



**COMPARATIVE STUDY OF HEMODYNAMIC AND PHYSIOLOGICAL  
HEALTH INDICATORS AMONG STUDENTS LIVING IN DIFFERENT  
ECOLOGICAL REGIONS OF KARAKALPAKSTAN**

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**Abstract:** *The health status of students is strongly influenced by environmental, climatic, and socio-economic conditions. Karakalpakstan, located in the northwestern part of Uzbekistan, is characterized by ecological diversity and environmental challenges, particularly in areas affected by the Aral Sea crisis. This study examines the hemodynamic and physiological health indicators of students living in different ecological regions of Karakalpakstan. The purpose of the study was to identify differences in cardiovascular and physiological parameters among students from environmentally favorable and unfavorable areas. Hemodynamic indicators such as systolic blood pressure, diastolic blood pressure, heart rate, and pulse pressure were analyzed alongside physiological indicators including respiratory rate, body mass index, and physical endurance. The study involved university students aged 18–23 years from several districts of Karakalpakstan. Comparative analysis demonstrated that students from ecologically unfavorable regions showed higher levels of cardiovascular stress, elevated heart rate, and reduced adaptive capacity compared to students from relatively favorable regions. Environmental pollution, dust-salt aerosols, poor water quality, and climatic factors may contribute to these physiological differences. The findings emphasize the importance of monitoring student health and implementing preventive healthcare strategies in ecologically vulnerable regions. The study contributes to understanding the relationship between environmental conditions and human physiological adaptation in Karakalpakstan.*

**Keywords:** *Hemodynamics; physiological indicators; students' health; Karakalpakstan; ecological regions; cardiovascular system; environmental health; adaptation; Aral Sea crisis; blood pressure.*

Human health is closely associated with environmental conditions and lifestyle factors. In recent decades, environmental degradation has become one of the major public health concerns worldwide. Ecological problems can significantly influence the functional state

of the cardiovascular, respiratory, and nervous systems, particularly among young people whose bodies are still adapting to social and environmental stressors. Students represent an important population group because academic pressure, changes in lifestyle, and



environmental exposure can affect their physiological well-being and overall health status. Karakalpakstan is one of the regions most affected by ecological problems in Central Asia due to the desiccation of the Aral Sea. The drying of the sea has caused climate changes, increased soil salinity, air pollution, and the spread of toxic dust and salt particles across nearby territories. These environmental conditions negatively influence the health of the local population and may contribute to chronic diseases, cardiovascular disorders, respiratory problems, and decreased physiological adaptation. Residents living in ecologically unfavorable areas are exposed to higher levels of environmental stress compared to those living in relatively favorable regions. Hemodynamic indicators such as blood pressure, pulse rate, and cardiac function are considered important markers of the body's adaptive response to environmental and psychological stress. Physiological parameters including respiratory function, body mass index, and endurance capacity also provide valuable information about the general health condition of individuals. Monitoring these indicators among students living in different ecological zones can help identify early signs of functional disturbances and health risks. The purpose of this study is to compare hemodynamic and physiological health indicators among students living in different ecological regions of Karakalpakstan. The study aims to

evaluate the influence of environmental conditions on cardiovascular and physiological adaptation in young adults. Understanding these relationships may contribute to the development of preventive healthcare measures and strategies for improving student health in ecologically challenged regions.

The ecological situation in Karakalpakstan has attracted considerable scientific attention due to its long-term effects on public health. The Aral Sea environmental disaster has altered climatic conditions and increased environmental pollution throughout the region. Salt storms, contaminated water sources, and poor air quality are among the major environmental factors affecting the population. Young people living in these areas may experience physiological stress that influences their cardiovascular and respiratory systems. The present study focused on university students aged between 18 and 23 years who permanently reside in different ecological regions of Karakalpakstan. Students from relatively favorable ecological areas and environmentally unfavorable areas participated in the research. The comparison of these groups allowed the assessment of environmental influences on physiological adaptation and hemodynamic functioning.

Hemodynamic parameters were measured using standard clinical methods. Systolic blood pressure, diastolic blood pressure, heart rate, and pulse pressure were recorded under resting conditions. These indicators



provide important information about cardiovascular function and adaptive mechanisms. Elevated blood pressure and increased heart rate are commonly associated with stress, environmental exposure, and reduced cardiovascular adaptation. The results demonstrated noticeable differences between students from different ecological zones. Students living in environmentally unfavorable regions showed higher average systolic and diastolic blood pressure values compared to students from favorable areas. Increased blood pressure may indicate chronic stress on the cardiovascular system caused by environmental and climatic factors. In addition, heart rate values were higher among students from ecologically affected regions, suggesting greater physiological tension and reduced adaptive reserves.[1]

Respiratory indicators were also evaluated in the study. Respiratory rate and functional respiratory capacity are important measures of physiological health. Students from unfavorable ecological regions demonstrated slightly elevated respiratory rates, which may be related to poor air quality and exposure to airborne pollutants. Dust and salt particles originating from the dried Aral Sea bed can negatively affect respiratory function and contribute to chronic irritation of the respiratory tract.[2] Body mass index (BMI) was another parameter included in the assessment. BMI is widely used to evaluate nutritional status and general health condition. Although most students

had BMI values within the normal range, slight variations were observed between ecological groups. Nutritional factors, socioeconomic conditions, and lifestyle differences may contribute to these findings. Students from rural and ecologically affected areas may experience limited access to balanced nutrition and healthcare services. Physical endurance and adaptive capacity were also examined through functional tests. Students from favorable ecological regions generally demonstrated better endurance and faster recovery after physical activity. In contrast, students from environmentally unfavorable areas showed signs of reduced physical performance and slower recovery rates. These differences suggest that ecological stress can influence the functional reserves of the body and reduce tolerance to physical нагрузка.

Environmental conditions play a crucial role in shaping physiological adaptation. Continuous exposure to adverse ecological factors may activate stress-response mechanisms in the body. Long-term activation of these mechanisms can eventually lead to functional disturbances in the cardiovascular and respiratory systems. Young adults living in ecologically challenged territories may therefore be at increased risk of developing chronic health problems later in life.[3]

Another important factor influencing student health is psychological stress. Academic workload, social adaptation, and economic



difficulties can affect hemodynamic parameters. Students from environmentally unfavorable regions may experience additional emotional stress associated with poor living conditions and health concerns. The combined effect of environmental and psychological stressors can negatively influence autonomic regulation and cardiovascular stability. The findings of this study are consistent with previous research conducted in environmentally affected regions. Many studies have reported increased cardiovascular risk factors and reduced physiological adaptation among populations exposed to ecological pollution. Monitoring hemodynamic and physiological indicators is therefore important for early diagnosis and prevention of health disorders among students. Preventive measures should include regular medical examinations, promotion of healthy lifestyles, balanced nutrition, and physical activity programs. Universities and healthcare institutions should collaborate to improve health monitoring systems for students living in ecologically vulnerable regions. Environmental protection programs and improved public health policies are also necessary to reduce the long-term impact of ecological problems on human health. Overall, the study confirms that environmental conditions significantly influence physiological and hemodynamic health indicators among students in Karakalpakstan. Differences observed between ecological regions highlight the importance of considering

environmental factors in public health research and preventive medicine.

The present study investigated the hemodynamic and physiological health indicators of students living in different ecological regions of Karakalpakstan. The findings demonstrate that environmental conditions have a significant influence on the functional state of the cardiovascular and respiratory systems of young adults. Students residing in environmentally unfavorable regions showed higher blood pressure levels, increased heart rate, reduced physical endurance, and signs of decreased adaptive capacity compared to students from relatively favorable ecological areas. The ecological crisis associated with the drying of the Aral Sea continues to affect the health and quality of life of the population in Karakalpakstan. Environmental pollution, poor air quality, salt-dust storms, and limited access to clean water create chronic stress conditions that may negatively influence physiological adaptation. Young people living in these regions are particularly vulnerable because their bodies are exposed to both environmental and academic stressors. Hemodynamic indicators such as systolic and diastolic blood pressure, pulse rate, and respiratory parameters provide valuable information about the adaptive mechanisms of the human body. The observed changes in these indicators among students from unfavorable ecological regions suggest increased functional tension and possible early



manifestations of cardiovascular and respiratory dysfunction. Continuous monitoring of these parameters is important for identifying health risks at an early stage.

The study also emphasizes the importance of preventive healthcare measures in educational institutions. Regular medical screening, health education, promotion of physical activity, and balanced nutrition can help improve students' adaptive capacity and overall health. Psychological support programs may also reduce stress-related physiological disturbances among students. In conclusion, ecological factors

play an essential role in shaping the health status of students in Karakalpakstan. The results of this study highlight the need for interdisciplinary approaches combining environmental science, physiology, and public health to address the long-term consequences of ecological degradation. Further research involving larger populations and additional physiological markers is recommended to better understand the mechanisms of adaptation and develop effective health protection strategies for young people living in environmentally challenged regions.

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