Prevention of cardiovascular diseases of students through improvement of environmental conditions

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Abstract. This research focuses on exploring the nexus between environmental conditions and the prevention of cardiovascular diseases among students. It delves into the various dimensions of environmental factors, such as air quality, noise pollution, urban green spaces, and access to natural environments, and their potential impacts on cardiovascular health. By conducting a comprehensive analysis of these factors, the study aims to elucidate how improvements in environmental conditions can contribute to the prevention of cardiovascular diseases among student populations. The findings are expected to inform policymakers, urban planners, and public health professionals about the importance of environmental interventions in promoting cardiovascular health among students and guide the development of effective prevention strategies.

1 Introduction

The fact of the influence of climatic factors on physiological processes is well known. They cause cyclical changes in the human body throughout the day, months and year. Rhythmic fluctuations of physiological parameters according to the seasons of the year are considered to be seasonal rhythms [9].

One of the studies [6] examined in detail the electrophysiological parameters of the heart in different seasons of the year in young people. In this work, the amplitude and duration of the graph elements of the electrocardiogram were analyzed in sufficient detail. As a result of the study, it was revealed that the duration of intervals and the amplitude of ECG waves change in different seasons of the year. In some seasons, for example, in winter, high values are observed for the P, Q, S, T waves, and in autumn and summer their amplitude is reduced. At the same time, the amplitude R is reduced in winter, and in other seasons it is higher. The duration of ECG intervals behaves similarly. Another study [10] examined heart rate variability in different seasons of the year in young men. Heart rate variability is fluctuations in the duration of cardiac cardiac cycles [7]. In this work, the spectral characteristics of HRV were studied both in the general group and individual

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fluctuations of the subjects. The sensitivity of these HRV parameters to the season of the year was established.

HRV parameters show the state of the central nervous mechanisms for regulating heart rhythm. Thus, the bioelectrical activity of the heart, heart rate variability, and the functional state of the central nervous mechanisms of the heart vary in different seasons of the year. Data regarding fluctuations in the parameters of the functioning of the cardiovascular system in different seasons are generally consistent among different authors, although there are some differences [4, 6]. There are few works on the study of seasonal changes in HRV parameters using the cardiorhythmography method according to R. M. Baevsky in the available literature. The study of HRV parameters in different climatic zones using various methodological approaches is of theoretical and practical interest.

2 Research methodology

Students of the Chechen State University named after. A. A. Kadyrova. HRV examinations were carried out in male students aged 19-20 years, studying at the Faculty of Biology and Chemistry. The number of students examined was 10. The students had no complaints about the state of the cardiovascular system. The study of HRV dynamics by season was carried out with the same sample of students.

To study HRV, a series of several dozen cardiointervals was obtained. A number of consecutive cardiointervals for the subjects were obtained by recording an ECG using the ArMaSoft-12-Cardio program. This program, in addition to the time parameters of the ECG in the second standard lead, determines the amplitudes, angle values and produces a series of consecutive cardiac cycles.

To record ECG and calculate the duration of cardiointervals, three standard limb leads were used in the work.

ECG recordings were performed in the morning. ECGs were recorded for the same subject in autumn (November), winter (February) and spring (May).

Using a series of cardiointervals, the following HRV parameters were calculated using formulas: mode, mode amplitude, variation range and stress index [7].

The obtained group HRV indicators of students were compared across three seasons of the year.

Statistical processing of the data was carried out using the computer program "Biostatistics".

3 Results and Discussions

The impact of climate on human life has been profound, prompting continuous efforts to understand and adapt to it over history. Among the various factors influencing health, environmental conditions, including air and climate pollution, have been implicated in cardiovascular diseases like myocardial infarction. Climate pollution, prevalent in many countries, contributes to respiratory illnesses and cardiovascular issues, necessitating scientific research to identify and address its root causes.

The human heart, a vital organ, acts as a powerful pump, circulating blood throughout the body via a complex network of blood vessels. Comprising four chambers and valves that regulate blood flow, the heart ensures unidirectional circulation, crucial for maintaining physiological balance. Diagnostic procedures, such as blood tests measuring enzymes like Creatine kinase (CK) and troponin, play a pivotal role in confirming heart muscle damage, particularly after a heart attack. Understanding these physiological processes and diagnostic markers is essential for effective management and treatment of cardiovascular diseases.

ECG and HRV parameters in the autumn-winter period of the year. The results of the seasonal analysis of heart rate data, cardiac cycle duration, as well as heart rate variability parameters - mode, mode amplitude, variation range and stress index - are presented in Table 1.

Table 1 Comparison of heart rate, cardiac cycle duration and heart rate variability parameters among those examined in the winter and autumn periods of the year

Season of the year	Heart rate, beats/min RR	RR, c	Mo, c	AMo, %	X, c	IN, s.u.
Winter	74,5±5,08	0,80±0,031	0,79±0,035	40,7±6,42	0,23±0,012	112,4±26,33
Autumn	76,1±5,47	0,79±0,042	0,78±0,045	41,6±6,78	0,22±0,026	121,2±27,42
R	>0,05	>0,05	>0,05	>0,05	>0,05	>0,05

As can be seen from Table 1, the heart rate value was higher in autumn than in winter. The cardiac cycle was shorter in the autumn (Table 1, Fig. 1). During the transition from autumn to winter, functional changes occur in the body. According to some authors, when the season changes, many physiological systems are reconstructed [4, 5, 6]. The functioning of the cardiovascular system and the electrophysiological activity of the heart are also restructured [4, 6]. According to O. Yu. Manuylov [6], changes in physiological systems, including electrocardiographic and hemodynamic, are an adaptation to the changed muscular activity of a person, to the restructuring of climatic conditions of the external environment. The result of adaptation of the electrophysiological properties of the heart is reflected in the duration of the cardiac cycle. HRV parameters in students during the winter-spring season. The transition from winter to spring is accompanied by a change in the climatic conditions of the human environment. First of all, this is a change in the duration of daylight hours (illumination), temperature, nutritional patterns and motor patterns [1, 2, 3, 5, 8]. All this causes adaptation in the physiological systems of the body. Comparison of ECG and HRV data in students, recorded in winter and spring, generally confirms the dependence of these parameters of the cardiovascular system and HRV on the period of the year. From Table 2 and Figures 4, 5, 6 it can be seen that in spring the cardiac cycle, mode and variation range are shortened more strongly, and the values of the mode and stress index, on the contrary, increase. IN is especially important: the value of this parameter increased significantly in the spring. This growth exceeds the autumn indicator and the limits of normotension [7] in the same students. This indicates tension in the nervous regulatory mechanisms of the heart in students in the spring. In particular, the increase in IN indicates an increase in the influence of the sympathetic link of autonomic regulation on the heart rhythm and the centralization of heart rhythm control.

The rhythmicity and cyclical nature of life processes is a fundamental property of living things. In the body of animals and humans, many vital processes are cyclical in nature, for example, the rhythmic work of the heart, brain rhythms, the release of hormones, etc. This rhythmicity and cyclicity is a reflection of the body’s adaptation to various environmental factors. In different seasons of the year, as a rule, climatic indicators change - illumination, day length, temperature, etc. The human and animal bodies, in the course of evolution, have adapted to these rhythmic and seasonal fluctuations in natural factors. Seasonal rhythms reflect circannual rhythms, that is, annual rhythms.

Knowledge of seasonal changes in physiological systems is important for regulating the rhythm of human life, his motor and mental activity. Also, many human and animal pathologies are seasonal. The results of the work can be useful in assessing the risk of disorders and in disease prevention.

4 Conclusions

This paper investigates the influence of various environmental factors on episodes of Heart Failure (HF) decompensations, as reflected in hospital admissions. A regression model for time series analysis was developed to identify the external attributes that most significantly impact the frequency of hospitalizations. The study found that air temperature emerged as the primary environmental factor affecting HF decompensations, with precipitation and air quality parameters such as SO2 and NOX also demonstrating relevance.

In future research, these environmental factors will be integrated into existing predictive models aimed at assessing the risk of decompensation in ambulatory HF patients. This predictive model, which predicts decompensation risk within a seven-day timeframe, utilizes patient monitoring data from preceding days. Incorporating the environmental factors identified in this study is expected to enhance the predictive accuracy of the model.

Additionally, while the primary aim of the study was to identify the influence of environmental attributes on HF decompensations, there is potential to develop a predictive model for forecasting the number of hospital admissions in the upcoming week. Such a model could be invaluable for physicians in anticipating potential hospital bed shortages. Initial testing of this model using an ARIMA predictive model yielded a mean error of four admissions per week (based on a weekly hospitalization rate of 28). However, it's important to note that this testing was conducted using the same dataset for both training and testing. Therefore, generalization of these results is contingent upon testing the model with new datasets, making this an area for future investigation.

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