development of diseases.

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