

Functional Characteristics of Adolescents in Urban and Rural Areas of the Krasnoyarskiy Krai (Central Siberia)

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Abstract: The work contains the analysis of functional indicators of 14 – 16 aged adolescents living in urban (Lesosibirsk) and rural areas (Bor settlement). These are northern territories where external anthropogenic environmental factors are combined with harsh climatic conditions, which enhances their impact on human health. Moreover, the city of Lesosibirsk is the largest center of the timber processing and timber-chemical industry of the Krasnoyarsk Territory, which has a significant impact on the atmosphere, soil and water. The analysis of external respiration function has demonstrated a decrease in the parameters as relative to the sex-and-age norms. VC indices are lower than the due VC ($p < 0,05$): in Females by 0,9–1,1, in Males – 0,5–0,66 liters. In general, the parameters of external respiration (VC and PEF) are reduced in the adolescents of urban areas (Lesosibirsk) against the ones of rural areas (Bor settlement). Regarding the cardiovascular system indicators, each group has the testees with an increased heart rate (>90 bpm). Such proportion is significantly high among the Females of Lesosibirsk (38%); in this group, there is a majority with high BSI values (45%) has been noted; as for the Males, this indicator ranges of 23,5-26,6%, and in the Females – 38,9 – 45%. In general, the analysis of HRV indicators demonstrates a balance in the autonomic nervous system for the hear regulation in most examinees (47,1 – 73,3%).

Keywords: Functional Parameters, Adolescents, Functional State, Heart Rate Variability, Baevskiy Stress Index

1. Introduction

In the recent decades, there has been a relative improvement in the health of urban children and a health deterioration of the children living in rural areas [1]. The situation can be attributed to insufficient measures to improve the living conditions of the rural population, insufficient funding for rural health care. Moreover, the negative trends that worsen the health indicators of adolescent children are increasing, so very often we have to

talk not about health preservation and strengthening, but about health saving [2]. The results of special scientific studies reveal that the most pronounced changes in the health condition of children occur during school education. Moreover, school age is one of the most difficult stages, during which the child's body reaches biological maturity and at the same time the foundations of both mental and physical health for the entire period of further education are laid [3]. At the same time, children living in an urban environment, in comparison with adolescents from rural

areas, have a constant and high-quality Internet and access to various types of materials, and hence the development of dependent behaviors in urban adolescents takes place. According to Ramadass S., *et al.* (2017) it is an important factor that worsens the health of the younger generation [4]. Research by scholars from China states that dynamic urban populations are generally prosperous, while most rural areas live in poverty. [5] Continuing trends in malnutrition, which may include stunting and underweight, remain a significant problem among children and adolescents in rural China [5, 6]. In their works, Zhou S. *et al.* (2020) notes that the most common cause of malnutrition among children is inadequate nutrition, for example, unhealthy eating habits (for example, eating food or drinks high in fat, salt and / or sugar) in urban students. For rural schoolchildren, the main problem is not a lack of calories, but rather a lack of nutrient-rich food due to poor economic development in rural areas [7]. Childhood overweight and obesity, associated with both undernutrition and overnutrition, are associated with adverse health outcomes later in life [8, 9]. Overweight and obesity are not only serious health problems that affect the growth and development of children and adolescents, but they can also cause developmental problems such as psychological disorders [10], cognitive dysfunction, impaired motor function [11]. According to the studies performed by Blum R. W. *et al.* (2012), active processes of maturation of the nervous system and brain occur in the adolescent period of ontogenesis and any environmental influences can negatively affect its final development, and thus, by the time of graduation from school and admission to higher educational institutions, they find themselves with a low level of mental and functional body condition. The abovementioned fact sufficiently restricts young people in obtaining and mastering the knowledge and competencies of their future profession [12].

In the Northern territories, external man-made environmental factors are mixed with harsh climatic conditions, which reinforces their influence on the people's health. Lesosibirsk is the largest center of the timber processing and timber-chemical industry of the Krasnoyarskiy Krai, which exerts a significant impact on the atmosphere, soil, and water.

The research is aimed at comparing the functional parameters of adolescents in urban (Lesosibirsk) and rural (Bor settlement) areas of the Krasnoyarskiy Krai and finding the percentage ratio of those who do not meet sex and age norms.

2. Objects and Methodology

This investigation is based on 14 – 16 aged Females and

Males, with an average age of $15,2 \pm 0,07$ years. Bor is represented by 34 respondents (18 Females and 16 Males), Lesosibirsk – by 38 adolescents (21 Females and 17 Males). All the testees are healthy or have non-relevant health problems. The assessment is carried out in the morning time, in school medical room, with a normal temperature inside. The whole research is permitted in written form by the parents or legal representatives.

The functional parameters of the cardio-respiratory and autonomic nervous systems were studied.

Vital capacity (VC) is measured by spirometry, peak expiratory flow (PEF) – by a peak flow meter; vital index means VC (ml)/BW (kg). To estimate the cardio system state, heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) are taken; the numbers for HR are recorded with “Alton-03”, an H3-lead 12T ECG-recorder. To examine the body functional state, the analysis of heart rate variability (HRV) is done, i.e. Vegetative balance index (VBI), Vegetative rhythms index (VRI) and Baevsky Stress Index (BSI) were considered [13]. The statistical data processing was done using SPSS software pack and based on the means (M) and errors ($\pm m$). To calculate the delta, a one-way ANOVA test for independent, distribution-free samples is applied. The differences are statistically relevant if $p < 0,05$.

3. Results

The functional state of 14-16-year-olds in urban (Lesosibirsk) and rural areas (Bor settlement) living in the Northern territory of the Krasnoyarskiy Krai was analyzed. The analysis of external respiration system (VC and PEF) has revealed a decrease in the values in all the testees relative to their sex-and-age norm. The VC is lower than the due VC ($p < 0,05$): in the females by 0,9–1,1, in the males – by 0,5–0,66 litres (Table 1). The share of adolescents whose VC is lower than the due VC (more than 20%) is bigger in urban areas. In general, this indicator for the females varies within 50–71,4% and for the males – 26,7–41,2%. Also, in the adolescents from Lesosibirsk, there is a decrease in PEF, if to compare with the ones from Bor. Nevertheless, the differences are not significant ($p < 0,05$). On average, the VI in the males in both groups is almost 62 ml/kg, which corresponded to the level above average, in the females from Lesosibirsk – 54 ml/kg, i.e. below the average level, in the females from Bor – 57 ml/kg (average level). Lower function of external respiration can be caused by environmental factors (Lesosibirsk is one of the ten dirty cities of Krasnoyarskiy Krai), as well as by the other etiological factors, to understand which, a deeper study is required.

Table 1. External respiration indicators in adolescents (urban/rural areas).

Sex	Location	VC, l (M \pm m)	Due VC, l (M \pm m)	% of examinees with normal VC	% of examinee with below-norm VC	PEF, l/sec	VI, ml/kg (M \pm m)
Females	Lesosibirsk	2,84 \pm 0,08	3,93 \pm 0,11	28,6	71,4	3,18 \pm 0,16	54,4 \pm 1,8
	Bor (settlement)	3,11 \pm 0,13	3,98 \pm 0,07	50,0	50,0	3,45 \pm 0,07	57,0 \pm 1,9
Males	Lesosibirsk	3,51 \pm 0,17	4,17 \pm 0,15	58,8	41,2	4,01 \pm 0,24	62,6 \pm 4,3
	Bor (settlement)	3,79 \pm 0,15	4,29 \pm 0,11	73,3	26,7	4,37 \pm 0,28	62,1 \pm 4,1

The cardiovascular system functional indicators (heart rate, systolic and diastolic blood pressure) correspond to the sex-and-age norms. On average, SBP and DBP indicators correspond to the sex-and-age norms (Table 2). However, in

each focus group, there are Females and Males who have quite rapid heart rate (>90 bpm). The share of such examinees is especially high among the Females in Lesosibirsk (38%).

Table 2. Cardio-vascular system indicators ($M \pm m$).

Sex	Location	HR, bpm	% with $0 \geq 90$ HRm bpm	SBP, mm Hg	DBP, mm Hg	VBI, points	VRI, point	BSI, point
Females	Lesosibirsk	83,6 \pm 3,7	38	110,9 \pm 2,0	73,3 \pm 2,0	262 \pm 84	8,49 \pm 1,86	188 \pm 53
	Bor (settlement)	80,1 \pm 2,5	22	106,6 \pm 2,2	69,7 \pm 1,6	244 \pm 39	7,31 \pm 0,88	162 \pm 26
Males	Lesosibirsk	76,9 \pm 2,5	12	116,2 \pm 2,0	76,2 \pm 2,3	157 \pm 40	5,83 \pm 0,87	111 \pm 25
	Bor (settlement)	80,2 \pm 3,8	13	115,3 \pm 2,6	77,8 \pm 1,8	181 \pm 23	7,06 \pm 0,88	128 \pm 22

The analysis of VBI has marked that its values are higher in the Females than in the Males, though these differences are slight ($p > 0.05$) (Table 2). VBI normal values are 100 – 300 ms⁻¹. Increased indicators signal about hypertonicity in the sympathetic section, while a decrease – about vagotonia. [7] The share of students with normotension ranges from 47,1 to 73,3%. Also, there are the testees with sympathicotonia (11,8 – 27,8%), which is indicative of some stress in the body. This indicator is the highest among the Females in Bor – 27,8%. The values of VBI indicator are consistent with VRI, the normal values of which are within 7,1 – 9,3 points and testify to the autonomic balance as far as the autonomic loop activity is concerned. Most teenagers have the mean of ARI corresponds to normotension. In urban girls – 8.49 \pm 1.86 points, rural – 7.31 \pm 0.88 points; in urban boys – 5.83 \pm 0.87. With the exception of a group of boys from Lesosibirsk, their VRI was 5,83 \pm 0,87 points, which means a shift in the balance towards the parasympathetic sector, i.e. high adaptability of the cardiovascular system to environmental conditions. Vagotonia has been found in 41,2% of adolescents in Lesosibirsk.

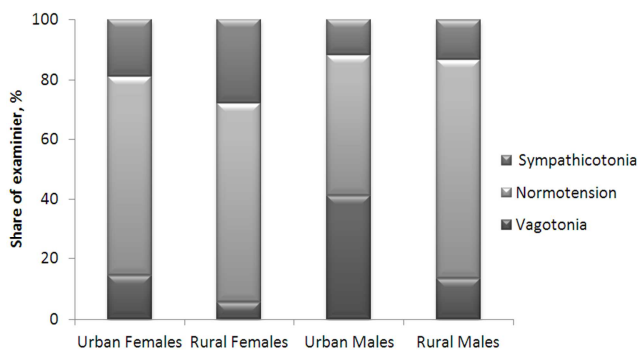


Figure 1. Share of adolescents having a different status of the autonomous nervous system.

The Baevsky stress index reflects the performance of cardio central control mechanisms and allows assessing adaptability of the cardiovascular system to external and internal conditions (climatic, social, physiological, etc.). On average, the BSI in the Males does not exceed normal limits (80 – 150 points) [Baevskiy, Berseneva, 2008], while the Females have shown increased values. In this way, the Females from Lesosibirsk have higher figures against the ones of rural area – 188 \pm 53 and 162 \pm 26 points respectively. The BSI values for boys in Lesosibirsk were 111 \pm 25, in Bor

settlement – 128 \pm 22 (Table 2).

Increased indices suggest stress, where the body remains. The high BSI has been identified in the Males – within 23,5–26,6%, in the Females – 38,9–45% (Figure 2).

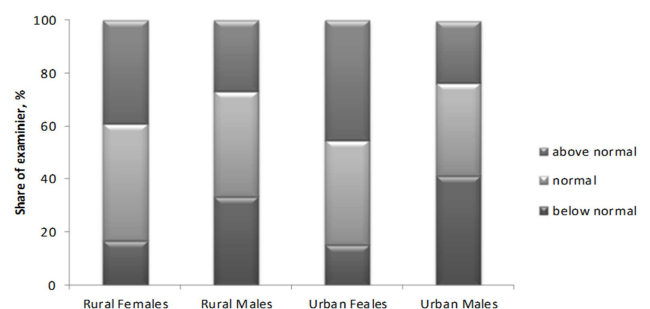


Figure 2. Distribution of study participations by Baevsky stress-index.

4. Conclusions

Thus, this work analyzes the functional characteristics of the adolescents aged 14 – 16 in urban (Lesosibirsk) and rural (Bor settlement) areas of Krasnoyarskiy Krai (Central Siberia). The functional analysis of external respiration system (VC and PEF) has shown their decrease in the adolescents of urban areas (Lesosibirsk) in relation to the ones of rural areas (Bor settlement). In all groups, VC is lower than the due VC ($p < 0.05$): in the Females by 0,9–1,1, in the Males – by 0,5–0,66 liters. Lower function of external respiration can be caused by environmental factors (Lesosibirsk is one of the ten dirty cities of Krasnoyarskiy Krai), as well as by the other etiological factors, to understand which, a deeper study is required.

The cardiovascular system functional indicators (heart rate, systolic and diastolic blood pressure) correspond to the sex-and-age norms. However, each focus group has the adolescents with an increased heart rate (>90 bpm). The share of such examinees is especially high among the Females in Lesosibirsk (38%). This group has also the biggest percent of respondents with high BSI values (45%). The Baevskiy's index reflects the performance of cardio central control mechanisms and allows assessing adaptability of the cardiovascular system to external and internal conditions (climatic, social, physiological, etc.). The high BSI has been identified in the Males – within 23,5–26,6%, in the Females – 38,9–45%. In general, the analysis of HRV indicators demonstrates, in most cases, a balance in the autonomic nervous

system in the heart regulation (47,1 – 73,3%).

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