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State of Individual Health, Cardiorespiratory System of Junior Schoolchildren in the Far North with Different Temperament Trait Indices

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The article presents an integrative health assessment with measurement of the indices of sensitivity and pativeness, studies heart rate variability (HRV) and respiratory function in junior schoolchildren in the Far North with different temperament trait indices. It was found that junior schoolchildren in the Far North had an interrelation between typological characteristics of temperament and the standard of health, mechanisms of regulation of cardiac rhythm and functional indices of external respiration. Junior schoolchildren in the Far North, whose temperament is characterized by the low intensity of behavioural symptoms, have higher adaptive reserves, functional indices of external respiration and predominant parasympathetic influence in the regulation of heart rate. Thus, the results of the study have shown that the formation of temperament types occurs in the early school years, which may affect the efficiency of adaptive reactions of children living in the Far North and the state of their personal health.

Keywords: temperament, junior schoolchildren in the Far North, standard of health, cardiorespiratory system.

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Research area: pedagogy, psychology.

Children in the Far North are the most socially vulnerable group of the population living in particularly difficult conditions, which adversely affects their health and development, so these facts require detailed study and the need to consider a number of natural and climatic factors that directly

affect the adaptation mechanisms of a growing organism.

It is well known that adverse biological, medical, social, psychological and other factors are the main predictors of pathologies in cardiovascular, respiratory, nervous, endocrine and other systems (Tokarev S.A., Buganov A.A.,

2007). In addition, in the Far North the health and development of the younger generations are affected by the uncontrolled climatic, geographic and biosocial factors that are typical of the high-latitude regions and have particular harmful effects on the child's body and help to speed up the formation of pathology. There is evidence that in the extreme conditions of the circumpolar region, the cumulative effect of the above factors has a significant impact on the effectiveness of adaptation and potential on the public health (Shesterikova N.V., Tokarev S.A., 2004).

According to the statistics and the results of scientific research, over the past decade the state of health of children in the Russian Federation has undergone significant adverse changes (Kuchma V.R., Zvezdina I.V., Zhigareva N.S., 2008; Baranov A.A., Kuchma V.R., Rapoport I.K., 2011). They are characterized by the increasing prevalence of functional disorders and chronic diseases that are particularly pronounced in the period of schooling (Igisheva L.N., 2008; Baranov A.A., Kuchma V.R., Sukhareva L.M., 2009). Health problems at the high school age are largely determined by the influence of behavioural risk factors: smoking, drinking, physical inactivity, etc. (Chekalova S.A., Bogomolova E.S., Leonov A.V., Kuzmichev Iu.G., Chekalova N.G., Nazarova M.M., 2009; Maiorov R.V., 2012; Slobodskaja E.R., Akhmetova O.A., Kuznetsova V.B., Rippinen T.O., 2012; Varshal A.V., Slobodskaja E.R., 2013). At the same time, the high frequency of disorders in the health of junior schoolchildren currently defines the need to study medical, psychological and social aspects of its formation during elementary school attendance (Savilov E.D., Il'ina S.V., 2012; Kondakova O.E., Gezalova N.V., Shilov S.N., Kozhevnikov V.N., 2013).

The beginning of school is a powerful stress factor that changes the way of life of children,

their order of the day, timetable of lessons and recreation (Chekalova N.G., Silkin Yu.R., Shaposhnikova M.V., Chekalova S.A., Bogomolova E.S., Glushenkova D.A., Shcherbaneva M.S., 2009; Dziatkovskaia E.N., 2011). The change of the dynamic stereotype leads to stress of adaptation mechanisms and reduction of functionality of schoolchildren's organisms, which is worsened by the influence of unfavourable factors, including the lifestyle related. At this, the main factor causing disorder of mechanisms of self-regulation of individual functional systems of junior schoolchildren with the subsequent development of chronic diseases is often a psycho-emotional stress (Slobodskaja H.R., Akhmetova O.A., 2010; Iliukhina V.A., 2011; Verkhoturova N.Yu., 2012, Il'ina I.V., 2012).

At present, the ideas of temperament traits are explained by differences in the excitability of the brain systems that integrate the behaviour of the individual, his emotions and vegetative functions (Potylitsyna V.Yu., 2008; Petrosian E.Iu., Savchenkov Iu.I., 2009; Riasik Iu.V., Tsirkin V.I., Trukhina S.I., 2010; Khabarova I.V., Shilov S.N., 2012). Both systems cause autonomic mobilization (Savchenkov Iu.I., Soldatova O.G., Shilov S.N., 2013), which largely, in our opinion, explains the adaptive role of temperament.

Circulatory and respiratory systems have a leading role in the adaptive responses of the body when it is exposed to the influence of a variety of factors, ensuring the necessary level of energy and metabolic processes. The cardiorespiratory system is one of the first to get involved in the process of adaptation of the organism to changing environmental conditions and its changing settings may serve as criteria for the effectiveness of adaptive responses (Shlyk N.I., Sapozhnikova E.N., Kirillova T.G., Semenov V.G., 2009; Mikhailov N.A., 2011; Kushnir S.M., Struchkova I.V., Makarova I.I., Antonova L.K., 2012; Ushakov I.B., Orlov O.I.,

Baevskii R.M., Bersenev E.Iu., Chernikova A.G., 2013).

Therefore, the question about the features of the functional state of breathing, heart rate regulation and the standard of individual health of junior schoolchildren in the Far North with different indices of temperament traits is of an undoubted scientific interest.

The aim of our research is to carry out a quantitative evaluation of individual health and determine the state of the cardiorespiratory system of junior schoolchildren in the Far North with different indices of temperament traits.

Almost healthy junior schoolchildren in the Far North were tested to determine the type of temperament by means of a parental questionnaire DOTS-R (The Revised of Temperament Survey) adapted for Russia. This technique presents the possibility of accurate quantification of 9 temperament traits of children. The identification of temperament types was conducted by the behaviour index (BI), which includes such temperament features as activity, sensitivity (threshold), mood and intensity, and by the behaviour stereotype strength index (BSSI), which is the sum of quantitative indices of rhythm and adoptability (Petrosian E.Iu., Savchenkov Iu.I., Domracheva M.Ia., Domrachev A.A. Patent of the Russian Federation IPC 7A 61 in 5/16; Petrosian E.Iu., Savchenkov Iu.I., 2009). All the children were divided into groups by BI; into "intense" (In), "adequate" (Ad) and "quiet" (Q) and by BSSI: into "rigid", "plastic" and "labile", respectively, with high, middle and low index values.

All the junior schoolchildren in the Far North were tested by the following indices: heart rate (HR), systolic and diastolic blood pressure (SBP, DBP), vital capacity (VC), hand power; veloergometry cardiointervalography (by the diagnostic complex "VALENTA"), Stange's test (test of timed inspiratory capacity), Rufe's test

(heart rate recovery time after dosed physical load). The obtained data was processed by a computer program "HELMI-test of 7-10 year-old children" (Kulikov V.P., Bezmaternykh L.E., Kozlov S.D.) and was presented in the form of opinions on the index of santiveness – health potential that determines its probable quantity and quality (PS) and pativenesses – the probability of the disease, limitation of viability (PP).

Heart rate variability (HRV) and respiratory function were studied by a hardware-programmed complex "VALENTA". The following indices of heart rate were recorded and evaluated: heart rate (HR), tension index of regulatory systems (stress index, TI), Mo – mode, AMo – mode amplitude, the average value of the power of spectrum of a high-frequency component of heart rate variability (BV), the average value of the power of spectrum of a low-frequency component of heart rate variability (SV-2) and of a very low-frequency component of heart rate variability (SV-1), the number of pairs of cardio intervals with difference of more than 50 ms in % to the total number of cardio intervals in the array (pNN50), and also the centralization index (CI) in rest and in a clinoothostatic test.

In order to assess a respiratory function such indices as forced vital capacity (FVC), forced expiratory volume (FEV₁), peak volume rate (PVR), forced expiratory rate at 25-75 % of forced vital capacity (FEV₂₅₋₇₅ %), minute ventilation (MV), respiratory rate (RR), maximum ventilation (MV), Tiffeneau index were recorded.

According to different indices of behavioural responses, 51% of the surveyed children in the Far North showed the average values. "Intense" and "quiet" children were identified in equal numbers. By the strength of the formed stereotypes 50% of the children were included in the group of "plastic" children; the other kids in almost equal parts were included in the groups of "labile" (25.7%) and "rigid" (23.8%) children.

The analysis of the integrative index of health established that the tested junior schoolchildren in the Far North on the average had an index of santiveness that did not exceed 60%. This indicates a moderate reserve of their health, rather high probability of disease development (Soldatova O.G., Shilov S.N., Potylitsyna V.Yu., 2008). At the same time “quiet” children, both boys and girls, had an index of santiveness higher than the “adequate” and “intense” groups, which proves a greater reserve of their health and adaptive capacity in comparison with other groups of the tested children in the Far North.

The “quiet” children had a moderate index of reliable negative correlations (correlation coefficient from 0.38 to 0.48) of the index of santiveness with temperament traits characterizing behavioural activity and approach. The index of santiveness of “intense” junior schoolchildren had reliable negative correlations with rhythm, attention and, what is interesting, the behaviour index.

Our studies of integrated health indices show that junior schoolchildren in the Far North have low reserves of health, and therefore a significant probability of disease development (Bardetskaya Ya.V., Potylitsyna V.Yu., 2013). It is important that the reserves of health may be provided not only by the functional capacity of cardio-respiratory and other systems of the body, but also by the intensity of the child’s personality temperament traits, especially of those that characterize behavioural activity. Health reserve depends on the index of the child’s personality temperament traits, especially those that characterize behavioural activity. The children in the Far North whose temperament is characterized by a low behaviour index (“quiet”) have a more favourable level of the body’s functioning. Their health potential is higher than that of the “intense” children with distinct temperament traits that characterize the activity of behaviour.

In this case, the strength index of behavioural stereotypes in the characteristic of temperament traits of the child’s personality in the studied age period, are apparently still not fully formed, so they have only a small influence on the adaptive capacity of the organism, as well as on the quantitative parameters of health.

The analysis of the main hemodynamic indices in the groups of junior schoolchildren in the Far North with different temperament trait indices characterizing the activity of the behaviour revealed a reliably higher initial autonomic level for boys and girls with high BI compared to “quiet” and “adequate” children. In the groups of children with different plasticity of behaviour we did not detect any differences in the basic hemodynamic indices.

In the analysis of heart rate variability at rest we found that there were some differences in the studied indices in the groups of the children in the Far North that differ in BI. Thus, the “quiet” children had lower mode amplitude and stress index, reduced power of SV-1, more pairs of cardio intervals with difference of more than 50 ms in % of the total number of cardio intervals in the array and a bigger power of BV and SV-2 compared with the “intense” children.

The findings indicate the prevalence of a parasympathetic component of autonomic regulation in children with a “quiet” temperament type. As the dominance of a parasympathetic component of the regulation indicates a more efficient and effective level of functioning of the body and adaptation processes (Kulikov V.P., Doronina N.L., Gatalskii K.K., 2008; Khuraskina N.V., Aleksandrova L.A., Chemerova L.F., 2010; Kolpakov V.V., Bepalova T.V., Tomilova E.A., Larkina N.u., Mamchits E.V., Chernogrivova M.O., Kopytov A.A., 2011; Bardetskaya Ya.V., Potylitsyna V.Yu., 2014), we can say that children with a low index of behavioural symptoms are characterized by a more favourable functional capacity of the

cardiovascular system. There were no significant differences in heart rate variability at rest in children with different plasticity of behaviour.

It is well known that children and adolescents, regardless of age, sex, place of residence, have individual typological features at the level of maturity of regulatory systems, especially of the cardiovascular system. We identified 4 groups with reliable quantitative and qualitative differences in the indices of heart rate variability characterizing different degrees of tension and interaction between the sympathetic and parasympathetic parts of the autonomic nervous system, autonomous and central control loops of the heart rhythm. The first group, according to the authors (Sapozhnikova E.N., Shlyk N.I., Shumikhina I.I., Kirillova T.G., 2012), are the children with high activity of a sympathetic part of the autonomic nervous system and the central levels of regulation, the second group consists of the children with high activity of a sympathetic part of the autonomic nervous system and a low degree of tension of the central levels of control, the third group includes the children with high activity of a sympathetic

part of the autonomic nervous system, increased activity of the central regulatory systems and low activity of a sympathetic part of the autonomic nervous system, the fourth group are those with high activity of a parasympathetic part and low activity of a sympathetic part and central structures of heart rate regulation. The most optimal ratio between the autonomous and central regulation of heart rate is observed in children of the third group; exactly these children have the highest functional reserves of the system of regulation of blood circulation. The first group with predominance of the central mechanisms of control was attributed by the authors to an unfavourable rate.

When dividing the examined children in the Far North into groups with quantitative and qualitative differences in the indices of heart rate variability, we found that the highest percentage of the children of the third, optimal, group of autonomic regulation of heart rate fall into the category of “quiet” boys and girls while the least percentage of the same children are among the “intensive” (Fig. 1). In the groups of children that differ in the index of strength of

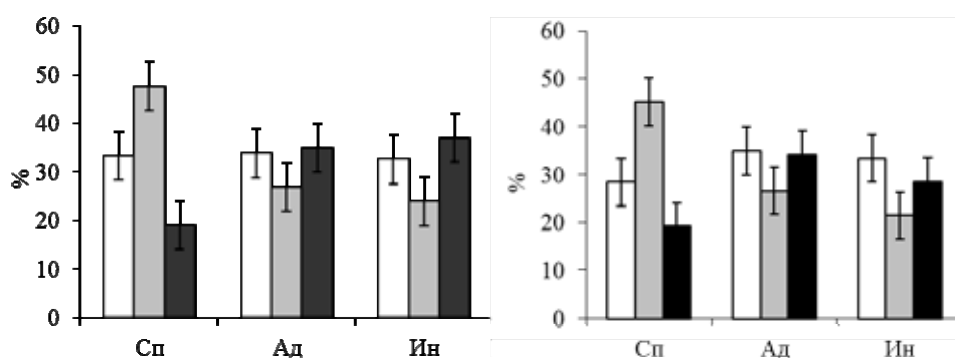


Fig. 1. Occurrence of groups with characteristics of regulation of heart rate in groups of “quiet” (СП – Q), “adequate” (Ад – Ad) and “intensive” (ИН – In) boys and girls; □ – children with high activity of a sympathetic part of the autonomic nervous system and a low degree of tension of the central levels of control, ■ – children with high activity of a parasympathetic part of the autonomic nervous system, increased activity of the central regulatory systems and the low activity of a sympathetic part of the autonomic nervous system, ■ – children with high activity of a parasympathetic part and low activity of a sympathetic part and central structures of heart rate regulation

developed behaviour stereotypes the occurrence of an optimal balance between the autonomous and central regulation of heart rate is almost the same.

In assessing autonomic reactivity it was revealed that the “quiet” junior schoolchildren in the Far North with a low index of behavioural symptoms in a reliably greater percentage of the cases have initial vagotony and hypersympathicotonic reaction during functional load (Table 1). The children who belong to the “intense” group have a hypersympathicotonic reaction recorded in a smaller percentage of cases, which indicates a high initial tonus of the sympathetic nervous system, and as a consequence the absence of its additional activation during the transition to a vertical position.

In the groups of children varying in the strength index of developed behaviour stereotypes, the differences in autonomic reactivity were not revealed.

The correlation analysis of the relationship of the indices of heart rate variability and the index of temperament traits revealed their lack in “adequate” children, while there are reliable correlations between the indices of heart rate variability and the index of temperament traits

in the case of the “intense” and “quiet” junior schoolchildren in the Far North (Table 2).

The significant ($p < 0.05$) correlations ($0.5 < r < 0.7$) of the index of temperament traits with the indices of heart rate variability (TI, SV-1, BV, SV-2) in children with different plasticity of behaviour were identified only in the group of “labile” children; in case of boys in this group, these correlations have such features of temperament as threshold, mood and approach, while the girls’ correlations have mood, attention and distractibility (Potylitsina V.Iu., Bardetskaia Ia.V., 2013).

In the analysis of the indices of respiratory function in groups of junior schoolchildren in the Far North with different temperament traits indices some differences were also identified. Thus, the respiratory rate of “quiet” children is less than that of the “intensive” ones, while the minute ventilation and the maximum ventilation rate are reliably higher than that of children of the “intensive” type. In the groups of children with different strength of developed stereotypes the “plastic” children are characterized by more optimal indices of the respiratory function.

The obtained results show a more optimal functioning of ventilation of junior schoolchildren

Table 1. Autonomic reactivity of junior schoolchildren in the Far North with different index of behaviour manifestations in a clinooorthostatic test

Groups	n	Autonomic reactivity (occurrence, %)		
		Asympathicotonic	Normal	Hypersympathicotonic
Boys				
Q	55	4.1	39.8	56.1
Ad	128	14.5*	36.4	49.1
In	57	32.1* [#]	40.9	27.0* [#]
Girls				
Q	66	4.9	36.8	59.2
Ad	140	11.2*	37.3	51*
In	67	32.9	32.1	34.9* [#]

Note: difference is reliable at $p < 0.05$: * – from the group of “quiet” children, # – from the group of “adequate” children.

Table 2. Correlation coefficients of heart rate variability and index of temperament traits of junior schoolchildren in the Far North ($p < 0.05$)

Temperament trait	Groups by BI	BV	SV-2	SV-1	TI
Activity	Q				-0.56
	In				0.61
Rhythm	Q				-0.63
	In				0.56
Mood	Q	0.53	0.55	0.46	-0.54
	In	-0.62		-0.66	0.64
Attention	Q	0.64	0.65	0.56	-0.7
	In	-0.56		-0.7	0.66

in the Far North whose behaviour is characterized by a low index of behaviours – the “quiet” children and the “plastic” children, whose temperament is characterized by the average values of the strength index of developed behaviour stereotypes.

What is the mechanism and physiological significance of the detected patterns of a relationship between temperament traits of the child’s personality, individual health and functional indices of cardio-respiratory system? The existing concept of a “range of adaptation” comes from evaluation of the ability of functional systems to change their characteristics to provide homeostasis in the implementation of adaptive mechanisms, including the way through the change of behaviour regimes. In this regard, our results confirm the recent series of assumptions that temperament refers to individual

differences in the excitability of behavioural and physiological systems, as well as in behavioural and neural mechanisms of reactivity modulation (Karavaeva E.N., Soldatova O.G., Pats Iu.S., Savchenkov Iu.I., 2011).

Thus, our study suggests that “quiet” children in the Far North, whose temperament is characterized by a low behaviour index, are marked by the domination of a parasympathetic part of heart rate regulation at rest, the most optimal ratio between the autonomic and central heart rate regulation, and the higher functional indices of external respiration. This is a factor that contributes to a more economical and effective level of body functioning, adaptive processes and the state of individual health in children of junior school age in the Far North with a low behaviour index.

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Состояние индивидуального здоровья, кардиореспираторной системы младших школьников Крайнего Севера с разной выраженностью темпераментальных черт

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Проведена интегративная оценка здоровья с определением показателей сангвизности и пативности, исследовалась вариабельность сердечного ритма (ВРС) и функция внешнего дыхания у младших школьников Крайнего Севера с разной выраженностью темпераментальных черт. Установлено наличие у младших школьников Крайнего Севера взаимосвязи типологических особенностей темперамента с уровнем здоровья, механизмами регуляции сердечного ритма и функциональными показателями внешнего дыхания. У младших школьников Крайнего Севера, темперамент которых характеризуется низкой выраженностью поведенческих проявлений, более высокие адаптивные резервы, функциональные показатели внешнего дыхания и преобладает парасимпатическая регуляция сердечного ритма. Таким образом, результаты исследования показали: формирование типов темперамента происходит уже в младшем школьном возрасте, что может повлиять на эффективность адаптационных реакций организма детей, проживающих в условиях Крайнего Севера, и на состояние их индивидуального здоровья.

Ключевые слова: темперамент, младшие школьники Крайнего Севера, уровень здоровья, кардиореспираторная система.

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Научная специальность: 13.00.00 – педагогические науки, 19.00.00 – психологические науки.
