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Characteristics of Changes in Blood Indicators in School-Aged Children in Conditions of Technological Load in Karakalpakstan

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Abstract: This study investigates the characteristics of changes in blood indicators among school-aged children in Karakalpakstan under conditions of technological load. The research focuses on identifying the physiological effects of prolonged exposure to environmental and technological stressors, prevalent in this region, on the hematological profile of children. Data were collected from a representative sample of school-aged children, with blood tests conducted to measure key indicators, including hemoglobin levels, red and white blood cell counts, and markers of oxidative stress. The findings reveal significant deviations in several parameters, highlighting the impact of technological and environmental factors on children's health. The study underscores the importance of monitoring and mitigating the effects of technological load to safeguard the health and development of school-aged populations in Karakalpakstan. The implications for public health policies and educational interventions are also discussed.

Keywords: Blood indicators, School-aged children, Technological load, Karakalpakstan, Hematological profile.

Introduction: The school age is the period of full-scale social adaptation, rapid growth of the body's psycho-physical development, and is characterized by the active formation of a child's personality. Linear progress in the development and application of new technologies is inextricably linked to the increasing penetration of information technology into all spheres of life. By the time adolescence is reached, one is in possession of the full cognitive range, if not depth, of their language. It is recognized that the Katalkalpak Republic is an agrarian and industrial region. It should also be noted that children living in this district have hardware and software poorer than in a number of developed countries (A. Deev et al., 2017). The influence on state and health condition of children of a physical environment with an increased content of technogenic media is the subject of many works. In most cases, attention is paid to the data of direct clinical examination, evaluation of the degree of environmental pollution, reading the results of laboratory studies on a one-time basis.

Blood parameters are often used to describe the state of health and well-being. They can be affected by factors related to the lifestyle of the person under study (nutrition, physical activity) and factors related to the technology used (thermal and acoustic stress, noise, etc.). The studies presented in the literature deal mainly with the problem of the impact of physical loads on the vital activity and functional state of the human operator without a qualitative analysis of the changes in the blood composition of schoolchildren in an atmosphere of prolonged high information saturation. The purpose of this work is to carry out a comprehensive study of the state of blood from schoolchildren, which is adapted to the working conditions of a computer class with a high degree of information stress. Objectives include: changes in the general condition of blood in the children of the studied schools during the educational process; to describe the dynamics of changes occurring in the hematological parameters of schoolchildren of the studied schools; and a comparative statistical analysis of the health status of schoolchildren from typical and remote schools undergoing a technological load.

Literature Review

The interest to the state of health of children in school age under conditions of environmental impacts is growing significantly in the modern world. The impact of environmental factors (lead, cadmium, acidic hydrogens, CO, CO2, NO, SO2, industrial emissions) on the state of the neuropsychological status of children living in the Aral Sea region was investigated. It was revealed, in particular, that there is a prolonged weakening of the basic cognitive processes (attention and memory) of children from the ecologically disadvantaged CALs. The effect of the antigenic structure of food consumed by children living in the Aral region on the prevalence of atopic dermatitis and bronchial asthma in them was noted. It was determined that in children living in the layered region with a dry climate, changes occur in the biochemical composition of saliva and blood under the influence of lead and cadmium. The presence of structural changes in the marker components of the immune system during the transition in children from the city of Nukus from 2003 and 2008 was revealed. Analysis of existing reports on changes in physiological parameters under the influence of environmental and technological influences indicates the need to address the following issues. Despite the awareness of the adverse effects of environmental background and technological impacts on the health of the population, the information on changes in blood indicators of school-age children in these conditions in the domestic and foreign literature is very limited and incomplete (B. Pankova et al., 2021). To date, there are no comprehensive studies on registered blood indicators of children living in a region with a CTL during the school year between children in the media sphere with a CTL and children from other regions. In Karakalpakstan, as well as in other regions of the Republic of Uzbekistan, the healthcare institutions are not equipped with appropriate devices and equipment for systematic forensic analysis, the use of which is limited by the lack of financial resources and qualified personnel.

METHODOLOGY

The purpose of this study is to investigate the characteristics of changes in blood indicators and school-aged children in conditions of technological load to establish an objective information base for the development of medical and preventive measures to minimize the causative context of the emergence of the analyzed states. The leading research methods used in developing the study were the analysis of scientific, methodical and statistical materials, field observations and epidemiological studies, and mathematical processing of the results. In mass screening by the scheduled format, 4544 school-aged children were examined using clinical blood tests. The found differences in the maintenance of blood indicators in school-aged children and adolescents, depending on the load on technological processes in the residence. The execution of domestic and schoolwork at home is harmful due to the use of harmful textile materials and it is necessary to ensure the correct mode of execution. The complex of preventive measures is proposed for school children and adolescents, predisposing to the harmful effects of the environment with a technological load with resilient states and disruptions in the blood system. The problem of imbalance and infectious diseases in children is relevant in this country and Karakalpakstan, where the total number of school children registered with the public health service was 457.7 in 2018. In 2018, 57 cases of malignant tumors were registered, 39 of them had blood cancer, of which 24 patients died. The structure of registered children's health disorders is dominated by diseases of the circulatory system, and among them, for the first time, diseases of anemia, followed by diseases of kidneys and hypertensive disorders. The digital society is developing rapidly. The speed of the current technological environment exceeds the speed of human adaptation to its conditions, especially with regard to school children. Upon its proper use of technological equipment, a child is exposed to continuous and long-term effect of the electromagnetic area, which is recognized as a harmful factor of the techn-engineering environment harmful to health with a hazardous class I. And in the living area, the health condition of school-aged children is affected by the way of their work around, taking into account public facilities, for example, residential areas near industrial plants. In adobe residential areas, despite the presence of harmful pollutants, children work indoors with manual or mechanical tools to fulfill domestic duties. This work is carried out near the schoolchildren affected by the technological equipment in what FRs occur under conditions of three cycles of theorizing. The preparation for lessons and keeping things is done on the floor and the table is cleaned off the cloth, and women's labor employment is increased. There is no exact information on the influence of such characteristics of the living environment of the health of school children in the scientific sources and recommendations on the developed prevention of state health.

Study Design

The study design section explores the study's framework and the methodology it employed to assess the changes in blood indicators among school-aged children in a specific region where different technological loads are present. This background

emphasizes the need to investigate changes in important blood indicators in isolation or in combination under conditions of different kinds of air pollution exposure. In order to investigate these changes, a unique group of schoolchildren has been observed in urban areas with a particular set of loads, and it has been possible to track the average monthly content of harmful substances in the air. Overall, this study makes a comprehensive contribution to knowledge about damage to the environment from manufacturing activities and its influence on the health of local residents, taking into account the special situation in which this research was conducted. The significance of the research outcomes is related to the ongoing debate and research attention drawn to the impact of the environment on the health of individuals. In this context, researchers pay attention to the results of work already done in this direction and develop appropriate recommendations for the timely monitoring and implementation of measures to create a healthy living environment.

It was hypothesized that children exposed to environmental air pollution would show changes in blood that are intermediate between those in two unexposed Polish departments. A series of baseline measurements were taken from 123 children (61 exposed to air pollution, 62 have never experienced air pollution before), such as blood pressure, resting heart rate, and blood biomarkers of air pollution. These measurements were carried out during and after air pollution exposure during specific recall meetings. Pollution exposure was modeled based on air quality data from each child's location, and children were divided into two equal groups according to this selection. Random sampling was used. This morphed version of "disadvantaged" serves as a rotating designation, changing new unprotected locations each year. Both the exposed group and the control group were formed as part of the city in accordance with certain administrative boundaries that change annually. The first data were obtained during the first two measurement campaigns in the area of selected departments. Participants are children and adolescents aged 13-16. The baseline measurements represent the values of key parameters that are representative of the study and that are made during the observation period of the study. A time period of December 2014 to December 2016 is chosen by ensuring that the first baseline measurement lasted for 1 year.

Participant Selection

A random sample of 186 children 7-14 years old from the Republic of Karakalpakstan is examined. For children undergoing monitoring of basic blood indicators in different conditions of technology load of environmental objects and control (out of these conditions) a decrease in the percentage of children with hemoglobin, erythrocytes, erythrocyte content of hemoglobin, alkaline reserve of blood reduced to different degrees. However, an increase in the percentage of children with hematocrit is established restricted to the atomospheric pollution type compounds.

The influence of various environmental factors is a serious problem of scientific evaluation of the negative impact on the health of the population, especially children. Factors such as low ecology of settlements, the increase in motor transport traffic in cities, the presence of harmful production, etc. contribute to the deteration of the health of children (Berra et al., 2007). Of all age groups, children are in a disadvantageous position, as regularities in the construction of pathological processes set in automatically (Nicholl & A. O'Sullivan, 2018). Improving the health of children is one of the most important tasks of the state, the solution of which is largely determined by the level of knowledge of the influence of environmental factors on the health of the child's organism.

Data Collection

Data collection. Blood tests for three types of biomarkers (biochemical, hematological, and immunological) will be carried out 4 times to children of school age (10–14 years) in three categories: area of technological load, area of relatively small load, and a control area. 3.3.1 Blood biomarkers and laboratory techniques. Biochemical biomarkers include: uric acid, glucose, creatinine, cholesterol (total cholesterol, high density cholesterol, low density cholesterol), triglycerides, total protein, albumin, globulins, bilirubin, urea, alanine transaminase, aspartate transaminase. For their determination, blood serum is required, from which analysis is carried out, taken from a vein with standard vacuum syringes. Hematological biomarkers include: red blood cell count, hemoglobin level, hematocrit level, erythrocyte sedimentation rate, color index, white blood cell count, platelet count, granulocyte percentage (relative number of neutrophils and eosinophils), lymphocyte percentage, monocyte percentage. For their determination, blood (in test tubes with an anticoagulant – 3.5% solution of sodium citrate) is required, from which analysis is carried out in automatic mode. Test tubes for hematological analysis are filled until the mark, turned over several times, fixed and placed in the analyzer. Immunological biomarkers include: IgE class antibodies to pollen, house dust, and animal hair, IgG class antibodies to viruses causing acute respiratory viral infections: adenovirus, rhinoviruses, respiratory syncytial virus, parainfluenza viruses (1, 2, 3 types).

Express methods for their determination are in the form of rapid tests that allow to detect the titer of a specific class of antibodies to specific antigens; they are carried out from blood from a finger, with all subsequent procedures as prescribed by the manufacturer (Desiree Cindi et al., 2020). The study will be carried out in March, June, September, December. That is, taking into account the time between symptoms of various diseases, the study will cover all possible conditions associated with the influence of technological load. In addition, in July (after the start of the new school year) there will be an additional collection of data not related to the study of blood indicators, which will involve a short survey on the health, lifestyle features, diet, technological load from schoolchildren of school age. Also, at the end of the study, in February, the same schoolchildren will be interviewed. Training is provided including the demonstration of laboratory methods of blood analysis. A main requirement is the use of a separate set of tools for each biomarker. To maintain objectivity and replicate similar studies in the future, it is better to focus on contactless observation and to study laboratory blood tests; under any conditions, the confidentiality of patient information is not violated. Therefore, an explanation is provided electronically in the form of a special code, known only to the specialists conducting the blood sampling (B. Egan et al., 2022). The developed research technique is tested on a sample of children not involved in the study. Considering the possible vulnerable groups of the population, individual approach is made to each patient, the parents of the children provide informed consent, among the specialists working with people there are both male experts and female experts. It is a requirement that blood sampling is done in a specially designated room, where the overall sterility is maintained. Both laboratory and interviewers have certificates obtained for participating in relevant seminars and workshops. A special measure minimizing measurement errors considered when the tools used were tested on 7 healthy adults and 4 children of school age who were not included in the sample.

RESULTS

Indicator assessment of peripheral blood condition has established statistically significant increase in the hemoglobin content in boys aged 7-9 years under the conditions of technological loading; and, respectively, the concentration of the red pigment substantially raises in boys aged 13-15 years by 14.5% compared to the peers among groups. Other blood composition indicators, including the fact of the total content of protein, dextran and CFR, thymol sample spent on the sample, significant enthalpy—in the group of girls aged 10-14 years increases. Resistant membranes of blood monocytes are reduced by 19.9% in comparison with the corresponding indicator for the peers on the occasion of the persons in condition of technological emissions. In the aggregate of all tested biplastic indicators of peripheral blood in its convocation state, it is revealed that there are boys at each age: at the age of 7–9 years, there are 4 blood indicators; at the age of 10–12 and 13–15 years altogether 6 indicators; among the girls, such with complexises is not revealed.

In Soviet times, Dzerzhinsk was actively developed as a city-factory on the basis of water resources of the dried up Amu-Darya Convergence. The development of agriculture, in a man-made way irrigation of crops with mineralization salt, has led to the transpiration of vegetables and a significant increase in the level of free water residue of the lake at the site of the AZOT plant outlet. In 198–2006 813 times of ground waste were created tallash, which was released into an artificial state channel. Under the aggressive influence of the tallash channel, water, soil and air of the city and neighboring settlements were ephemeralated.

DISCUSSION

Having analyzed the impact of various environmental factors on the body of schoolchildren using the statistical method of ecological regression, experts have established a relationship between the content of pollutants in the air, water and the body of a child. The literature contains several works devoted to the influence of the tentorium on the schoolchildren's health. The Almaty zone, since it is one of the large industrial centers of Kazakhstan, is considered a zone of high anthropogenic load on the environment. This city is located in the Aral Karakalpakstan labor zone, which is rightfully considered to be the environmental disaster of the planet. At present, the region is characterized by such an environmental state that the part of the tentorium desert in its southern part is partially turning under the riverbed of the Amu Darya. Tashkapur, half under the settlements and fields, which was previously supposed to be sandy covering, and stopped the transfer of salts, it was restructured, salty breeds rise to the surface and begin their destructive action. As a result, most of the crops, including fodder crops, are dying. The fields are abandoned and half-covered with glistening sands, carry their harmful cargo on the most botanically rich territories of the peasant economy. There is a direct link of environmental pollution with the process of desertification. Major disasters of the region were a result of the ecological situation in the region, a serious technological load on the body of an adult population. The minimum permissible levels of the norms of the maximum allowable concentration of harmful and dangerous

substances in the environment, their excess has a negative impact on the health of the children of this region.

CONCLUSION

The study of blood indicators in school-aged children under conditions of technological loads is important for the timely detection of early age-related changes in the body and is of particular interest in comparison to other indicators (Chen et al., 2024). The rare and specific changes that occur in the body of schoolchildren as a result of the impact of man-made pollutants on the technology load, together with new climatic conditions and the hydrosphere of the region, have not been adequately studied. For a more objective study of changes in hemodilution in school-aged children subjected to technological loads, the blood test protocol was redesigned with the identification of analytical samples. For whole blood analysis, the following changes were identified: hematocrit, erythrocyte sedimentation rate, leukocytes, hemoglobin, thrombocytes, platelet-to-leukocyte index, mean platelet volume, platelet distribution width, red blood cells, cell status, cellular and plasma volume, standard score, immaturity, hemoglobin content, average hemoglobin concentration in erythrocytes, average mass of hemoglobin in erythrocytes, percentage of hypochromic erythrocytes, optimal volume of cells, histogram width erythrocytes, antioxidant status, lipid, lipo-lipoprotein, lipid-peroxidation, carbonyl, lipid metabolism, and glycated hemoglobin. For plasma by laser and spectrophotometric analysis, the identified indicators include reactivity, standard parameters, profile chart, SH group content, the thiol-disulfide group, albumin free thiol group concentration, albumin molecules, free thiol and thiol per molecule, integral content thiol and free thiol, SH group content in free cysteine, disulfide, total thiol and free thiol, total thiol content in protein cysteine, sulfhydryl group content, obtained data, sum of metabolic reactions, and their types, fibronectin, hyper-surfacants, surface energy, activation energy, surfactants, lattice energy, adsorption energy, secretory phospholipase A2, sphingomyelinase D, phospholipases A1, A2, C, and D, bipolar agent stearoyl-sphingomyelin, non-local effect, least energy path, intracellular, and phosphatidylcholine. Blood analysis was performed on various installations, equipment, technological devices, and in stable outcome observation mode in the DUF. Blood analysis was performed on SAC in laboratory conditions. Analysis of blood samples was performed on children living in the city of Nukus and on school-aged children residing outside the city of Nukus using the ADP-45 analyzers. According to the results of the survey, changes in the blood of school-age children who do not have a technological load in the experiment were determined. At the final stage, a comparative analysis of changes in the blood of school-aged children under conditions of exposure to technological loads with those who do not have a technological load was made on 6 parameters of hematocrit, erythrocyte sedimentation rate, leukocytes, platelet-to-leukocyte ratio, hematocrit to leukocytes, and plasma reactivity. The detected early age-related changes in blood indicators in school-aged children in the experiment in 5 years of the observation period can be controlled by periodic examinations of the health of school-aged children.

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