

Vadzyuk S. N., Shmata R. M. Features of autonomous regulation in young subjects with increased vestibular analyzer sensitivity. *Journal of Education, Health and Sport*. 2020;10(2):11-17. eISSN 2391-8306. DOI <http://dx.doi.org/10.12775/JEHS.2020.10.02.001> <https://apcz.umk.pl/czasopisma/index.php/JEHS/article/view/JEHS.2020.10.02.001> <https://zenodo.org/record/3634765>

The journal has had 5 points in Ministry of Science and Higher Education parametric evaluation. § 8. 2) and § 12. 1. 2) 22.02.2019.  
© The Authors 2020;

This article is published with open access at Licensee Open Journal Systems of Nicolaus Copernicus University in Torun, Poland  
Open Access. This article is distributed under the terms of the Creative Commons Attribution Noncommercial License which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author (s) and source are credited. This is an open access article licensed under the terms of the Creative Commons Attribution Non commercial license Share alike. (<http://creativecommons.org/licenses/by-nc-sa/4.0/>) which permits unrestricted, non commercial use, distribution and reproduction in any medium, provided the work is properly cited.  
The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 02.01.2020. Revised: 25.01.2020. Accepted: 03.02.2020.

## Features of autonomous regulation in young subjects with increased vestibular analyzer sensitivity

<sup>1</sup>Vadzyuk S. N., <sup>1</sup>Shmata R. M.

<sup>1</sup>Department of Physiology with the Basics of Bioethics and Biosafety, I. Horbachevsky Ternopil National Medical University, Ukraine

**Corresponding author:** Vadzyuk S.N., Doctor of Medical Science, Professor, Head of the Department of Physiology with the basics of bioethics and biosafety, I. Horbachevsky Ternopil National Medical University, Ukraine, ORCID: <https://orcid.org/0000-0001-9105-8205>, e-mail: [vadzyuk@tdmu.edu.ua](mailto:vadzyuk@tdmu.edu.ua)

Shmata R.M., assistant of the department of physiology with the basics of bioethics and biosafety, I. Horbachevsky Ternopil National Medical University, Ukraine, ORCID: <https://orcid.org/0000-0003-0773-4317>, e-mail: [roman@tdmu.edu.ua](mailto:roman@tdmu.edu.ua)

### Abstract

**Introduction:** Each person's body have adaptation during the load due to different changes in the cardiovascular system. One of the first systems that responds to any factors and is actively involved in the processes of adaptation is the autonomic nervous system. It is known that as a result of excitement of the vestibular analyzer kinetosis develops - "motion sickness", which is accompanied by nausea, dizziness, unsteadiness of gait, general weakness. In this regard, assessment of the functional state of the body and its adaptive reserves continues to be one of the most important problems of modern physiology and medicine.

**The purpose** of the study was to evaluate the features of autonomous regulation in subjects with increased sensitivity of the vestibular analyzer.

**Materials and methods:** 60 people between the ages of 18-19 were examined. Vestibular sensitivity was determined with a help of questionnaire. The state of the autonomic nervous system was determined by analyzing heart rate variability using a 5-minute ECG registration technique. The registration and recording was performed by the «PolySpectr +» computer program.

**Results and discussion:** Based on the questionnaire, the students were divided into 2 groups: with proper and with increased vestibular sensitivity. In students with proper vestibular sensitivity, the LF / HF ratio of 1.06 indicates a balanced type of autonomic heart rate modulation. The analysis of spectral indices in subjects with increased vestibular sensitivity

showed a lower overall power of the spectrum, which indicates less functional reserves of the organism. We set much higher HF waves, which indicates an increase in the activity of the parasympathetic system. This is also indicated by the LF / HF ratio of 0.59. When considering the rhythmograms of subjects with increased vestibular sensitivity, 64% of 1-st grade rhythmograms, 20% of 2-nd grade rhythmograms and 16.6% of 3-rd grade rhythmograms were registered. When assessing rhythmograms of the 3-rd class, it can be concluded that the level of functional reserves of subjects with increased sensitivity of the vestibular analyzer can be reduced, which may lead to a decrease in the adaptive capacity of these subjects.

**Conclusions:** In subjects with increased vestibular sensitivity, the parasympathetic autonomic nervous system makes the greatest contribution to the regulation of cardiac rhythm.

**Key words:** increased sensitivity of the vestibular analyzer, autonomous regulation, functional reserves of the organism, rhythmograms.

### **Introduction**

Adaptation of the organism to loads is closely related to the reactions of the cardiovascular system and its regulatory mechanisms [1]. The analysis of heart rate variability, changes in parameters of which reflect the adaptive capacity of regulatory systems of the body and the dynamics of their development, is widely used in physiology to assess the functional state of the organism [2].

It is known that the functional state of the human body is determined by three main factors, such as the level of functioning, the degree of tension and functional reserves [3]. One of the vital organs in maintaining the proper functioning and regulation of the voltage level is the vestibular analyzer, whose sensitivity depends on changes in the body's functional reserves [4]. It is a multidimensional biological converter of energy of linear and angular accelerations into bioelectric signals entering the central nervous system, where the position of the head and body in space is analyzed.

The autonomic nervous system is one of the first responding to any factor and is actively involved in the processes of adaptation and pathogenesis of many somatic diseases. Therefore, it is necessary to study the features of autonomous regulation in young people with increased sensitivity of the vestibular analyzer. In the scientific literature there is evidence that unprepared people using transport develops "motion sickness", accompanied by nausea, dizziness, unpredictable gait, general weakness due to excitement of the vestibular apparatus [5]. Therefore, assessment of the functional state of the body and its adaptive reserves continues to be one of the most important problems of modern physiology and medicine.

**Purpose of the research.** To evaluate the features of autonomous regulation in subjects with increased sensitivity of the vestibular analyzer.

### **Materials and methods**

60 students, aged 18-19, participated in the survey. Vestibular sensitivity was assessed with a help of questionnaire [6]. An analysis of the heart rate variability was performed using the 5-minute ECG registration technique using the PolySpect + computer program complex (Kharkiv, Ukraine) to determine the status of the autonomic nervous system. The examination was performed after a 10 minutes in a supine position on the couch. Recording of 5-minute sections of rhythmograms was performed by recording the ECG in the II standard lead at a tape speed of 50 mm/s. The results were evaluated in the form of rhythmograms of time analysis, spectrograms and cardiointervalography according to R.M. Bayevsky [7].

The evaluation was performed on the values of such indicators as:

- time: R-Rmin, ms – the shortest duration of R-R intervals in the survey; R-Rmax, ms is the highest duration of R-R intervals in the survey; RRNN, ms is the average duration of R-R intervals; SDNN, ms - standard deviation of values of normal R-R intervals (RRNN);
- indicators of spectral analysis – TP, ms<sup>2</sup> – total power of the spectrum, reflects the total activity of the influence of the autonomic nervous system on the heart rhythm, HF, ms<sup>2</sup> – high-frequency oscillations of the heart rhythm in the range of 0,15 - 0,4 Hz, LF, ms<sup>2</sup> – low-frequency oscillations of the heart rhythm in the range of 0.04 - 0.15 Hz, VLF, ms<sup>2</sup> – oscillations of the heart rhythm in the range of very low frequencies – 0,003 – 0,04 Hz.

Cardiointervalography according to R.M Baevsky – (M), arithmetic mean duration of cardiointervals, p; (MS), – mean-square deviation (MS) of the duration of R-R intervals, s<sup>2</sup>; Mode (Mo) is the range of values (R – R) of the most commonly encountered intervals; number of cardio intervals corresponding to the range of mode, %; voltage index (VI).

The study was conducted at certified by the Ministry of Health of Ukraine laboratory of psychophysiological research at the Department of Physiology with the Basics of Bioethics and Biosafety of I. Horbachevsky Ternopil National Medical University (Certificate №003/18).

Prior to the survey, we received informed consent from all participants. Our research does not contradict accepted bioethical standards of the Helsinki Declaration adopted by the General Assembly of the World Medical Association on Human Rights, the International Code of Medical Ethics and Laws of Ukraine and can be used in scientific work (decision of the commission on bioethics of I. Horbachevsky Ternopil National Medical University, protocol № 55 of November 4, 2019).

Statistical processing of the data was performed in the program "BioStat 5" by the method of nonparametric statistics, determining the U – Mann-Whitney test.

### **Results and discussion**

Based on the questionnaire, the subjects were divided into 2 groups: with proper and with increased vestibular sensitivity (Table 1).

**Table 1**

Indicators of time heart rate analysis in subjects with proper and hypersensitive vestibular analyzer

Indicator	Group		p
	Proper sensitivity of the vestibular analyzer n-30	Increased sensitivity of the vestibular analyzer n-30	
R-R min, ms	726,3	472,6	p<0,05
R-R max, ms	1026,7	1005,5	p>0,05
RRNN, ms	850,1	793,3	p<0,05
SSNN, ms	70,6	72,1	p>0,05

Note. p <0.05 – significant differences by U - Mann-Whitney criterion.

The results of the study of the general variability of the heart rhythm by the method of statistical analysis revealed that in subjects with proper vestibular sensitivity R-R min, RRNN were significantly higher than in subjects with hypersensitivity of the vestibular analyzer (p <0.05) (Table 1).

In students with proper vestibular sensitivity, the LF/HF ratio of 1.06 indicated a balanced type of autonomic heart rate modulation (Table 2).

**Table 2**

Indicators of spectral analysis of cardiac rhythm in subjects with proper and hypersensitive vestibular analyzer

Indicator	Group		p
	Proper sensitivity of the vestibular analyzer n-30	Increased sensitivity of the vestibular analyzer n-30	
TP, ms <sup>2</sup>	4037	1914	p<0,05
VLF, ms <sup>2</sup>	931	432	p<0,05
LF, ms <sup>2</sup>	1598	554	p<0,05
HF, ms <sup>2</sup>	1508	929	p<0,05
LF/HF	1,06	0,59	p<0,05
%VLF	23,1	22,6	p>0,05
%LF	39,6	28,9	p<0,05
%HF	37,4	48,5	p<0,05

Note. p <0.05 – significant differences by U - Mann-Whitney criterion.

In students with proper vestibular sensitivity, the overall power of the neuro-humoral

modulation spectrum was high. The state of neuro-humoral regulation was ensured by a high level of sympathetic and parasympathetic influences in the modulation of cardiac rhythm (Table 2).

The analysis of spectral indices in subjects with increased vestibular sensitivity showed a lower total spectrum power (TP), which indicated lower functional reserves of the organism. Significantly higher HF waves were set, indicating increased activity of the parasympathetic system. This was also indicated by the LF/HF ratio of 0.59. The total power spectrum of neuro-humoral modulation was high. The state of neuro-humoral regulation was characterized by high level of parasympathetic and low level of sympathetic and humoral-metabolic influences in modulation of heart rhythm.

When assessing the indices of variational heart rate in individuals, regardless of the stability of the vestibular analyzer, we found that the values of Mo coincided with M, which corresponds to the normal duration of the cardio interval and normocardia (Table 3).

**Table 3.**

Indicators of cardiointervalography according to the method of Baevsky in subjects with appropriate and hypersensitive vestibular analyzer

Indicator	Group		p
	Proper sensitivity of the vestibular analyzer n-30	Increased sensitivity of the vestibular analyzer n-30	
M, c	0,85	0,81	p>0,05
MS, s <sup>2</sup>	0,04	0,09	p<0,05
Mo, s	0,85	0,81	p>0,05
AMo, %	23,5	41,2	p<0,05
VI, c.u	22,7	35,2	p<0,05

Note. p <0.05 – significant differences by U – Mann-Whitney criterion.

The results of the mean-square deviation (MS) of the duration of R-R intervals indicated a high parasympathetic influence on the regulation of cardiac rhythm in subjects with increased vestibular sensitivity.

Indicator amplitude mode (AMo), reflecting the stabilizing effect of centralization of heart rhythm management in subjects with increased vestibular sensitivity was higher than in subjects with proper vestibular sensitivity (p <0.05).

Voltage index (VI) in subjects with hypersensitivity indicated the tension of regulatory mechanisms, as opposed to subjects with proper sensitivity (p <0.05). In subjects with proper sensitivity for the value of this indicator revealed eitonia, which indicated the balanced tone of the parasympathetic and sympathetic parts of the autonomic nervous system.

In determining the classes of rhythmograms by the classification of Berezniy and Rubin (1997), we found that 53% of the rhythmograms of the 2-nd class and 47% of the 1-st class were identified in the subjects with proper vestibular analyzer stability. Rhythmograms of the 3-rd class were not observed in the subjects of this group (Fig. 1).

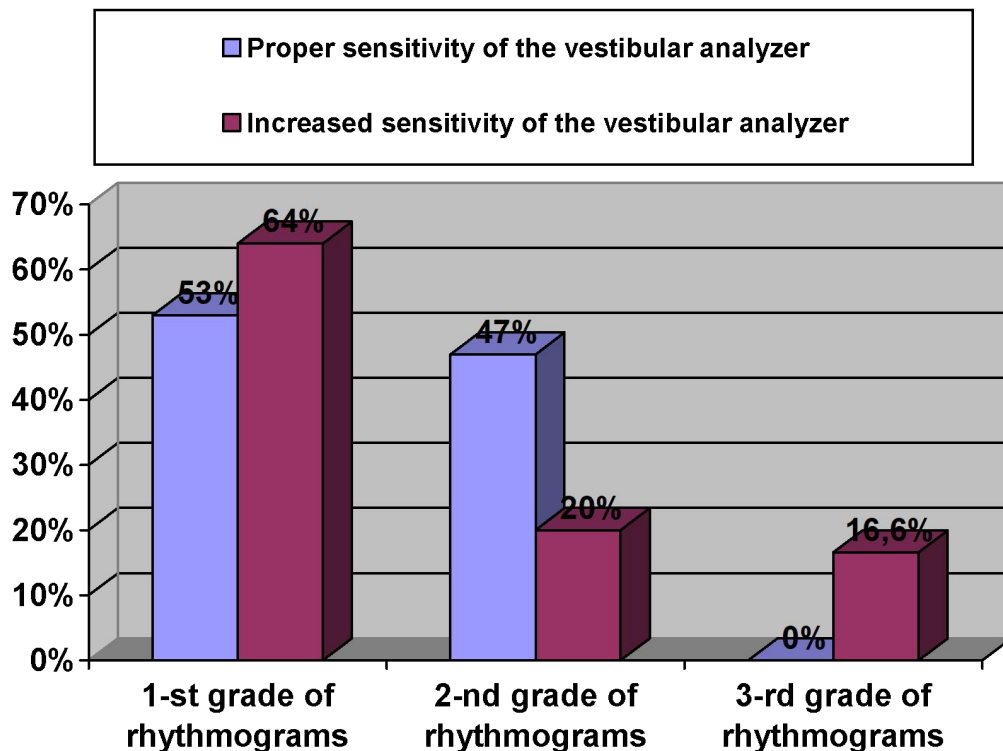


Fig. 1. Definition of classes of rhythmograms according by the classification of Berezniy and Rubin (1997) in individuals with different vestibular sensitivity.

Thus, in subjects with adequate sensitivity the balance of the autonomic nervous system is characterized by a mixed (balanced) type of autonomic heart rate modulation. Assessing the average values of these rhythmograms, it can be concluded that these indicators indicate a high level of functional and adaptive capabilities [8, 9].

With regard to the rhythmograms of subjects with increased vestibular sensitivity, we observed 64% of 1-st grade rhythmograms, 20% of 2-nd grade and 16.6% of 3-rd grade rhythmograms.

By evaluating the rhythmograms of 3-rd grade of subjects with increased vestibular sensitivity, it can be concluded that the level of functional reserves is reduced, which may lead to a decrease in the adaptive capacity of these individuals.

### Conclusions

1. Students with proper vestibular stability are characterized by a balanced type of autonomic heart rate modulation.
2. In subjects with increased vestibular sensitivity, the parasympathetic autonomic nervous system makes the greatest contribution to the regulation of cardiac rhythm.

## References

1. Tokaeva LK, Pavlenkovych SS, Parshyna SS, Bepalova TA. Osobennosti adaptivnykh reaktsyi serdechno-sosudystoi systemy studentov-sportsmenov s razlychnoi vestybuliarnoi ustoychivostiu y vehetativnoi rehuliatsyei [Features of adaptive reactions of the cardiovascular system of student athletes with different vestibular stability and autonomic regulation]. *Sovremennye problemy nauky y obrazovaniya*. 2014; 6: [www.science-education.ru/120-15649](http://www.science-education.ru/120-15649).
2. Vovkanych L, Vynogradskyy B, Vlasov A. Vykorystannya pokaznykiv variabel'nosti sertsevogo rytmu dlya kharakterystyky funktsional'noi pidgotovlenosti sportsmeniv–biatlonistiv [The use of heart rate variability indicators to characterize the functional fitness of biathlon athletes] *Moloda sportyvna nauka Ukrainy*. 2010; 3:50–55.
3. Pavlichenko PP, Popov VD. Metody diahnostryky funktsionalnoho stanu profesiinykh sportsmeniv v riznykh umovakh [Methods of diagnostics of the functional state of professional athletes in different conditions]. *Aktualni problemy suchasnoi medytsyny*. 2015; 15(2):98-105.
4. Bronshtein A, Lempert T. Holovokruzhenye [Dizziness] M.: HƏOTAR-Medyna, 2010; 216.
5. Kulyk VO, Kulyk LI. Vplyv vestybuliarnoi stymuliatsii na pokaznyky variabelnosti sertsevogo rytmu [Influence of vestibular stimulation on indicators of heart rate variability]. *Medytsyna transportu Ukrainy*. 2009; 3: 6-10.
6. Vadziuk CN, Shmata RM, Mykhailiuk OL. Poshyrenist ta proiavy vestybuliarnoi dysfunksii v osib yunatskoho viku [Prevalence and manifestations of vestibular dysfunction in adolescents] *Visnyk sotsialnoi hihiieny ta orhanizatsii okhorony zdorovia Ukrainy*. 2017;1:24–28.
7. Baevskiy RM. Analiz varyabelnosti serdechnoho rytmu: ystoryia, fylosofya, teoriya y praktyka [Analysis of heart rate variability: history, philosophy, theory and practice]. *Klynycheskaia ynformatyka y telemedytsyna*, 2004;1(1): 54–65.
8. Utkyna AH. Osobennosti metodyky fizycheskoho operatyvnoho kontroliia sostoianiya sportsmena pry pomoshchy «Ynformatsyonno-dyagnostycheskoho kompleksa vosstanovleniya funktsionalnoho sostoianiya orhanyzma sportsmena» [Features of the method of physical operative control of the athletes condition with the help of "Information-diagnostic complex of restoration of the functional state of the athletes organism"]. *Slobozhanskyi naukovo-sportyvnyi visnyk*. 2015; 2(46):210–213.