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## **RESEARCH ARTICLE**

# **The Role of the Adaptive potential of Foreign students in Kazakhstan carrying out a scientific project as part of Academic Mobility under the SCORE program**

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### **ABSTRACT:**

The Department of Normal Physiology of Karaganda Medical University (Kazakhstan) has been actively participating in academic mobility under the SCORE program since 2015. A university student has the opportunity to familiarize himself with and complete a scientific project under the guidance of teachers from a foreign university in any country, immersing himself in the social conditions and culture of the host country. The purpose of this study was: to study the mechanisms of adaptation of a foreign student to the new climatic and social conditions of Kazakhstan when carrying out a scientific project; comparison of the reserve capabilities of the body of a foreign student with the level of regulation of the functional systems of Kazakh students. Materials and methods. The adaptation mechanisms of a Brazilian student from UNIVÁS, Minas Gerais and Kazakh students (56 boys, 50 girls) from KSMU, Karaganda were studied. To assess the body's adaptive reactions and the functional state of regulatory systems, the HRV analysis method was used. The main statistical, variational and complex indicators of the CIG before and after physical activity (Martine's test) were determined and analyzed. The predominance of modulating sympathetic-parasympathetic regulatory influence over humoral-metabolic and central ergotropic regulatory stimuli in Kazakhstani students was revealed. A comparative analysis of the dynamics of indicators RRNN, Mo, RRmax, RRmin, AMo and the values of complex indicators: VRI (vegetative rhythm index), IVE (Index vegetative equilibria), IARP (indicator of the adequacy of regulatory processes), SI (stress index) showed more pronounced activity of the parasympathetic department of autonomic regulation in boys (Kazakhstan and Brazil) compared to girls. Compared to Kazakh students, the activity of the parasympathetic division of the ANS in the Brazilian student is more pronounced, as indicated by complex indicators of HRV (variation range, IVE, VRI) reduced below the norm. Conclusion. It is necessary to ensure that the reserve capabilities of adaptation mechanisms are determined in all candidates for the SCORE program before the start of mobility using the HRV method. This will allow us to identify the candidate's individual adaptation characteristics, which will prevent possible depletion of adaptation mechanisms and will help to successfully complete the research project, enjoying the acquaintance with the culture of the host country.

**KEYWORDS:** Adaptation, student, SCORE, HRV, regulatory mechanisms.

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### **INTRODUCTION:**

The Committee on Research Exchange / SCORE offers more than 3,000 research scientific projects, in which medical students from all over the world can participate. Any higher education institution at the present stage faces the primary task of maintaining students' motivation for studying<sup>1,2</sup>. Educational institutions offer students various methods of active learning, such as PBL, brainstorming, Flipped Classroom, ILS<sup>3,4</sup>. The method of scientific projects is one of the highly effective motivating methods of teaching. At the present



stage, our university has the opportunity to accept foreign students on the basis of our scientific laboratories of the NCJSC "Karaganda Medical University" (Kazakhstan) to carry out a scientific project. This program provides future doctors with an opportunity to get acquainted with scientific research and its diversity in another country. The project is implemented for a month at the medical university of the host country and includes mandatory familiarization with the culture and customs of the country. This maintains a high positive emotional attitude of students, which plays an important role in the learning process<sup>5</sup>. However, the student finds himself in new climatic and social conditions, which is inevitably accompanied by the emergence of stress and affects the success of the learning process<sup>6,7,8,9</sup>. To determine the basic level of stress resistance and control the dynamics of stress, a number of authors use the HRV method according to Baevsky<sup>10-13</sup>. Successful completion of a research project depends on the adaptive capabilities of the student's organism. In such research program student not only participates in research but must also prepare and defend his research project upon completion of the mobility. The HRV method allows one to quickly assess the reserve capabilities of the student's regulatory systems and monitor their dynamics during migration. Some authors claim that most foreigners experience an initial "culture shock", the consequences of which are reflected not only in the ability to work productively, but also in the quality of life<sup>14</sup>. The research exchange program does not provide an opportunity for long-term adaptation. A student arriving from another country is given a short period of adaptation, limited to one month of an active scientific and equally active cultural program.

Thus, the issue of studying the adaptation of students to new environmental conditions, both climatic and social, in the active process of academic mobility under the SCORE program is relevant.

#### **PURPOSE OF THE STUDY:**

To study the mechanisms of adaptation of the regulatory systems of the Brazilian body student in the social and climatic conditions of Kazakhstan when performing scientific research project.

Compare the reserve capabilities of the body of a Brazilian student with the level adequacy of the processes of regulation of functional systems of Kazakhstani students.

#### **MATERIALS AND METHODS:**

To achieve this goal, daily monitoring of all parameters of cardiovascular system (CVS), respiratory system (RS) from the first day of arrival of a student from Brazil to

Kazakhstan. Student 2 courses UNIVÁS, Minas Gerais. Adaptation took place under conditions of a sharp change in warm weather Brazilian climate to the harsh winter climate of Central Kazakhstan with an average air temperature in December  $-30^{\circ}/-35^{\circ}$ . Functional changes were studied cardiovascular and respiratory systems of the student. Registration completed interpretation and comparative analysis of HRV (heart rate variability) indicators in 2nd year students (56 boys, 50 girls) from Karaganda Medical University (Kazakhstan) with HRV indicators Brazilian student. The state of the cardiovascular system was assessed by dynamics heart rate, SBP (systolic blood pressure), DBP (diastolic blood pressure), PP (pulse pressure) and oxygen saturation percentage. Respiratory status assessment systems were carried out according to the determined parameters of external respiration: TV (tidal volume), IRV (inspiratory reserve volume), ERV (expiratory reserve volume), VC (vital capacity of the lungs). To assess the body's adaptive reactions, functional state of regulatory systems used the method of analysis heart rate variability. Key indicators of cardiointervalography identified and analyzed: RRNN, SDNN (standard deviation), Mo, AMo, VR (variation range/DX) and complex indicators: VRI (vegetative rhythm index), IVE (index vegetative equilibria), IARP (indicator of the adequacy of regulatory processes), SI (stress index of regulatory systems).

All indicators were recorded before and after moderate physical activity in the form of 20 deep squats with arms thrown out.

Electrocardiograph "Kardipia-200", program "Poly-Spectrum-Express-Analysis", spirometer-pneumotachometer" Spiro S-100", pulse oximeter KMP-PO70. Statistical processing of the material was carried out using a standard application programs "Statistica" for a personal computer.

#### **RESULT AND DISCUSSION:**

The first week of a Brazilian student's stay in Kazakhstan is characterized by pronounced "background resting vagotonia". The student experienced the impact of a sharp change in climatic conditions from  $+30$  degrees summer temperature in Brazil to  $-30/-35$  degrees in December severe winter in Kazakhstan. Foreign the student was involved in the implementation of the scientific project from the first days. He is actively participated in research of Kazakhstani students, in studying and mastering new research methods.

In accordance with the scientific project "Assessment of the adaptive capabilities of the body according to the degree of tension of regulatory systems" which he chose at SCORE, before the student was given the following



tasks: to study the basic patterns functioning of the body of a healthy person and its regulatory systems; master methods for assessing the functional state of the cardiovascular system and respiratory system; master the method analysis of heart rate variability in assessing the body's adaptive capabilities when exposed to various stress factors; master registration techniques and analysis of electrocardiogram, cardiointervalogram using the program "Poly-Spectrum-Express-Analysis" and electrocardiograph "Cardipia-200"; master using spirometry and pneumotachometry using the "Spiro S-100" device.

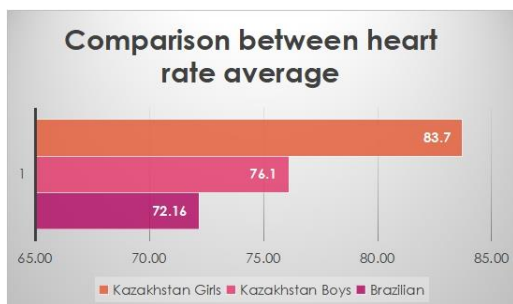
The results of the scientific project were presented at a meeting of the Department of Physiology KSMU.

The results of a study of Kazakhstani students studying at KSMU showed that the average heart rate at rest in the group of girls is higher than in the group boys (84 beats per minute). In boys, the average heart rate at rest was 76 beats per minute. This fact indicates a more emotional state of girls during the process of physiological studies. Heart rate indicators of a Brazilian student at rest in the first weeks in Kazakhstan rarely reached 80 beats per minute (Fig. 1.) Average heart rate in Brazilian student 72 beats per minute, which is lower than the heart rate of Kazakh students (Fig. 2.)



**Figure 1: Dynamics of heart rate indicators of a Brazilian student in the first weeks in Kazakhstan.**

After moderate physical activity in the form of squats, the average heart rate of the young men increased to 106.7 cycles per minute, with increase by 29%. In girls, after squats, average heart rate increased by 18% (102.2 cardiac cycles per minute). The Brazilian student's heart rate increased by only 10%.



**Figure 2: Comparative heart rate values of Kazakh students (girls, boys) and a Brazilian student at rest.**

Blood pressure in boys, both systolic and diastolic at rest, is higher than in girls. After exercise, both boys and girls experience a rise in blood pressure, but in boys it is more pronounced. Pulse pressure after exercise in girls was 44.5mm Hg, for boys - 52.3mmHg. The percentage of blood oxygen saturation in girls remains virtually unchanged during exercise, but there is a tendency to increase. In 50% of the subjects, oxygen saturation increased by 1%, in 30% it remained unchanged. This parameter decreased by 1% only in two girls. In boys, oxygen saturation decreased in 80% of the subjects, in 20% of cases it decreased, which indicates more oxygen consumption during physical activity in men. The average body mass index in both the group of girls and the group of boys corresponds to the physiological norm.

The average duration of the RR interval in girls is lower both before exercise and during recovery. The decrease in this indicator in girls after exercise is more pronounced and reaches 0.59 s, which is 0.16 s below the norm. This decrease indicates a pronounced humoral influence of the sympathetic nervous system on the sinus node during physical activity in girls. In the group of boys, the decrease in the average duration of the RR interval was within normal limits.

Analysis of the dynamics of the standard deviation during physical activity revealed an increase in autonomic regulation in the group of girls at rest, as indicated by an increase in this indicator to 0.10 s. In boys, this indicator at rest does not exceed the normal value (0.07 s), after exercise it increases to the highest limit of normal. In girls, after exercise it decreases to the highest limit of normal. These changes indicate an increase in vagal regulation and activity of the trophotropic action of the parasympathetic nervous system during the recovery period in the group of boys, and a slight decrease in the activity of autonomic regulation in the group of girls, which is suppressed by an increase in the activity of sympathetic regulation.

Mo, which is closely related to heart rate, after exercise in both groups decreases to 0.67 units in boys and 0.61 units in girls, which indicates tachycardia, which develops during physical activity. At rest, Mo is within normal limits in both girls and boys, but in girls it is lower, which correlates with the detected increased heart rate in relation to the average heart rate in boys at rest. The Brazilian student's Mo at rest was 0.87.

The average value of the mode amplitude, which reflects the stabilizing effect of centralization of heart rhythm control, is within normal limits at rest in 40% of the studied boys and in 80% of girls. In 30% of young men, there is an increase in the activity of the sympathetic division of the ANS, in 30% there is a moderate



predominance of parasympathetic regulation. In girls, the predominance of sympathetic regulation before exercise is observed in 10% of cases, and in 10% of cases the predominance of parasympathetic regulation. After the load, the average AMO value decreases in both girls and boys, however, in boys the trophotropic influence of the parasympathetic system is more pronounced, because their average value of this indicator after load is below 30%, with a normal value of 30% to 50%. The average score for a Brazilian student was 31.35%, indicating a strong activity of the parasympathetic system.

The variation range is higher than the average value in boys and girls before and after physical activity. The adaptive capabilities of the regulatory system of girls are higher, since the average value of the variation range in them has more pronounced dynamics during physical activity and amounted to 0.149s. For boys it is 8 times less - 0.018s.

50% of boys and 30% of girls showed a low value of IVE at rest, which indicates the predominance of parasympathetic activity of the ANS before physical activity. Pronounced activity of the sympathetic division of the ANS was detected in only one student; among girls, no increase in the activity of sympathetic influence was detected. A positive point is the restoration of the balance of autonomic regulation in this student after physical activity; his IVE decreases from 425.0 to 62.2 units after physical activity. However, among the girls, a case of pronounced inertia and passivity was identified, as indicated by a sharp decrease in IVE at rest to 5.6 units. This figure increases to 31.2 after physical activity. The recovery of IVE after physical activity suggests that these students need regular physical activity to maintain autonomic balance in regulating heart rate. A comparative analysis of average values showed a more pronounced influence of the parasympathetic division of the ANS in girls compared to boys, both before and after the load. The average score of the Brazilian student in the first 12 days at rest was 91.40 (Fig. 3).

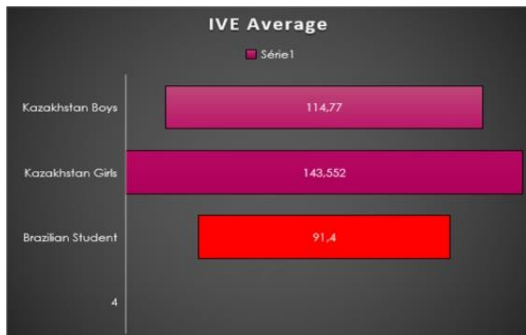


Figure 3: Average value of IVE at rest in Kazakh students and Brazilian student.

However, daily monitoring of the IVE of the Brazilian student showed consistently low values of the IVE, which indicates pronounced vagotonia of the student who arrived in the Republic of Kazakhstan (Fig. 4.).



Figure 4: Dynamics of IVE of Brazilian student in the first weeks of his stay in Kazakhstan.

VRI has insignificant dynamics during physical activity and corresponds to the norm. The average value is slightly higher for girls both before and after the load. This fact indicates greater activity of the autonomous regulatory circuit in the group of boys in relation to girls. However, one case of pronounced activity of the central regulatory circuit was identified in girls after exercise and two cases in boys: one before exercise, one after. The Brazilian student has VRI 3.34 (with an average normal value of 3-10), which is lower than the VRI of Kazakhstan boys (3.92) and girls (4.60) and indicates a more pronounced predominance of parasympathetic regulation in the Brazilian student.

Analysis of the dynamics of IARP revealed an adequate state of the regulatory systems before the load in 60% of the studied young men; in 40% of the young men, an increase in the tension of the central regulatory departments before the load was detected. After the load, increased IARP values above normal were recorded in 30% of cases and only 10% of them are the result of an increase after the load, 20% of them are the result of a decrease in the increased IARP values before the load. Thus there is increase in IARP after exercise in 90% of the studied young men, and decrease in 10%. In girls, a decrease in IARP after exercise was detected in 30% of cases and an increase in 70%. Before loading, an increased IARP value in girls was detected in 50% of the subjects. Thus, the balance between the level of functioning of the sinus node and sympathetic activity in girls is shifted towards the latter, which indicates greater activity of the central regulatory circuit in girls before and after physical activity. Young men have a balanced functioning of regulatory systems, in which the influence of the vagus on the sinus node predominates, which indicates the predominance of the autonomous circuit in the regulation of heart rate.





Figure 5: Dynamics of IARP of Brazilian student.

Analysis of the dynamics of SI showed an adequate response of regulatory systems to physical activity in both boys and girls. The average value of SI for boys is lower than for girls, both before and after the load. However, an increased value of this index was noted in two girls before the load; after the load in one, this indicator decreased to normal, in the other it increased. In young men, the SI was increased at rest in only one student, while after the load it recovered to normal (decreasing its value by 5.5 times). The reaction of the Brazilian student to physical activity corresponds to the reaction of the young men of Kazakhstan with a lower value at rest - 54 units, for Kazakh students - 58 units.

## CONCLUSION:

1. Data from the analysis of HRV parameters indicate the predominance of modulating sympathetic-parasympathetic regulatory influence over humoral-metabolic and central ergotropic regulatory stimuli in Kazakhstani students studying at KSMU.
2. The value of the indicators RRNN, Mo, RRmax, RRmin is higher, and the value of AMo and the value of complex indicators: VRI, IVE, IARP, SI in Kazakhstani boys is lower than in girls, which indicates a more pronounced activity of the parasympathetic department of autonomic regulation in boys according to compared to girls.
3. In girls, a balanced state of the ANS (vegetative balance) was revealed, as indicated by the identified moderate increase above the norm in SDNN, DX, IARP, and a decrease in the average value of the duration of the RR interval (M) and Mo. The functional state is satisfactory.
4. In young men, a moderate predominance of parasympathetic activity was revealed, which indicates the optimal state of regulatory systems and ensures more economical functioning of the cardiovascular system when exposed to stress factors.

The first week of Brazilian student in Kazakhstan is characterized by pronounced "background resting vagotonia".

With moderate physical activity, a below-normal decrease in such HRV indicators as DX, VRI and IVE was revealed, which indicates a shift in the autonomic balance towards parasympathetic activity and indicates the predominance of autonomous regulation of heart rate. The result of this type of regulation was rapid adaptation to new living conditions within a week.

The predominance of parasympathetic regulation in the Brazilian student is moderate, which ensures an optimal state of regulatory systems and indicates a good functional state and high stress resistance of the body.

Thus, despite the sharp change in climatic and social conditions and the predominance of emotional euphoria that accompanies new meetings and acquaintances, this indicator does not exceed normal values of 30-50%, which does not indicate the expected increase in the activity of sympathetic regulation and the appearance of the effect of centralization of heart rate control.

Compared to Kazakh students, the Brazilian student's autonomic balance indicator indicates a more pronounced activity of the parasympathetic division of the ANS. The activity of the Brazilian student's autonomous regulatory circuit persists for a month from the first day of his stay on Kazakh soil, which indicates the adequacy of the regulatory processes. This is probably due to this not being the student's first experience of participating in a research exchange program.

Thus, the optimal state of regulatory systems was identified for the Brazilian student, which allowed him to quickly adapt to the new climatic and social conditions of Kazakhstan.

After moderate physical activity, the Brazilian student, like the Kazakh students, showed a moderate predominance of parasympathetic regulation. However, the activity of the parasympathetic division of the ANS is more pronounced in the Brazilian student.

## INFERENCE:

Considering the high load on the body of students participating in academic mobility, associated with a sharp change in climatic and social conditions in a short period of time, it is necessary to ensure that the reserve capabilities of adaptation mechanisms are determined in all candidates before the start of mobility using the HRV method. This will reveal the individual characteristics of the candidate's adaptation, which will prevent possible depletion of adaptation mechanisms and will help to successfully complete the research project, enjoying the acquaintance with the new culture of the host country.



## CONFLICT OF INTEREST:

The authors declare that there is no conflict of interest.

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