

Features of Psychophysiological Adaptation of Foreign Students in Medical Universities

Características de la Adaptación Psicofisiológica de los Estudiantes Extranjeros en las Universidades de Medicina

Aigul Chonkoeva^{1*}, Ykyval Taalaibekova², Cholpon Zhaparalieva³, Nurlanbek Mannap uulu⁴, Aikerim Chonkoeva⁵

SUMMARY

Introduction: Psychophysiological adaptation of foreign medical students is a pressing issue due to the increasing influx of students from abroad. **Objective:** This study aimed to identify the factors affecting the adaptation of international students in the process of studying at medical universities of the Kyrgyz Republic, with a special focus on climatic conditions, study load, and stress factors. **Method:** The study was conducted from 2022 to 2023 at Ala-Too International University and the International Graduate School of Medicine, involving 150 first-year students from India and Pakistan. The analysis of data obtained from questionnaires, physiological tests, and biochemical analyses revealed significant changes in levels of anxiety, stress tolerance, and physiological indicators

such as cortisol levels, blood pressure, and heart rate, as well as the state of the respiratory system. **Result:** At the beginning of the semester, 60 % of students had an elevated level of situational anxiety with an average of 48.2 points, indicating high stress due to adaptation to a new educational and cultural environment. By the end of the semester, a decrease in the level of situational anxiety was recorded, which indicates a gradual adaptation to the educational process and new living conditions. There was also a decrease in cortisol level (from 580 to 470 nmol/L) and improvement of cardiovascular system indicators: average blood pressure decreased from 135/85 to 128/82 mmHg, and heart rate decreased from 82 to 76 beats per minute, indicating a decrease in stress and improvement of students' general condition. Correlation analysis revealed a significant relationship between anxiety level and physiological indicators such as heart rate and cortisol level. These data highlight the need for a comprehensive approach to support international

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¹ORCID: 0000-0002-7760-2785¹

²ORCID: 0009-0002-9368-1820²

³ORCID: 0009-0009-7401-6615³

⁴ORCID: 0009-0003-7105-6351⁴

⁵ORCID: 0009-0001-7343-8375⁵

^{1*} Department of Fundamental and Morphological Disciplines, Ala-Too International University, Bishkek, Kyrgyz Republic. E-mail: aigulchonkoeva7@gmail.com

² Department of Fundamental Disciplines, International Higher School of Medicine, Bishkek, Kyrgyz Republic. E-mail: y-taalaibekov@outlook.com

³ Department of Fundamental Disciplines, International Higher School of Medicine, Bishkek, Kyrgyz Republic. E-mail: c.zhaparalieva@hotmail.com

⁴ Department of Fundamental and Morphological Disciplines, Ala-Too International University, Bishkek, Kyrgyz Republic. E-mail: n_mannapuulu@outlook.com

⁵ Department of Therapeutic Disciplines and Family Medicine, Ala-Too International University, Bishkek, Kyrgyz Republic. E-mail: achonkoeva@hotmail.com

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students, including psychological assistance, social support, and regular monitoring of physiological indicators, which helps to improve adaptation and reduce stress levels.

Keywords: Cortisol, blood glucose, triviolence level, heart rate, vital capacity of lungs, stress tolerance, biochemical analysis.

RESUMEN

Introducción: La adaptación psicofisiológica de los estudiantes de medicina extranjeros es un problema acuciante debido a la creciente afluencia de estudiantes extranjeros. **Objetivo:** El objetivo de este estudio fue identificar los factores que afectan la adaptación de los estudiantes internacionales durante sus estudios en las universidades de medicina de la República Kirguisa, con especial atención a las condiciones climáticas, la carga de estudio y los factores de estrés. **Método:** El estudio se llevó a cabo entre 2022 y 2023 en la Universidad Internacional Ala-Too y la Escuela Internacional de Posgrado de Medicina, con la participación de 150 estudiantes de primer año de India y Pakistán. El análisis de los datos obtenidos mediante cuestionarios, pruebas fisiológicas y análisis bioquímicos reveló cambios significativos en los niveles de ansiedad, la tolerancia al estrés e indicadores fisiológicos como los niveles de cortisol, la presión arterial y la frecuencia cardíaca, así como en el estado del sistema respiratorio. **Resultados:** Al inicio del semestre, el 60 % de los estudiantes presentaba un nivel elevado de ansiedad situacional con una media de 48,2 puntos, lo que indicaba un estrés elevado debido a la adaptación a un nuevo entorno educativo y cultural. Al final del semestre, se registró una disminución del nivel de ansiedad situacional, lo que indica una adaptación gradual al proceso educativo y a las nuevas condiciones de vida. También se registró una disminución del nivel de cortisol (de 580 a 470 nmol/L) y una mejora de los indicadores del sistema cardiovascular: la presión arterial media disminuyó de 135/85 a 128/82 mmHg, y la frecuencia cardíaca disminuyó de 82 a 76 latidos por minuto, lo que indica una disminución del estrés y una mejora del estado general de los estudiantes. El análisis de correlación reveló una relación significativa entre el nivel de ansiedad y los indicadores fisiológicos como la frecuencia cardíaca y el nivel de cortisol. Estos datos ponen de relieve la necesidad de un enfoque integral para apoyar a los estudiantes internacionales, que incluya asistencia psicológica, apoyo social y seguimiento regular de los indicadores fisiológicos, lo que ayuda a mejorar la adaptación y reducir los niveles de estrés.

Palabras clave: Cortisol, glucosa en sangre, nivel de triviolencia, frecuencia cardíaca, capacidad vital pulmonar, tolerancia al estrés, análisis bioquímico.

INTRODUCTION

As an increasing number of foreign students enrol in medical schools, it has become crucial and urgent to help them adjust psychologically. It can be exceedingly difficult to learn in a new school and culture, especially for students who are going to medical school, because the curriculum and learning are highly demanding. Due to the numerous differences in school requirements, weather, and culture, international students find it challenging to adjust. They become more stressed and undergo significant mental and physical changes because of such an event.

Coping is a dynamic process in which people consider what their environment needs and use their resources to continue coping, according to the transactional model of stress and coping, which was applied in this study (1). In this context, cognitive adaptation is defined by psychological responses elicited by exposure to new stressors, including academic pressure, cultural differences, and environmental influences. Physiological adaptations are marked by the activation of the hypothalamic-pituitary-adrenal (HPA) axis and biological indicators, including cortisol levels, heart rate, blood pressure, and respiratory rate. When cortisol levels and heart rate increase, the body responds more quickly to stress. When levels of these hormones decrease, the body recovers. Changes in vital capacity (VC) and other respiratory symptoms reflect the body's response to external stressors, such as temperature or altitude. The purpose of this integrated model is to explain the interaction between cognitive perception and physiological reactions in shaping the adaptive capacity of international medical students in a new academic and social environment.

Language barriers and adverse weather conditions are common problems for international students. Hachemi et al. (2) studied the adjustment problems of students in India and Pakistan and found that language skills and geographical climate had a significant impact on anxiety levels. However, their study did not examine the

influence of academic stress on anxiety levels. Significant differences were found, especially among medical students who experienced high levels of academic stress. It is also important for students to adapt to new academic standards and the associated stress. Gamsizkan et al. (3) showed that international students experience greater stress due to adjusting to new educational norms. However, their study did not examine the impact of weather conditions on adjustment, which limits our understanding of the wide range of factors that influence students' adjustment. International students also have considerable difficulty adjusting to cultural differences. Yılmaz and Temizkan (4) found that students' adjustment to a new cultural environment often results in high levels of stress, which negatively affects their academic performance. However, the study did not assess physiological parameters such as cortisol levels or blood pressure, which may provide a more objective picture of the adaptation process.

Gradual reduction in anxiety is an important part of the adaptation process. Wang et al. (5) showed that anxiety levels in university students decreased significantly after the first month of study. However, their study focused only on psychological factors and did not consider physiological changes, which hinders a comprehensive understanding of university student adaptation. Social support is also crucial for how well students adapt. Demuyakor (6) investigated the effect of social support in his study and found that a supportive environment reduces anxiety levels. However, Demuyakor did not consider the impact of academic workload, which is an important factor, especially in medical schools where the demands of study are higher.

Physiological measures, including cortisol levels, can be used to assess adaptation. Kristiana et al. (7) emphasised the importance of these measures in assessing adaptation. However, their study did not consider the impact of cultural differences on physiological changes, which could help provide a more complete understanding of stress on international students. To facilitate effective adaptation of students, comprehensive support, including social and psychological aspects, is necessary. Oh and Ahn (8) emphasised the importance of such an approach. Still, their study does not consider the relationship between

physiological indicators and anxiety levels, which could actually lead to a deeper understanding of the adaptation process.

One of the problems that international students face is not having enough social and mental health support. Jamshaid et al. (9) stressed the need for a consistent plan to help students and said that psychological support is essential for successful adaptation. However, their study did not include physiological data, which limits our understanding of the overall impact of adaptation factors. Further research is needed to clarify the role of these factors.

In view of the evidence, this study aimed to investigate how first-year medical students at Kyrgyz Republic's universities psychologically and physiologically adapt to a foreign educational and cultural environment. For this, it will be: Assess changes in situational anxiety and perceived stress over the course of the semester; Monitor physiological measures of stress and adaptation, such as cortisol levels and cardiovascular and respiratory parameters; Examine the relationship between psychological and physiological adaptive responses.

This study demonstrated the need for a comprehensive strategy to support international students and emphasised the need for a more comprehensive strategy that includes both academic and social aspects. Therefore, strategies should be developed that effectively consider all factors that influence the adaptation of today's international students.

MATERIALS AND METHODS

The study was conducted from 2022 to 2023 at Ala-Too International University and the International Graduate School of Medicine in the Kyrgyz Republic. The sample consisted of 150 first-year international students from India and Pakistan, aged 18 to 20 years ($M \pm SD = 19.7 \pm 0.17$). Out of them, 75 males and 75 females, thus ensuring a balanced sex distribution. The sample was randomly generated to ensure the representativeness of the data, with a balanced distribution of sex and country of origin. The study included students with comorbid somatic diseases, but they were excluded. To assess

psychophysiological adaptation, a set of methods was used, including questionnaires, physiological tests, and biochemical analyses. This study aligned with the ethical principles of research, including anonymity, confidentiality, and beneficence. Ethical approval of the study was obtained from the Ethics Committee of the Ala-Too International University with No. 182964.

The conceptual framework for this research was based on Lazarus and Folkman's transactional model of stress and coping, which views adaptation as an ongoing interaction between external stressors and internal coping capacities. Within this framework, the study assessed psychological responses such as anxiety and perceived stress as cognitive appraisals of environmental demands. At the same time, physiological and biochemical markers were used to evaluate somatic reactivity. This dual approach allowed for a comprehensive examination of psychophysiological adaptation among international students facing academic, cultural, and climatic challenges.

A questionnaire (the Spielberger-Hanen test) was used to assess anxiety levels (10). This test consisted of 40 questions divided into two parts and rated on a 4-point Likert scale. The assessment was conducted twice, once during the first 2 weeks of the semester and again at the end of the semester, to monitor fluctuations in anxiety levels during the adaptation process. For cross-cultural validity, the questionnaire was translated into Hindi and Urdu using a back-translation procedure, and its internal consistency was confirmed through a pilot test (Cronbach's $\alpha > 0.85$). The questionnaires were completed anonymously, which reduced the influence of socially desirable responses and increased the reliability of the data collected. Students completed the questionnaires during lectures under the guidance of the researchers. This reduced external influences on the responses and ensured consistency throughout the study period. The results were used for further research to clarify the relationship between anxiety levels and physiological indicators. Additionally, the Perceived Stress Scale (PSS-10), a 25-item instrument rated on a 5-point scale, was employed to assess the level of stress resistance and the subjective evaluation of adaptation to the learning process (11). The PSS-10 assessed

students' ability to cope with academic and social stress. Both surveys were administered anonymously throughout the study and directly by trained researchers to ensure consistency and limit social media bias.

Biochemical blood tests were performed to assess physiological adaptation parameters such as cortisol and glucose levels. To minimise the influence of external factors on the test results, blood samples were collected in the morning on an empty stomach. Blood samples were collected into sealed containers using sterile 10 mL disposable syringes (BD Plastipack). All blood collection and analysis procedures were performed according to standard biosafety procedures to avoid contamination and ensure the accuracy of the test results. The time of sample collection was limited to ensure comparability of samples between individuals. All examiners followed the same procedure to minimise testing variability.

The obtained blood samples were analysed in the laboratory at the National Centre for Maternal and Child Health. Determination of serum cortisol levels was carried out by an immunological method according to standard procedures, with basal levels of 800, evening levels of 1 800, and night levels of 2 300. Total daily cortisol mass (mg) in the studied time interval (15 hours) was calculated according to the formula (1):

$$m = 0.00362 \times CBV \times \sum_{i=1}^{N=3} C_i, \quad (1)$$

Where m is the mass of cortisol secreted in the studied time interval, mg; 0.00362 is the coefficient of cortisol transformation from the metric unit of nmol/L concentration to mg/L; C_i is the concentration of cortisol in samples, nmol/L.

Daytime cortisol reactivity was defined as the rate of change in cortisol levels between nighttime and baseline levels over 15 hours, $\text{nmol L}^{-1} \times \text{h}^{-1}$ (2):

$$\text{Reactivity} = \frac{|m(\text{HOvernight}) - m(\text{basal})|}{15 \text{ hours}}, \quad (2)$$

Blood glucose was determined colorimetrically by the glucose oxidase-peroxidase (GOD-POD) method. To assess the functional state of the cardiovascular system, an Omron M6 Comfort automatic digital tonometer was used to measure systolic and diastolic blood pressure. HR and heart rate variability (HRV) were determined by CardioVisor software, which provided time-domain and frequency-domain metrics essential for quantifying autonomic nervous system activity. The functional state of the respiratory system was assessed by the method of spirometry on the Spiropet Spirometer apparatus according to the basic and dynamic parameters of external respiration: VCL; functional residual lung capacity (FRC); reserve expiratory volume (REV); total lung capacity (TLC); minute respiratory volume (MRV); alveolar ventilation (AV).

A ChoiceM Med pulse oximeter determined blood oxygen saturation (SaO_2). In addition, Shtange and Henche tests were applied to assess hypoxia tolerance. The protocol for these tests followed standard instructions, and measurements were conducted under identical environmental conditions. The measurements were performed twice: at the beginning of the academic term and three months after the start of the study, which allowed us to track the dynamics of changes in the adaptation state of the students. Before each measurement, the study participants rested for 10-15 minutes to stabilise cardiovascular and respiratory parameters, which ensured accurate and reliable results.

Statistical analysis of the data was performed using IBM SPSS (version 27). Descriptive statistics were presented as mean and standard deviation. Differences between indicators measured at different stages of the study were assessed by comparing changes over time using paired t-tests. Pearson correlation coefficients were used to determine the strength and direction of the relationship between psychometric characteristics (e.g., anxiety, stress resilience) and physiological indicators (e.g., cortisol, HR, blood pressure). The significance level was set at $p < 0.05$. A multivariate analysis of variance (ANOVA) was conducted to examine the influence of gender, age, and country of origin on adaptation parameters. This multivariate approach allowed the identification of interaction

effects and clarified the role of background variables in moderating the adaptation process. The Spielberger-Hanin scale and the PSS-10 were used to assess psychological adaptation. Body size and HR, cortisol, and spirometry provided physiological information. Combining these data allowed for a detailed analysis. All manipulations involved in this study were performed in accordance with the Declaration of Helsinki, which ensures adherence to ethical standards and humane treatment of participants (12). Each study participant was informed of the purpose and procedures of the study. An informed consent form was signed.

RESULTS

The presented results are consistent with the three main goals of this study: first, changes in psychological stress and depression over time were described; second, changes in physical resilience parameters were analysed; and third, the relationship between psychological and physiological factors was investigated, and an integrated model of coping with adverse situations was developed. The study has shown that international students studying at medical universities in the Kyrgyz Republic experience significant changes in psychophysiological indicators during the adaptation process to new living and learning conditions. Analysis of data obtained from questionnaires, physiological tests, and biochemical analyses revealed both individual and group differences in anxiety levels, stress tolerance, and physiological parameters. These data provide a deeper understanding of which factors have the most significant impact on the adaptation of international students and how their learning environment can be improved. The analysis of questionnaire data using the Spielberger-Hanin scale revealed an increased level of anxiety in a significant part of international students (Table 1).

The results of the study showed that at the beginning of the academic term, the level of situational anxiety was elevated in 60 % of the study participants, with an average value of 48.2 ± 5.6 points, which exceeds the norm for this age group (30-45 points). This suggests that the process of adapting to a new educational and

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Table 1. Psychophysiological indicators of foreign students at the beginning and end of the educational process at the university (M±SD)

Indicator	Beginning of the semester	End of the semester	Percentage of students with disabilities
Situational anxiety (scores)	48.2±5.6	42.3±4.8	60
Personal anxiety (scores)	52.1±6.1	52.1±6.1	40
Stress resistance (points)	34.5±4.3	41.7±3.9	55

Source: created by the authors.

cultural context is a significant stressor for most students. By the end of the academic term, the level of situational anxiety had decreased to an average value of 42.3±4.8 points, indicating a gradual adaptation of students to the educational process and new living conditions. Despite the overall decrease in situational anxiety, personality anxiety remained consistently high in 40 % of the participants, with a mean of 52.1±6.1 points, indicating the presence of a stable anxiety state associated with the long adaptation process and the influence of multiple stressors, including learning loads, climatic features, and social differences.

A special questionnaire was used to assess stress tolerance, and the results showed that 55 % of students experienced a high level of stress at the beginning of the semester. The average stress tolerance score was 34.5±4.3, indicating a low ability of students to cope with academic and domestic stresses. These data confirm that adapting to a new environment presents a significant strain on students, especially those who are experiencing study abroad for the first time and have to adjust to new cultural and social

conditions. By the end of the semester, the index had improved to 41.7±3.9, which may indicate a positive influence of adaptation mechanisms and social support from teachers and fellow students, as well as a gradual decrease in stress levels as students became accustomed to the new environment.

Measurements of physiological parameters such as blood pressure, HR, and HRV showed significant changes over the academic semester (Table 2). At the beginning of the semester, 45 % of the students had elevated blood pressure (mean 135/85 mmHg), which is higher than the normal values for this age group (120/80 mmHg). This indicates that stress factors, such as climate change, academic workload, and social adaptation, had a significant impact on the state of the students' cardiovascular systems. By the end of the semester, the mean blood pressure had decreased to 128/82 mmHg, indicating improved adaptation to the stressful conditions of the educational process and stabilization of physiological indicators as students became accustomed to the academic schedule and requirements.

Table 2. Cardiovascular system indicators in students at different stages of adaptation to learning

Research stage	Blood pressure (mmHg)	HR (bpm) (M±SD)	HRV (%) (M±SD)
Beginning of the semester	135/85	82±6	5.2±0.4
End of the semester	128/82	76±5	7.8±0.6

Source: created by the authors.

The heart rate at the beginning of the semester averaged 82 ± 6 beats per minute, which is higher than the norm (60-80 beats per minute) ($p < 0.05$). This elevated rate may be related to the high level of anxiety and stress caused by the unfamiliar learning environment and change in living conditions. By the end of the semester, the index had decreased to 76 ± 5 beats per minute (with a significance level of $p < 0.05$), indicating a decrease in stress levels and an improvement in the general condition of the students. Heart rate variability also showed positive dynamics, with the coefficient of variation increasing from 5.2 % to 7.8 %, indicating an improvement in the adaptive capabilities of the cardiovascular system. The increase in heart rate variability is a crucial indicator, as it reflects the organism's ability to adapt to changing conditions and cope with the effects of stress.

Physiological indices between groups of girls and boys show that such indices as blood pressure and HR also had differences. For example, girls had an average blood pressure of 138/87 mmHg at the beginning of the term, whereas boys had an average blood pressure of 132/83 mmHg. Higher blood pressure in girls may be associated with a greater emotional reaction to stressful situations. By the end of the semester, these indices had decreased to 130/84 mmHg in girls and 126/81 mmHg in boys, indicating a tendency for the cardiovascular system to improve its adaptation process in both girls and boys.

The results of the study showed that in international students, the FRC of the lungs corresponded to the norms established by Indian researchers for this ethnic group (13). There was an ethnically determined decrease in FRC, which was associated with a reduction in expiratory reserve volume with normal

residual lung volumes, as well as lower values of VCL characteristic of this population. Low values of VCL were recorded in 46 % of young men and correlated with their hyposthenic and dolichomorphic body type. Obstructive processes in the lungs were detected in 5.2 % of students, which was confirmed by a decrease in the REV, VCL, forced expiratory volume in the first second (FEV1), blood oxygen saturation (SaO_2), and a significant increase in VCL on exertion. Restrictive changes were observed in 9 % of girls, confirmed by a decrease in TLC, MRV, and alveolar ventilation (AV).

Changes in the functional state of the respiratory system were compensatory and adaptive in 85 % of students, indicating their ability to adapt to new climatic conditions and meet the organism's metabolic needs. However, 51 % of boys had low resistance to hypoxia, compared to 18 % of girls, which is likely due to individual physiological differences and increased stress associated with adapting to new environmental conditions.

Biochemical blood tests revealed that the level of cortisol, a primary marker of stress, was elevated in 50 % of students at the beginning of the semester (Table 3).

The average cortisol level was 580 ± 50 nmol/L, which significantly exceeds the normal range (100-535 nmol/L). This indicates a significant impact of stress factors on the students' organism in the first months of their stay in new conditions. By the end of the academic term, the level of cortisol decreased to 470 ± 45 nmol/L, which may indicate a reduced impact of stress factors and better adaptation to the study and living conditions.

Table 3. Biochemical blood parameters in students at different stages of the study, ($M \pm SD$)

Indicator	Beginning of the semester	End of the semester	Percentage of students with disabilities
Cortisol level (nmol/L)	580 ± 50	470 ± 45	50
Glucose level (mmol/L)	5.9 ± 0.4	5.4 ± 0.3	20

Source: created by the authors.

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The results of the intergroup study revealed a more pronounced decrease in cortisol levels among girls compared to boys. Cortisol levels in girls decreased from 590 ± 55 nmol/L to 460 ± 48 nmol/L, whereas in boys, they decreased from 570 ± 50 nmol/L to 480 ± 46 nmol/L. This may indicate a more effective activation of adaptation mechanisms in girls, despite the initially higher level of anxiety. These results confirm that despite higher levels of anxiety at the beginning of the term, the girls were able to adapt more quickly to the new environment, which was reflected in lower levels of stress hormones. This highlights the importance of considering gender differences when designing support and adjustment programmes for international students.

Blood glucose levels also varied throughout the semester. At the beginning of the study, 20 % of students showed statistically significant elevations in glucose values (mean 5.9 ± 0.4 mmol/L), which may be related to increased stress

levels and dietary changes. Elevated glucose levels are often observed under conditions of stress, as the body secretes more glucocorticoids, increasing blood sugar levels. By the end of the semester, the average glucose level had decreased to 5.4 ± 0.3 mmol/L, indicating stabilization of metabolic processes and an improvement in students' diets as they adapted to new conditions (14).

Assessment of blood glucose levels showed that normalization of this indicator occurred evenly in both boys and girls. This indicates that the improvement of metabolic processes is related not only to sex differences, but also to general adaptive mechanisms such as improved nutrition, physical activity and social interaction. Thus, at the beginning of the term, the mean glucose level in girls was 6.2 ± 0.4 mmol/L and in boys, 6 ± 0.3 mmol/L. By the end of the term, the index had decreased to 5.5 ± 0.3 mmol/L in girls and 5.3 ± 0.2 mmol/L in boys (Table 4).

Table 4. Changes in blood glucose levels in boys and girls (M $\pm$ SD)

Sex	Start of semester (mmol/L)	End of semester (mmol/L)	Percentage of students with disabilities
Girls	6.2 ± 0.4	5.5 ± 0.3	22
Boys	6 ± 0.3	5.3 ± 0.2	18

Source: created by the authors.

Comparative analysis between boys and girls showed that the level of anxiety and physiological parameters of adaptation differed depending on gender (Table 5). Girls had a higher level of situational anxiety than boys at the beginning of the semester (50.3 ± 5.8 vs. 46.1 ± 5.2 points), which may be due to higher emotional sensitivity

to stressors (13). By the end of the semester, girls' anxiety level decreased to 44.1 ± 4.7 points, whereas boys' anxiety level decreased to 40.5 ± 4.9 points, indicating more effective adaptation in boys. This may be due to differences in stress coping strategies and social support.

Table 5. Comparative psychophysiological indicators of boys and girls during their studies at a university (M $\pm$ SD)

Sex	Situational anxiety (scores)	Blood pressure (mmHg)	Heart rate (bpm)	Cortisol level (nmol/L)
Girls	$50.3 \pm 5.8 \rightarrow 44.1 \pm 4.7$	$138/87 \rightarrow 130/84$	$85 \pm 7 \rightarrow 78 \pm 5$	$590 \pm 55 \rightarrow 460 \pm 48$
Boys	$46.1 \pm 5.2 \rightarrow 40.5 \pm 4.9$	$132/83 \rightarrow 126/81$	$80 \pm 6 \rightarrow 74 \pm 5$	$570 \pm 50 \rightarrow 480 \pm 46$

Source: created by the authors.

Correlation analysis showed the presence of significant relationships between the level of

anxiety and physiological indicators of adaptation (Table 6).

Table 6. Correlation dependencies between anxiety indicators and physiological parameters

Parameter 1	Parameter 2	Correlation coefficient (r)
Situational anxiety level	Heart rate	0.65 (p<0.05)
Stress resistance level	Cortisol level	-0.58 (p<0.05)
Blood pressure	Heart rate variability	-0.45 (p<0.05)

Source: created by the authors.

The correlation coefficient between the level of situational anxiety and heart rate was $r=0.65$ ($p<0.05$), indicating a direct correlation between the level of stress and the cardiovascular system's reaction. An increased level of anxiety can cause an increased heart rate, which is the physiological response of the organism to stress. In addition, a negative correlation was found between the level of stress tolerance and cortisol levels ($r=-0.58$, $p<0.05$), confirming the influence of psychological adaptation on biochemical markers of stress.

Comparative analysis of psychophysiological indicators also revealed that the level of anxiety and stress tolerance was strongly dependent on the social support provided to the students. Those students who reported a high degree of social support from classmates and lecturers in the survey results showed lower levels of situational and personality anxiety by the end of the semester. This study highlights the importance of creating a supportive social environment for international students. Social support plays a key role in the enrolment process and helps reduce stress (15). Students who have positive relationships with teachers and peers tend to be more resilient and less anxious.

The results show a significant change in anxiety levels among international students studying at a medical university in Kyrgyzstan, which is associated with improved stress levels (16). At the end of the study, stress responses decreased, and body temperature increased (Table 3). This indicates that students are gradually adapting to

their new learning and living environment. The gender gap in development highlights the need for gender-specific programs that support students' gender identity. This study also highlights the importance of building social networks and a supportive learning environment to improve students' academic performance. Therefore, this investigation demonstrates the value of a comprehensive approach to supporting the adaptation of international students. Providing a positive learning environment and social interaction helps reduce stress levels and increase student motivation (17-19).

In the process of students' adaptation, numerous factors have been identified that influence their psychophysiological state. In particular, factors such as climatic conditions, cultural differences, academic workload, and social isolation play an important role (20,21). As the results of the stress tolerance study showed, students who came from countries with warmer climates were more likely to report acclimatisation problems and sleep disturbances, which in turn had a negative impact on their psychophysiological state and anxiety levels. Given these characteristics, it is recommended that consideration be given to climatic differences and that additional support measures be provided for students from regions with climates that differ significantly from the local conditions.

Cultural differences play a significant role in how international students perceive themselves (22). Students who have difficulty integrating into a new culture tend to have higher

levels of anxiety and less ability to cope with challenges (23,24). This is especially true for students who have a language barrier and limited opportunities to interact with native speakers. In such circumstances, it is important to create an environment that encourages intercultural communication and organise activities that promote understanding and acceptance of cultural differences, as well as a welcoming atmosphere and a sense of belonging (25). This includes organising cultural events, providing support to student advisors, and using other measures to facilitate cultural exchange.

The results bring attention to the need to develop support programs for international students aimed at improving their adaptation to the learning process and living conditions. In particular, it is important to arrange stress management courses, provide psychological support, and conduct regular medical examinations to monitor physiological indicators. These interventions not only improve students' overall performance but also lead to improved academic achievement and a sense of belonging. Individual counselling, group stress management, meditation, and mental health programs aimed at improving students' mood and reducing stress provide psychological support. International students require a variety of support from organisations, including mental health professionals, social workers, and medical professionals, to adjust to their new schools and homes. Because students' levels of anxiety, their ability to cope with difficulties, and their cultural and environmental contexts vary, it is important to ensure that all students feel safe and comfortable in their schools and communities. This helps students better cope with stress, which in turn leads to improved academic achievement and self-esteem.

DISCUSSION

The findings indicate that international students enrolled in medical universities in the Kyrgyz Republic undergo substantial alterations in psychophysiological indicators during their adaptation to new living and educational environments. These changes impact both the psycho-emotional state and physiological factors, underscoring the necessity for a holistic and

interdisciplinary strategy to assist students during their readjustment.

One of the key indicators identified in the study was the high level of situational anxiety registered in 60 % of students at the beginning of the academic term. Using the Spielberger-Hanin scale showed that the average value of situational anxiety level was 48.2 ± 5.6 points, which exceeds the norm for this age group (30-45 points). This comparison enables us to confirm the significance of the identified results and their applicability in the context of international student adaptation. Zhao and Xue (26) also noted a high level of anxiety in international students who first entered a new cultural and learning environment. Specifically, by the end of the semester, the level of situational anxiety had decreased to 42.3 ± 4.8 points, indicating that students were gradually adapting to the new environment. A study by Dai and Hardy (27), who studied coping mechanisms of international students at a medical university in Europe, found similar results. Forty percent of the students reported high levels of anxiety, with a mean score of 52.1 ± 6.1 . This indicates persistent anxiety associated with strong control processes. According to Shroff et al. (28), anxiety among international students decreased as they became accustomed to the new environment, especially during interactions. This study also supports the importance of psychological interventions, such as stress management programs and individual counselling, in reducing persistent anxiety.

Students' stress tolerance was assessed using a special questionnaire, and 55 % of the study participants showed high levels of stress at the beginning of the academic term. The stress tolerance score was 34.5 ± 4.3 , indicating that students were unable to cope with academic and family problems. Similar results were obtained in the studies of Bai et al. (29) and Antoniou et al. (30). International students showed difficulties in adapting to the new country in the first months, as confirmed by Lopez-Gil et al. (31). This score increased to 41.7 ± 3.9 at the end of the season, as confirmed by Fuady et al. (32). This comparison demonstrates that social support is an important factor in the adaptation process of students. Physiological parameters such as blood pressure and heart rate change significantly during the transition. At the beginning of the academic year, 45 %

of students had systolic blood pressure (mean value 135/85 mmHg) higher than the normal level for their age (120/80 mmHg). These results support the findings of Yilmaz et al. (33) and Beltrán-Velasco et al. (34), who demonstrated the effects of stressors on the cardiovascular system of international students. On the other hand, Yu et al. (35) did not find a significant decrease in blood pressure during transplantation, suggesting that these symptoms are related to the human heart. However, in this study, a clearer trend of blood pressure reduction was noted by the end of the semester to 128/82 mmHg, indicating stabilisation of physiological indices as adaptation progresses, which also allows for more accurate conclusions about the positive impact of adaptation mechanisms.

HR at the beginning of the semester averaged 82 ± 6 beats per minute, which is higher than normal (60-80 beats per minute). This elevated rate is probably related to high levels of anxiety and stress. Similar results were obtained in the studies of Cemalcilar and Falbo (36) and Vergeles (37), where an increase in HR was also observed in students under stressful conditions. By the end of the semester, HR decreased to 76 ± 5 beats per minute, indicating an improvement in the organism's adaptive capabilities.

A key stress indicator, cortisol levels, also showed a positive trend. At the beginning of the semester, 50 % of students had the highest serum cortisol concentrations (mean 580 ± 50 nmol/L). This confirms that stress significantly affects their well-being. This comparison demonstrates that the observed upward trends among international students are similar to those found in other studies and confirms the generality of the observed pattern, which is consistent with the findings of Ma et al. (38) and Brisset et al. (39), highlighting the significance of the results obtained. By the end of the semester, cortisol levels had decreased to 470 ± 45 nmol/L, indicating improved adaptation with reduced stress. Cortisol levels are an important indicator of how the body responds to stress. As noted by Wang et al. (40), lower cortisol levels indicate the effectiveness of stress management strategies. This comparison suggests that lower cortisol levels are a key indicator of successful adaptation, which is consistent with previous research findings and supports some of the identified coping strategies.

Gender differences were another important variable in this study. At the beginning of the semester, girls had higher anxiety levels (50.3 ± 5.8 points), which may be related to a greater awareness of their stress responses (41). This finding is consistent with Alam et al. (42), who found that girls were more sensitive to stress. By the end of the semester, girls' anxiety decreased but remained higher than boys', suggesting that gender-specific support may also play a role, as found in the study by Jiang et al. (43). This highlights the importance of developing gender-inclusive programs to help students develop positive self-efficacy. Blood pressure measurements also showed differences. At the beginning of the semester, girls' blood pressure (138/87 mmHg) was higher than boys' (132/83 mmHg), which may impact their mental health (40). Lai et al. (44) showed that girls tended to exhibit more symptoms during a traumatic event. Values decreased by the end of the semester, indicating stable and corrected weight gain.

Correlation analysis revealed a significant relationship between anxiety levels and physiological indicators. The correlation coefficient between situational anxiety levels and heart rate was $r=0.65$ ($p<0.05$), indicating a direct relationship between stress levels and cardiovascular responses. Similar results were obtained by Török et al. (45) and Zhu et al. (46), which emphasised the importance of stress management to improve students' physical health. Thus, the results of this study confirm the importance of psychophysiological changes in the adaptation process of international students. These results are consistent with the results of many studies, such as those by Lopez-Gil et al. (31) and Alam et al. (42), which emphasise the need for a comprehensive approach to supporting international students. In particular, it is important to provide appropriate stress management and psychological support programs, considering gender differences and levels of social support. In addition, creating a supportive learning and social environment can significantly reduce stress levels and increase students' resilience, positively affecting their academic success and overall health.

CONCLUSIONS

International students studying at medical universities of the Kyrgyz Republic experience significant changes in psychophysiological indicators during the adaptation process to new living and study conditions. The study showed that international students in these universities undergo significant changes in psychophysiological indicators due to adaptation to new living and study conditions. The main factors affecting their condition include altitude hypoxia, climatic peculiarities, social isolation, and study loads. This stress, which was initially perceived as a serious challenge related to cross-cultural adaptation, was reflected in psychological and physiological indicators measured throughout the semester.

At the beginning of the semester, 60 % of students reported high levels of situational anxiety, while 55 % reported low levels of stress resilience. By the end of the semester, situational anxiety had decreased to 42.3 points, and their stress resilience had increased to 41.7 points. However, subjective anxiety remained elevated in 40 % of students, with a mean score of 52.1 points. Changes in physiological parameters, such as blood pressure and heart rate, indicated increased adaptive processes. During the training, blood pressure decreased from 135/85 mm Hg to 128/82 mm Hg, and heart rate decreased from 82 to 76 beats per minute. These results are consistent with interactive models of stress management, suggesting that increased resilience is reflected in reduced stress levels and physiological responses.

The ethnically determined decrease in functional residual lung capacity correlates with decreased reserve expiratory volume with normal residual lung volume and, consequently, decreased normal vital capacity values specific to this population. The level of the main stress marker, cortisol, was elevated in 50 % of students at the beginning of the term, and the value of which was reduced by the end of the term, from 580 to 470 nmol/L. Blood glucose level was elevated in 20 % of students at the beginning of the study (mean value 5.9 ± 0.4 mmol/L), which may be due to increased stress levels and dietary changes. By the end of the semester, the mean

value of glucose level decreased to 5.4 ± 0.3 mmol/L, indicating stabilisation of metabolic processes and improvement of students' diets as they adapted to new conditions.

Correlation analysis revealed a statistically significant positive correlation ($r=0.65$) between anxiety levels and physiological measures of stress coping, such as blood pressure, heart rate, and heart rate variability. An inverse relationship was also found between stress tolerance levels and cortisol levels ($r=-0.58$), confirming the influence of psychological stress coping on biochemical measures of stress. These results demonstrate relatively stable personality traits over time, supporting the aim of this study – to examine the interaction between cognitive, affective and emotional responses and physiological coping in the context of cross-cultural academic stress, outlined by the interactional model of stress and coping.

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