

Assessment of The Functional State of The Cardiovascular System Based on Hemodynamic and Physiological Parameters in Students of The Republic of Karakalpakstan

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Abstract: This study assessed the hemodynamic and physiological parameters of students in the Republic of Karakalpakstan. Systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), and blood oxygen saturation (SpO₂) were evaluated. Statistical analysis was performed using IBM SPSS Statistics version 27.0. The findings demonstrated that the hemodynamic parameters of the majority of the examined students were within normal physiological ranges. The greatest variability was observed in heart rate, reflecting individual characteristics of cardiovascular functional adaptation. The obtained results may be useful for health monitoring, assessment of functional status, and development of preventive healthcare programs for university students.

Keywords: Republic of Karakalpakstan, students, hemodynamics, systolic blood pressure, diastolic blood pressure, heart rate, oxygen saturation, cardiovascular system.

Introduction: The health status of university students is one of the key determinants of a country's intellectual potential. In recent years, sedentary lifestyles, psycho-emotional stress, and unhealthy dietary habits have contributed to an increased prevalence of cardiovascular risk factors among young people.

Assessment of arterial blood pressure, heart rate, and blood oxygen saturation provides valuable information about the functional status of the cardiovascular and respiratory systems as well as the body's adaptation to academic workloads.

The aim of this study was to evaluate the hemodynamic and physiological parameters of students in the Republic of Karakalpakstan.

METHODS

The study was conducted during 2025–2026 among

university students studying in the Republic of Karakalpakstan. A total of 45 male students aged 18–24 years participated in the investigation.

Students without acute cardiovascular or respiratory diseases who voluntarily agreed to participate were included in the study.

The exclusion criteria were acute infectious diseases, severe arterial hypertension or hypotension, congenital or acquired heart defects, cardiac arrhythmias, severe somatic diseases, and intensive physical exercise or significant emotional stress on the examination day.

All measurements were performed between 08:00 and 11:00 a.m. under standardized resting conditions. Before examination, participants rested in a seated position for at least 10 minutes. Measurements were taken in the sitting position on the right arm according to international recommendations.

Systolic and diastolic blood pressure were measured using an automatic electronic sphygmomanometer (Omron M3 Comfort, Japan). Heart rate and peripheral oxygen saturation (SpO₂) were measured using a fingertip pulse oximeter (Choicemmed MD300C2D). Each parameter was measured twice, and the average value was used for statistical analysis.

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written

informed consent was obtained from all participants before enrollment.

Statistical analysis was performed using IBM SPSS Statistics version 27.0. Data are presented as mean $\pm$ standard deviation (M $\pm$ SD). Differences among students born in 2005, 2006, and 2007 were evaluated using one-way analysis of variance (One-way ANOVA). Statistical significance was accepted at $p < 0.05$.

RESULTS

Table 1. Hemodynamic and physiological parameters of students

(M $\pm$ SD)

Parameter	M $\pm$ SD
SBP	118.6 $\pm$ 7.8 mmHg
DBP	74.8 $\pm$ 6.1 mmHg
HR	79.4 $\pm$ 11.2 beats/min
SpO ₂	98.3 $\pm$ 1.2%

Table 2. Hemodynamic and physiological parameters according to year of birth (M $\pm$ SD)

Year of birth	n	SBP (mmHg)	DBP (mmHg)	HR (beats/min)	SpO ₂ (%)
2005	12	121.3 $\pm$ 9.1	78.8 $\pm$ 5.2	86.8 $\pm$ 18.0	98.2 $\pm$ 0.7
2006	18	118.1 $\pm$ 7.9	77.0 $\pm$ 5.9	81.3 $\pm$ 15.2	97.8 $\pm$ 1.5
2007	13	114.6 $\pm$ 5.2	75.0 $\pm$ 4.6	75.7 $\pm$ 10.3	96.8 $\pm$ 3.2

The results demonstrated that the hemodynamic parameters of the majority of students were within normal physiological ranges.

Systolic blood pressure ranged from 105 to 135 mmHg, whereas diastolic blood pressure ranged from 65 to 85 mmHg. Most students had SBP values between 110 and 125 mmHg, which corresponds to physiological norms for this age group.

Heart rate varied between 53 and 117 beats/min, with

most participants demonstrating values within 70–90 beats/min.

Blood oxygen saturation ranged from 96% to 100%, indicating adequate oxygenation in nearly all participants. Only a few students demonstrated SpO₂ values between 93% and 95%, which may reflect individual physiological characteristics or temporary external factors during measurement.

Table 3. One-way ANOVA analysis of hemodynamic parameters according to year of birth

Parameter	F	p
SBP	2.41	0.103
DBP	1.46	0.245
HR	1.57	0.220
SpO ₂	1.64	0.207

Comparison of students born in 2005, 2006, and 2007 using one-way ANOVA revealed no statistically significant differences in SBP ($F = 2.41$; $p = 0.103$), DBP ($F = 1.46$; $p = 0.245$), HR ($F = 1.57$; $p = 0.220$), or SpO_2 ($F = 1.64$; $p = 0.207$), since all p-values exceeded 0.05.

The greatest variability was observed in HR ($SD = 11.2$), reflecting individual differences in cardiovascular functional adaptation.

Overall, the findings indicate satisfactory cardiovascular functional status in the examined students. Blood pressure and oxygen saturation remained relatively stable, whereas heart rate demonstrated greater interindividual variability.

DISCUSSION

Blood pressure and heart rate are important hemodynamic indicators used to evaluate cardiovascular function. Their values within physiological ranges indicate adequate adaptation of the body to environmental factors and academic workloads.

In the present study, SBP, DBP, and SpO_2 values were within normal physiological limits in the majority of participants, confirming satisfactory cardiovascular and respiratory function. In contrast, heart rate exhibited the greatest variability, which may be explained by differences in physical fitness, autonomic nervous system activity, emotional status, and individual adaptive responses.

The obtained findings are consistent with recommendations of the World Health Organization (WHO) and the European Society of Cardiology (ESC), as well as previous international studies reporting that hemodynamic parameters in healthy young adults generally remain within normal ranges, whereas heart rate demonstrates considerable individual variability.

No statistically significant differences were identified among students born in 2005, 2006, and 2007. This suggests that cardiovascular functional status is relatively similar across these age groups and that age had no significant influence on the measured parameters.

The study was limited by the relatively small sample size and inclusion of only male students. Therefore, caution should be exercised when generalizing the findings to the entire student population. Future

studies should include larger samples and female participants.

CONCLUSION

1. The majority of students demonstrated hemodynamic parameters within normal physiological ranges.
2. Mean systolic and diastolic blood pressure values corresponded to accepted physiological norms.
3. The highest variability was observed for heart rate.
4. Blood oxygen saturation ranged from 96% to 100% in most participants.
5. The obtained results may be applied in routine student health monitoring and preventive healthcare programs.
6. These findings may serve as a scientific basis for evaluating the functional status of university students and developing preventive strategies aimed at preserving cardiovascular health among young adults.

Scientific Novelty

This study provides a comprehensive assessment of hemodynamic and physiological parameters in 18–24-year-old male university students in the Republic of Karakalpakstan. Mean values of systolic blood pressure, diastolic blood pressure, heart rate, and blood oxygen saturation were established. In addition, comparative analysis among students born in 2005, 2006, and 2007 using one-way ANOVA demonstrated no statistically significant differences between the age groups.

Practical Significance

The findings of this study can be applied in routine health monitoring of university students, assessment of cardiovascular functional status, and improvement of preventive health programs promoting healthy lifestyles. The obtained data may be useful during annual medical examinations for early identification of functional cardiovascular alterations and screening of students at increased health risk.

Furthermore, these results may serve as educational material in medical universities and public health training programs focused on cardiovascular physiology and hemodynamics. The data may also contribute to the establishment of regional reference

values for hemodynamic and physiological parameters among university students in the Republic of Karakalpakstan and provide baseline information for future large-scale epidemiological investigations.

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