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Adaptation Capabilities of Functional Systems of the Body of Adolescents with Vegetative Dystonia Syndrome

Shadie Kurtieva

Center for the Development of Vocational Qualifications Medical Workers of the Ministry of Health of the Republic of Uzbekistan, Tashkent, Uzbekistan.

Corresponding author email: janna804@mail.ru

Abstract--- *The publication discusses the mechanisms of adaptation to physical activity in adolescents with autonomic dystonia syndrome, depending on gender and the presence of a history of perinatal pathology of the central nervous system. Analysis of the adaptive capabilities of the functional systems of the body of adolescents with autonomic dystonia syndrome and adolescents in the Youth Center of the city of Tashkent in dynamics for the period 2018-2020 revealed the tension of the adaptive capabilities of the heart rate regulation systems in the groups of examined adolescents with PPNS, the most pronounced in adolescent girls with PPNS.*

Keywords--- *adolescents, gender, nervous system, perinatal pathology, vegetative dystonia syndrome*

Introduction

The autonomic nervous system occupies an exceptional position in the body. By regulating and controlling its functions, it has a significant impact on the mechanisms of compensation and adaptation to various damaging factors of the external and internal environment. This determines the importance of the autonomic nervous system in the formation of the prerequisites for the onset and evolution of diseases (1). After an acute period of the disease, vegetative changes persist more or less for a long time and form a clinical picture of asthenic syndrome. This is determined by the state of the higher vegetative centers and hypothalamic-pituitary relations. Compensatory reactions that go beyond the "normative" indicators and are caused by the disorder in the activity of the higher vegetative centers, but do not reach extreme stress, constitute a whole class of pathological processes known as regulatory diseases. The functional moment of regulation diseases is transformed over time into a structural (organic) one and leads to the formation of a specific nosological unit (2,5,6).

Vegetative stigmatization testifies to the persisting tension of adaptive mechanisms and indicates the possibility of progression of these disorders with the involvement of other organs. The above provisions are theoretically substantiated in the works of highly reputable Russian and foreign physiologists and clinicians (3,4,7,8).

In this regard, the tasks of predicting the adaptation process, neuropsychiatric phenomena, assessing the functional capabilities, and the degree of neurological readiness of the organism acquire particular relevance. In this regard, the state of a modern adolescent will be determined by the vegetative regulation of psychophysiological processes, including in a state of neuropsychiatric stress, which will determine the degree of his adaptation. All of the above served as the basis for this study (Zavadenko et al., 2018; Kalyuzhny et al., 2021; Kishi, 2012).

Purpose of the study

To clarify the mechanisms of adaptation to physical activity in adolescents with autonomic dystonia syndrome, depending on the history of perinatal pathology.

Methods

A comprehensive multistage study of 243 adolescents with vegetative dystonia syndrome (SVD) was carried out in the Youth Center of the city of Tashkent in dynamics for the period 2018-2020. Of these, there were 87 adolescent boys, average age 15.0 ± 2.2 years, and adolescent girls 156, average age 15.3 ± 2.6 years. In the course of the study, groups of adolescents with SVD were formed depending on gender and a history of perinatal nervous system pathology (PPNS), group 1 was adolescent boys with PPNS, group 2 was adolescent boys without PPNS, group 3 was adolescent girls with PPNS and Group 4 adolescent girls without PPNS. (Table 1).

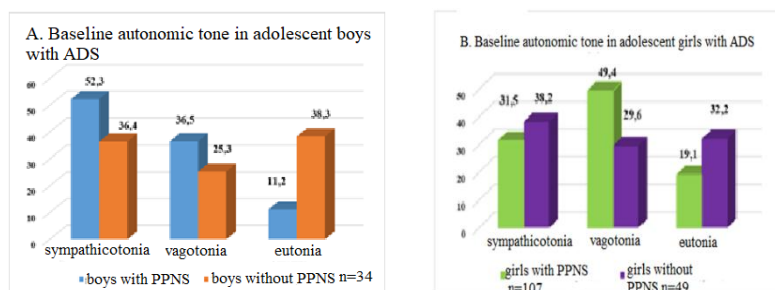
Table. 1
Distribution of subjects with SVD depending on gender and the presence of a history of previous perinatal pathology of the nervous system (PPNS)

Groups	teenage girls		teenage boys		Total	
	n	%	n	%	n	%
with PPNS	107	68,60%	53	60,90%	160	65,80%
without PPNS	49	31,40%	34	39,10%	83	34,20%
Total	156	100,00%	87	100,00%	243	100,00%

Assessment of the initial autonomic tone (VT) makes it possible to assess the state of autonomic indicators during the period of relative rest (equilibrium of the parasympathetic and sympathetic divisions of the ANS). An integral indicator reflecting the degree of adaptation of the organism to the disease is the stress index (SI). Vagotonia was determined at $SI < 30$ conventional units, eutonia - $SI = 30-60$ conventional units, sympathicotonia - $SI > 90$ conventional units, $SI > 160$ conventional units indicates hyper sympathicotonia reactivity (Loomba et al., 2009; Brener & Collins, 1998; Zimmer et al., 1997). The vegetative regulation of the heart rate was studied by the method of mathematical analysis of heart rate variability (HRV) using the hardware-software complex "Varicard 2.5". An ECG was recorded in the wedge position for 5 minutes, then a clinorhthostatic test was performed. Statistical analysis included the study of indicators SDNN (ms), RMSSD (ms), pNN50 (%); spectral analysis - in% HF, LF, VLF-waves; variation heart rate monitor - Mo (ms), AMo (ms), SI (conventional units). A comprehensive assessment of HRV was carried out based on the indicator of the activity of regulatory systems (IARS) with differentiation of various degrees of tension of regulatory systems. Psychometric methods also included determining the vital capacity of the lungs (VC, ml) by spirometry, calculating cardiorespiratory tests: Stange's test, Ruffier's index, Skibinskaya's index. The results obtained were processed as follows: calculation of the mean, standard deviation, Mann-Whitney U-test, correlation analysis. Programs used: Microsoft Office Excel, Stadia (Walter & Rey, 1997; Lynch et al., 2008; Silbiger & Neugarten, 2008).

Results

In the study groups, there was a significantly significant difference in the number of patients with different types of VT, depending on gender. Violation of autonomic homeostasis occurred in the majority of boys' patients with an initial predominance of the tone of the sympathetic part of the autonomic nervous system in 45 patients (51.7%) with hypersympathicotonic $n = 62$ (71.3%), asymptoticotonic - $n = 16$ (18.4%) and normal vegetative reactivity $n = 9$ (10.3%). In the group of girls with PPNS, the predominance of the influences of the parasympathetic division of the ANS (49.4%) was observed, sympathicotonia was detected in 31.5%. In the group of girls without PPNS, all types of autonomic tone prevailed almost in the degree of severity with a slight predominance of sympathicotonia - in 38.2% of cases (Fig. 1, A). In the group of adolescent boys with PPNS, 52.3% showed sympathicotonia, 36.5% - vagotonia. In the group of adolescent boys without PPNS, the percentage of eutonia and sympathicotonia prevailed slightly - 38.3% and 36.4%, respectively (Fig. 1, C). Sympathicotonia confirms the sufficient activity of the adaptive-compensatory mechanisms in boys, which is a favorable prognostic sign (Michelena et al., 2010; Wisniewski & Chernausk, 2009; Buell et al., 2005).



Picture 1. Initial autonomic tone of adolescents with SVD depending on gender and the presence of perinatal nervous system pathology (PPNS) in the anamnesis (%)

Analysis of statistical heart rate indicators (SDNN, RMSSD) in adolescent boys revealed a shift in the autonomic balance towards parasympathetic activity towards heart activity at rest in adolescent boys with PPNS relative to their peers without PPNS (Figure 2). In the course of the ortho test, the studied indicators showed a tendency to decrease associated with an increase in sympathetic influences, more characteristic of adolescent boys with PPNS (Gruenwald & Minh, 1961; Brookes et al., 1996; Karjono et al., 2017). In the clinoposition, SI values were 124.6 ± 41.9 conventional units in the group of adolescent boys with PPNS and adolescent boys without PPNS - 135.4 ± 26.2 conventional units, which indicates the dominance of sympathetic influences, most pronounced in adolescent boys with PPNS. In orthostatic, the highest values were found in adolescent boys with PPNS (327.5 ± 94.2 conventional units) relative to adolescent boys without PPNS (301.4 ± 103.7 conventional units), which is associated with increased central mechanisms regulation of the heart rhythm.

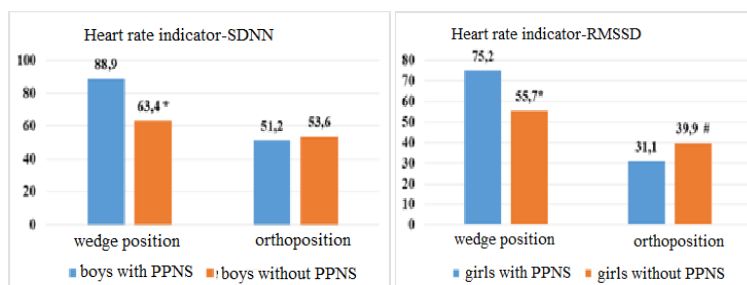
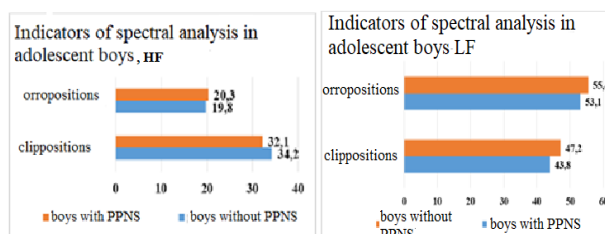


Figure 2. Indicators of statistical analysis of HRV (ms) in adolescent boys, depending on the presence of perinatal pathology in the anamnesis

Note: * - $p < 0.01$ (reliability of HRV indicators in clinoposition between boys with PPNS and without PPNS); # - $p < 0.01$ (reliability of HRV indicators in ortho position between boys with PPNS and without PPNS);

Taking into account the indicator of the spectral analysis of HRV HF% in the groups of adolescent boys in the clinoposition, a pronounced predominance of the parasympathetic link of regulation was observed (Figure 3).



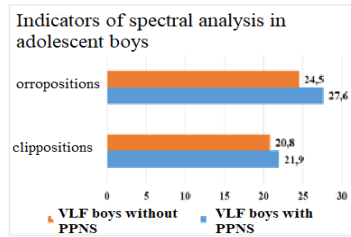


Figure 3. Indicators of spectral analysis in adolescent boys, depending on the presence of perinatal pathology in the anamnesis (%)

The exercise test led to an increase in the sympathetic effects of the ANS on the heart rate, which was most pronounced in the group of adolescent boys with PPNS ($19.8 \pm 2.4\%$). In the clinically and orthopedic position, the LF% indicator turned out to be higher than the norm in both groups of boys, and the VLF% values did not go beyond the norm. The study of the indicators of the statistical analysis of HRV among adolescent girls revealed a pronounced effect of the parasympathetic department on the regulation of the heart rate in the group of adolescent girls without PPNS and an increase in the tone of the sympathetic nervous system in adolescent girls with PPNS both in the clinoposition and in orthostatic (Figure 4).

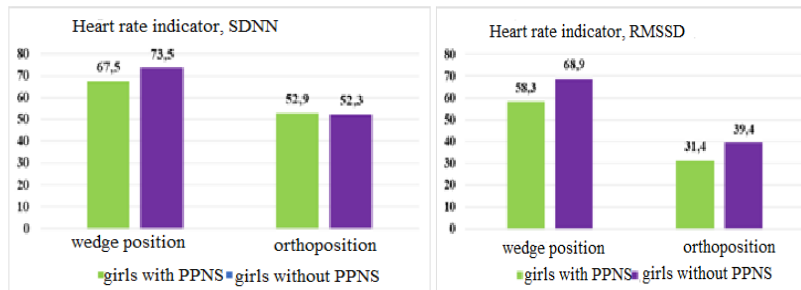
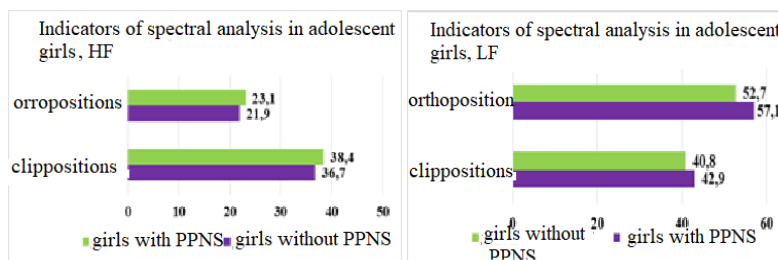


Figure 4 - Indicators of statistical analysis of HRV (ms) in adolescent girls, depending on the presence of perinatal pathology in the anamnesis.

SI values at rest indicated a greater activity of the sympathetic nervous system to regulate heart rate in adolescent girls with PPNS (163.8 ± 39.1 conventional units), in adolescent girls without PPNS SI values were within the normal range ($109, 6 \pm 18.1$ conventional units). This tendency persisted in the ortho position (adolescent girls with PPNS - 313.5 ± 81.6 standard units, adolescent girls without PPNS - 265.6 ± 56.1 standard units). The established dynamics of autonomic influences on heart rate in groups of adolescent girls was also confirmed by spectral analysis indicators (Figure 5).



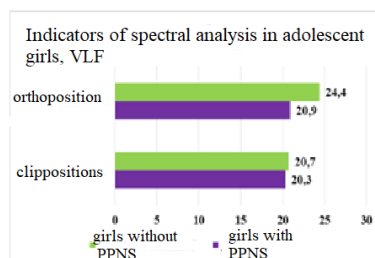


Figure 5. Indicators of spectral analysis in adolescent girls, depending on the presence of perinatal pathology in the anamnesis (%)

The study of intragroup differences in the percentage distribution of PARS in adolescent boys revealed the dominance of moderate stress (PARS 3-4) in the group of adolescent boys without PPNS (41.6%) and pronounced tension (PARS 4-6) in adolescent boys with PPNS (52.7 %) (Figure 6)

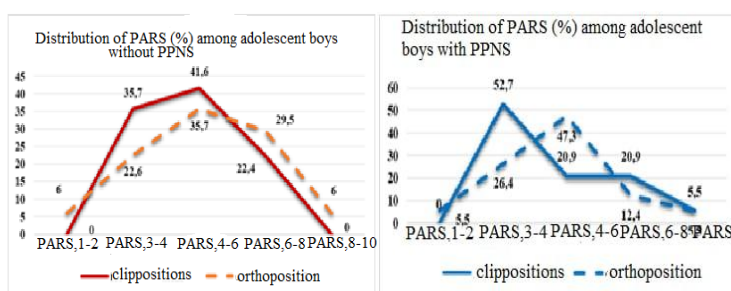


Figure 6. Distribution of PARS (%) among adolescent boys, depending on the presence of perinatal pathology in the anamnesis

In the ortho position in 35.7% of adolescent boys with PPNS and 47.3% of adolescent boys without PPNS, pronounced tension predominated. The percentage of adolescents with overstrain of regulatory systems in the group of adolescent boys with PPNS increased (29.7%), while in adolescent boys without PPNS it decreased (15.3%). In both groups of girls in the clinoposition, the prevalence of the state of pronounced tension (PARS 4-6) was revealed (Fig. 7).

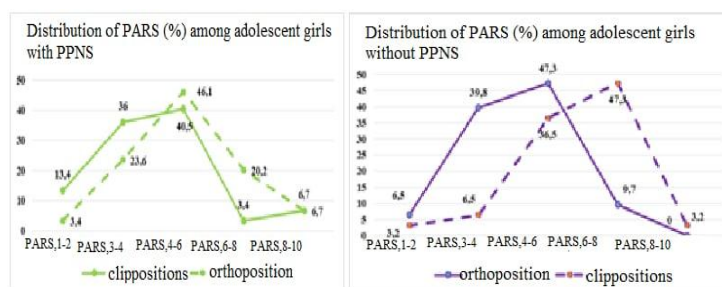


Figure 7. Distribution of PARS (%) among adolescent girls, depending on the presence of perinatal pathology in the anamnesis

Orthopedic tests in adolescent girls without PPNS led to a shift in the dominant values towards overstrain of regulatory mechanisms (47.3%), while maintaining a large percentage of girls with pronounced stress (36.5%). In the group of adolescent girls with PPNS, the state of pronounced stress remained predominant (46.1%), but the incidence of moderate stress decreased (23.6%), and the contribution of the state of overstrain (20.2%) to the overall picture of PARS distribution increased. The results of cardiorespiratory tests (Shtange's, Skibinskaya's, and Ruffier's tests) illustrate

relatively high reserve capacities in the group of adolescent boys without PPNS in comparison with other groups of adolescents (Figure 8).

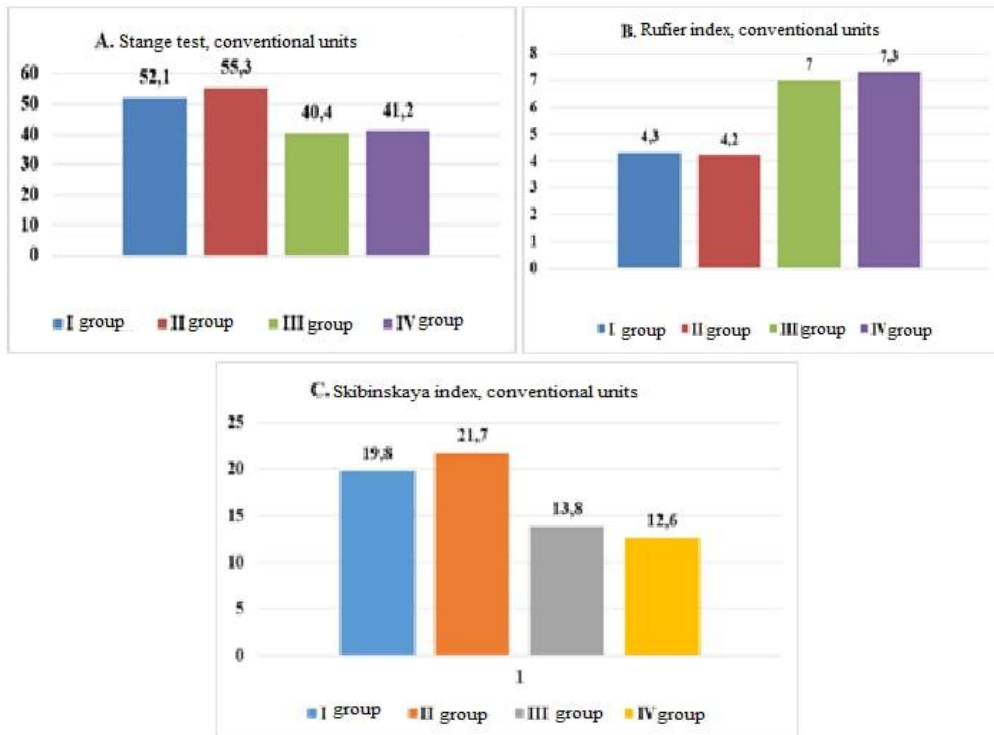


Figure 8. Indicators of Stange's test (A), Ruffier's index (B) and Skibinskaya's index (C) in adolescent groups, depending on gender and the presence of PPNS in history

Thus, taking into account the indicators of heart rate variability (SDNN, RMSSD, Mo, AMo, SI, HF, LF, VLF), the instability of the autonomic support of the heart rate was revealed in groups of adolescents with PPNS, manifested in boys in the predominance of sympathetic activity at rest and a shift in the autonomic balance towards sympathetic activity when performing the clinorthostatic test, and in girls - in the dominance of parasympathetic influences on the sinus rhythm, both at rest and in orthostasis. In groups of adolescents without PPNS, autonomic homeostasis was found to be more stable. The established features indicate the functional lability of the regulatory apparatus of the heart rhythm, which in the future may lead to a decrease in the adaptive capabilities of regulatory systems (Sholikah, 2014).

The functional capabilities of the cardiorespiratory system of the body of adolescents, taking into account the data of the Skibinskaya, Ruffier indices and the Stange test, were expressed in satisfactory adaptation in adolescents with SVD with PPNS of both sexes, adolescents-boys without PPNS - in high adaptive capabilities relative to other groups of adolescents. A comprehensive assessment of the functional state of regulatory systems revealed the tension of the adaptive capabilities of the heart rate regulation systems in the groups of examined adolescents with PPNS, the most pronounced in adolescent girls with PPNS.

Conclusion

For early diagnosis of autonomic cardiac disorders and the identification of early predictors of circulatory system diseases, it is necessary to carry out functional studies and exercise tests among adolescents.

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