SEASONAL CLIMATE CHANGES AND THEIR IMPACT ON FEMALE STUDENTS' IMMUNITY: RELATIONSHIP WITH THE CONCEPT OF SUSTAINABLE DEVELOPMENT

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Abstract

This study explores the impact of seasonal climate changes on the immunity of female students, highlighting the intricate relationship between environmental factors and health. Seasonal fluctuations, including temperature variations, humidity levels, and air quality changes, can significantly influence immune system responses. The research examines how these climatic factors affect the health and academic performance of female students, particularly in terms of increased susceptibility to illnesses during certain seasons. Moreover, the study emphasizes the importance of sustainable development in addressing these challenges. By promoting environmentally friendly practices and raising awareness about the impact of climate change on health, educational institutions can create supportive environments that enhance student resilience and well-being. The findings underscore the necessity of implementing health education programs focused on nutrition, physical activity, and stress management tailored to seasonal variations. Ultimately, this research advocates for a holistic approach that integrates health promotion with sustainable development strategies, aiming to improve the quality of life for female students in the context of a changing climate. The work is devoted to the study of the state of the health coefficient of female students in different seasons of the year. The conducted studies show that statistically significant changes in the blood pressure and health coefficient of girls are subject to seasonal changes. Thus, the level of SBP in girls increased to 127.5 mm Hg in winter, and was 113.4 in summer. The value of diastolic pressure in winter increased to 81.2 mm Hg, and the initial value was 74.5. The value of the health coefficient is maximum in winter - 1.83 and minimum in summer - 1.59. The heart rate in winter increased to 81.4 beats per minute, and in the control girls it was 77.2.

Keywords: Seasonal climate changes, season of the year, body weight, heart rate, blood pressure, health coefficient

I. Introduction

Seasonal climate changes have profound effects on various aspects of human health, including the immune system's functionality. For female students, who often juggle academic responsibilities, social engagements, and personal challenges, these seasonal fluctuations can pose significant health risks. Research indicates that variations in temperature, humidity, and air quality can lead to increased susceptibility to infections, allergies, and stress-related illnesses, all of which may adversely impact academic performance and overall well-being.

In recent years, the connection between environmental factors and health has gained increased attention, particularly in the context of sustainable development. The concept of sustainable development emphasizes the need for environmentally conscious practices that not only protect natural ecosystems but also promote the health and well-being of communities. As the climate continues to change, it becomes imperative to understand how these alterations affect specific populations, particularly vulnerable groups such as students.

This study aims to explore the intricate relationship between seasonal climate changes and the immunity of female students. It seeks to identify the specific ways in which environmental factors influence their health and to emphasize the importance of integrating health education and sustainable practices into academic settings. By understanding these dynamics, educational institutions can develop effective strategies to enhance the resilience and well-being of female students, ensuring they thrive academically and personally despite the challenges posed by a changing climate.

Considering that the health of an organism is determined by its adaptive capabilities, health is the process of adaptation of an organism to the environment [1]. A prerequisite for the successful functioning of the body is the assimilation of the rhythm set by nature. Due to the high level of coherence of cells, tissues, organs and body systems, the human body is often compared to a symphony orchestra. Biological rhythms caused by the rotation of the Earth around the Sun play an important role in the lives of humans and animals. Seasonal rhythms are considered to be seasons of the year that have different climatic conditions.

Rhythms with an annual period are the vegetation cover of the Earth, the migration of birds, the winter hibernation of animals and the activity of the reproductive system. The change of seasons is caused by the cycle of the year. The length of daylight causes the seasonal cycles of the plant and animal world.

The rhythmicity of biological processes is an inseparable property of living matter. The vital activity of plant and animal organisms occurs in rhythmically changing environmental conditions.

The process of adaptation to seasonal conditions of flora and fauna is aimed at creating optimal conditions for their vital activity. Various natural factors that affect a person and to which he adapts determine his health, well-being, activity, etc. Affecting all organs and systems of the human body, seasonal biorhythms change its performance and health. Accordingly, due to the adaptation of organisms to changing living conditions, biorhythms determine their survival. Different climate zones are characterized by different weather conditions. The reflection of various physiological processes in the human body occurs due to the presence of more than 100 biological rhythms.

Thanks to the biological clock, various rhythms of physiological processes are established. The complex of periodic changes called biorhythm is an amazing feature of the human body. Thus, biorhythm is a periodic change in the activity of the body's functional processes. The individual characteristics of the human body and the effectiveness of its mechanisms of adaptation to seasonal conditions determine its ability to withstand the impact of environmental factors.

The seasonal rhythms of each region are based on its climate. Thus, the features of the winter season of the year are an increase in the basal metabolism and fat metabolism, an increase in lung ventilation and irritability of the sympathetic branch of the autonomic nervous system.

In the summer season, the direction of changes occurring in the body is opposite.

Ukhtomsky A.A. believes that the time it takes for biological rhythms to be assimilated is individual for each person. Alternating increases and decreases in functional activity is more effective and economical than maintaining an average intensity for each organism. Achieving the highest possible human efficiency is only possible during the period of maximum activity.

The functional activity of the human body systems is high in the summer and low in the winter. The fact that a person works all year round requires him to maintain high activity of the body systems in the winter season.

Changes in biorhythms are a strong stress even for healthy people. In this connection, stimulation of the process of adaptation to living conditions must be carried out taking into

account the peculiarities of human biorhythms. If a person stops following the call of nature, then disturbances from the biorhythm system occur in a short time.

Currently, the interest of doctors and physiologists in seasonal changes has grown significantly [21, 15, 22]. The study of biological rhythms allows us to determine the state of physiological functions, adaptive reserves and the body's immune system.

In recent years, much attention has been paid to the practical use of biorhythms.

The importance of studies devoted to seasonal changes is that in order to assess the normal indicators of body systems, it is necessary to take into account their seasonal characteristics.

Thus, the basis of treatment for many diseases is the restoration of the normal rhythm of the heart, lungs, stomach, intestines and central nervous system.

Taking into account the characteristics of circadian rhythms, the accuracy of diagnosis and the effectiveness of therapeutic interventions will be higher.

The body's mastery of the laws of biological rhythms allows it to maintain high performance and health.

Therefore, research aimed at determining the state of health coefficient of female students is relevant.

II. Methods

The research was conducted in the laboratories of the Department of Physiology and Anatomy of Humans and Animals. The respondents of the research were 35 clinically healthy female students of the biology and chemistry faculty of the full-time form of study. The summer season indicators were considered as control. The readings were made in a state of rest in the middle month of each season. The calculation of the health coefficient was made according to the formula:

KZ = 0.01 × HR + 0.01 SBP + 0.008 DBP + 0.014 V + 0.009 MT + 0.004 Sex (m-1, f-2) - 0.009 P - 0.273

where:

HR – heart rate in beats per minute;

SBP and DBP – systolic and diastolic blood pressure in mmHg;

A – age in years;

BM – body weight in kg;

H – height in centimeters

To determine the heart rate, systolic blood pressure and diastolic blood pressure, an automatic tonometer OMRON was used M 3 Expert.

For statistical processing of the research results, the Biostatistics program was used, and for comparison of the average indicators of the groups, the Student's criterion was used.

Seasonal features of anthropometric indicators are given in Table 1 and Figure 1.

Table 1: The influence of the season on the physical development of girls

Season of the year	Indicators		
	Height in cm	Weight in kg	Age in years
Summer	162.6 ± 2.95	61.1 ± 1.20	18.9 ± 0.13
Autumn	165.0 ± 2.49	62.5 ± 0.97	19.2 ± 0.15
Winter	166.1 ± 2.81	64.1 ± 1.08	19.5 ± 0.16
Spring	162.8 ± 2.91	61.3 ± 1.28	19.8 ± 0.22

There are no reliable changes in the height and weight of girls by seasons, however, their level is higher in winter and lower in summer. Thus, the body length higher in winter by 3.5 cm compared to the summer level.

The increase in body weight in the group in winter was 3.0 kg compared to the initial value. The difference in age between the mean values of the groups was 0.9 years.

Other researchers have also come to similar results in their studies. Thus, body weight increases by up to 5% in autumn and winter [5]. Throughout the year, body weight is at its maximum in winter and minimum in summer, which is explained by high physical activity in summer and low in winter [8]. The increase in body weight of each person in autumn and winter conditions ranges from 2 to 5 kg, which occurs due to the reduction in daylight hours, leading to overeating, as well as a slowdown in the metabolic process [9]. In studies conducted by Japanese scientists on elementary school children, it was found that their weight increases in autumn and winter and decreases in summer [3].

According to the results of research by American scientists, it has been established that the growth rate of children is higher in the autumn-winter season of the year, compared to the level of spring-summer [7]. Factors such as the accumulation of fatty tissue, changes in diet, reduction in the duration of daylight hours, a decrease in ambient temperature and increased stress cause an increase in body weight in the autumn and winter [5].

IV. Discussion

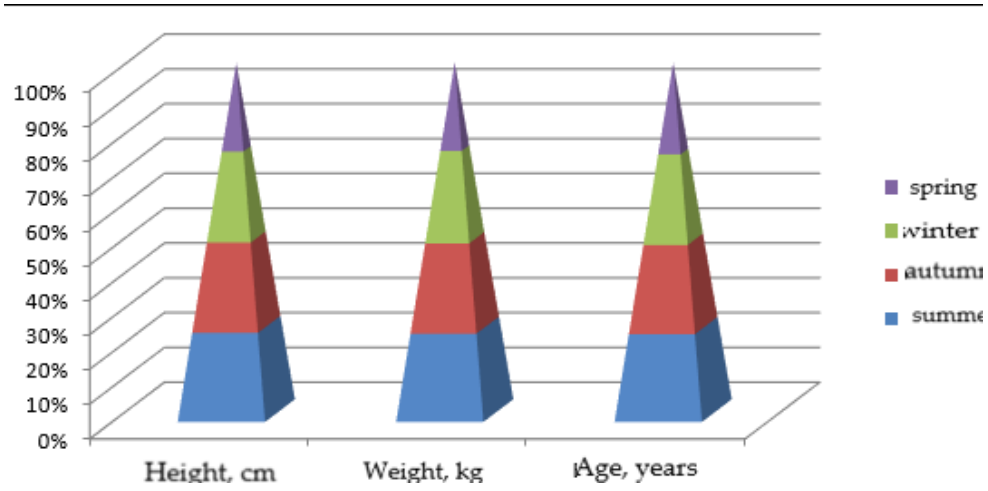

Figure 1: *Seasonal features of anthropometric indicators of girls*

The reasons for changes in body weight by season are activity and nutrition [4] . For example, an increase in physical activity and energy use in the summer reduces body weight, while a decrease in the winter, on the contrary, increases it [4]. In autumn and winter, the production of the hormone melatonin by the pineal gland increases, which increases drowsiness and appetite [4].

Scientists claim that the greatest growth rate of schoolchildren occurs in the first half of the year [3]. Scientists believe that cold climates contribute to increased height and weight, and that large bodies are better able to tolerate low ambient temperatures [10].

Table 2: *Seasonal features of some indicators of the cardiovascular system and health coefficient of girls*

	Indicators			
Season of the year	Heart rate in beats per minute	SBP in mmHg	DBP in mmHg	Health coefficient
Summer	77.2±1.61	113.4±2.28	74.5±1.56	1.59±0.053
Autumn	80.0±1.69	119.2±2.77	77.9±1.62	1.70±0.062
Winter	81.4±1.88	127.5±2.84***	81.2±1.78**	1.83±0.066**
Spring	80.3±1.58	120.5±1.96*	80.1±1.57*	1.75±0.042*

* – P < 0.05; ** – P < 0.02; *** – P < 0.01

Some indicators of the cardiovascular system and the health coefficient of girls in different seasons of the year are given in Table 2 and Figure 2. It follows from them that the season of the year has a statistically significant effect on SBP, DBP and the health coefficient.

Thus, the level of systolic blood pressure in girls in the winter and spring seasons of the year is higher by 14.1 ($P < 0.01$) and 7.1 mm Hg ($P < 0.05$) relative to the value in the summer period of the year.

The diastolic blood pressure value of girls in winter and spring increased by 6.7 ($P < 0.02$) and 5.6 mmHg ($P < 0.05$) compared to the level of control girls. The heart rate of girls in winter is 4.2 beats per minute faster compared to the value of girls in the control group. Our results are confirmed by other scientists. Thus, blood pressure is subject to seasonal changes [26, 17]. According to a number of authors, its value is higher in winter than in summer [90, 13, 69, 16, 18].

According to K.J. Radke and J.L. Jr. Izzo [24], the heart rate increases by 5% in winter.

Apparently, high levels of adrenaline and noradrenaline in the blood in winter increase heart rate, systolic blood pressure and diastolic blood pressure, while low levels in summer decrease them.

Our findings are confirmed by other authors. Thus, from the analysis of the results of studies by various authors, it can be concluded that the causes of seasonal fluctuations in HR, SBP and DBP are seasonal changes in the production of catecholamine hormones, temperature and day length [14, 23, 25, 27].

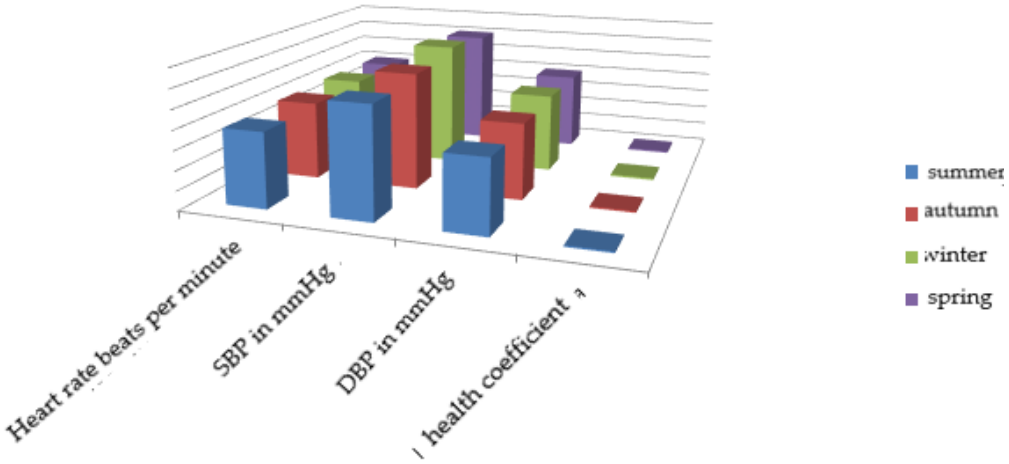

Figure 2: *The influence of the season on the level of heart rate, systolic blood pressure, diastolic blood pressure and the health coefficient of girls*

In winter, the concentration of catecholamines in the blood increases, and in summer it decreases [27].

Also, factors that increase blood pressure include low temperatures in the external environment, short daylight hours, narrowing of blood vessels and high sweating [23, 14, 25, 20, 12].

The level of the health coefficient of girls in winter and spring is higher by 0.24 ($P < 0.02$) and 0.16 ($P < 0.05$) relative to the initial value. The state of the health coefficient of girls in all seasons of the year indicates a satisfactory level of their health. With the increase of the value of the health coefficient of students, there is a decrease in their health level. A high level of health among girls is revealed in the summer period of the year, and a low one - in the winter season of the year.

Apparently, the improvement of girls' health in summer occurs due to a decrease in the intensity of metabolism, the prevalence of anabolism processes, an increase in the motor regime, an increase in the duration of daylight hours and the ambient temperature. Similar conclusions were reached in their studies [8, 9, 5, 4, 10] .

Analysis of the results of the studies by A.A. Artemenko [2] and E.A. Shtrikh [11] indicate that modern students are characterized by physical inactivity, poor physical fitness, and poor health. According to V.D. Sonkin and others [22], students have low physical fitness and poor

health. Thus, in the spring and winter seasons of the year, there is a reliable increase in the level of SBP, DBP and the health coefficient of female students.

The length and weight of girls' bodies do not undergo statistically significant changes across seasons. In winter, there is a 2.2% increase in body length and a 4.9% increase in weight compared to summer levels. The value is 10.3% higher in spring ($P < 0.05$) and 12.4% higher in winter ($P < 0.01$) relative to the control group value. The increase in the DBP value in spring was 7.5% ($P < 0.05$), and in winter – 9.0% ($P < 0.02$) compared to the value for the summer season. The increase in the health coefficient of girls in the spring season was 10.1% ($P < 0.05$), and in winter – 15.1% ($P < 0.02$) relative to the level of control girls. The heart rate level in winter is 5.4% higher than the baseline value.

The interplay between seasonal climate changes and the immune system of female students is a multifaceted issue that warrants thorough exploration. As this study indicates, fluctuations in weather conditions can significantly affect the health of this demographic, making them more susceptible to infections and illnesses. For instance, during colder months, lower temperatures and increased indoor crowding can facilitate the spread of respiratory viruses, while warmer months may bring about allergens like pollen, contributing to respiratory issues and allergies.

The heightened vulnerability of female students to seasonal illnesses not only affects their physical health but also their mental well-being. Stress and anxiety related to health concerns can detract from their academic focus and overall quality of life. Therefore, understanding the specific health implications of seasonal climate changes is crucial. Educational institutions should consider implementing preventive health measures, such as vaccination programs and awareness campaigns about seasonal illnesses, to safeguard students' health.

The link between these health challenges and sustainable development is particularly pertinent. Sustainable development emphasizes the importance of a healthy population in fostering economic growth and social equity. By addressing the environmental factors that contribute to seasonal health issues, universities can play a pivotal role in promoting sustainable practices. For example, initiatives aimed at improving campus air quality, enhancing green spaces, and encouraging sustainable transportation can mitigate some of the adverse health impacts associated with climate change.

A holistic approach is necessary to effectively address these issues. This involves not only raising awareness about the effects of seasonal climate changes but also integrating health education into academic curricula. Programs focusing on nutrition, physical activity, and stress management can empower female students to take charge of their health, equipping them with the tools to build resilience against seasonal health challenges.

Further research is essential to understand the long-term effects of seasonal climate changes on the immune health of female students. Longitudinal studies could provide insights into how these changes influence health over time and inform targeted interventions. Additionally, research exploring the effectiveness of specific health education programs in mitigating seasonal health risks can help develop best practices that educational institutions can adopt.

In conclusion, the impact of seasonal climate changes on the immunity of female students presents significant challenges that intersect with the goals of sustainable development. By recognizing the health implications of these environmental factors and implementing strategic interventions, educational institutions can foster healthier and more resilient student populations. A proactive approach will not only enhance the well-being of female students but also contribute to broader efforts toward sustainable development and community health.

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