Environmental Risks and Their Influence on Biological Age of the Population of the Volgograd Region

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Abstract. The analysis of environmental risks of deterioration in health of able-bodied population of the Volgograd region is presented in article. Air pollution is most closely connected with development of diseases of the cardio-respiratory system especially in persons between 35-40 years or more. Growth of the chronic diseases causes accelerated aging of the population making it difficult to continue active work. The research objective was to study the accordance of the calendar age to the biological age in people of various age groups living in regions with unfavorable ecological conditions. The analysis of accordance of the calendar and biological age is executed on the basis of complex researches on the function of the external respiration by methods of the usual and forced spirometry. The algorithm of carrying out researches on the accordance of biological age to calendar age in different age groups has been defined.

1. Introduction
Social and economic transformations of society, the regional development and development of the country are defined by the level of health of able-bodied population which is based on manpower, reproductivity, intellectual and cultural potential.

The negative social and environmental impacts which are going beyond functional and adaptive possibilities of the modern person can cause a number of changes in the functional systems at the homeostatic and behavioral levels [6, 7, 13].

The accumulation of damages in the live system is a function of time. Finally, violations of the regulatory and adaptive status provoke and accelerate development of noninfectious diseases in a person [8]. In our opinion, a cross-disciplinary research of all sets of climatic and anthropogenic factors influencing the life expectancy of the Russian population and limiting its active professional longevity is necessary.

The low birth rate, high mortality rate in all age groups, "demographic trend" are determined by historical events of the last century. Everything listed has resulted in the need for active study of a phenomenon known as "biological age" of the person. Preservation of labor potential, professional longevity and ability of the person to master new types of work in modern conditions of the ecological and social environment is the most important task of practical science.
The high level of technogenic and anthropogenic loadings of the environment, information loadings promote chronic stress under which a person stays for most of his life [1, 5]. At the present time, intensive transition of people to the modern urbanized way of life continues even in regions with small population.

The Internet, global information networks, mobile communication are strongly included into the everyday life of an individual. They are not only attributes of work, but also elements of daily leisure. The dependence of people on the Internet for mobile communication influences the nature of their relationship with their families and friends. Negatively and inadequate changes of consciousness and behaviour create prerequisite emergence of specific emotional status of a person.

The working population is both an economically and a politically dominating social group which provides professional development of industrial agglomerates at the regional and federal levels in the Russia federation. However, growth of chronic diseases in the working contingent of the mature age group causes accelerated aging of the population making it difficult to continue active work [3]. At the same time, the growth of the number of working persons at the pre-retirement age is an incentive motive of looking for ways of realizing a strategy for active professional longevity.

In this aspect, the important direction solution to the problem of accelerated aging is the research of qualitative factors of the ecology influencing the health of the population (of various age groups) in all regions of Russia. A quantitative prognosis of the contribution of various factors to development of a concrete disease can be constructed on the basis of the qualitative description of the "ecological factor - emergence and development of a disease" model [2, 4].

The illustrative region for the analysis of the influences of the living conditions, work and rest on the health of an individual in the south of Russia is the Volgograd region and its administrative center – Volgograd. The Volgograd region is one of the largest advanced industrial regions of the Southern Federal District of the Russian Federation.

The region is characterized by a difficult ecological situation for objective scientific analysis. The ecological conditions of the environment influence the state of health of the population of various age groups in different ways.

The difficulty of studying the gerontological aspects of the ecological situation of Volgograd is caused by the following combination: various climatic factors and quickly changing anthropogenic factors and technogenic impacts on the biosphere.

Climate of the Volgograd region is arid with sharply expressed continentality according to the report of committee of natural resources and ecology.

Average temperature of January is from -8 °C to -12 °C, July from +23 °C to +25 °C. The absolute maximum of air temperature +42 … +44 °C is observed usually in July – August. The absolute minimum of air temperature makes −36 … −42 °C is observed in January – February.

Air pollution is most closely connected with development of diseases of the cardio-respiratory system especially in persons between 35-40 years or more. This contingent is the main labour reserve of the country.

Despite it, complex researches on diseases of the cardio-respiratory system of working class persons at the pre-retirement age weren’t conducted so far because of the complexity of the procedure of inspection.

On the basis stated above, it is necessary to conduct a complex research on these ecological problems which have in recent years in the Volgograd region, and the subsequent analysis of interrelation of ecological factors and the most important indicators of the health of the population.

One of physiological methods of determining the biological age of the population of various age groups is the research of a functional state of respiratory system of the person.

It is known that negative changes in lung ventilation can be caused by external biomechanical reasons (decrease in speed and power qualities of respiratory muscles), and increase in aerodynamic resistance of tracheobronchial system to a stream of air.
Increase of aerodynamic resistance is caused by bronchial obstruction or decrease in mobility of a thorax. It is often observed in persons living in areas with an unsuccessful ecological situation. For example, those who live in Mikhaylovsk of the Volgograd region where the cement plant are located.

The research objective was to study the accordance of the calendar age to the biological age in people of various age groups living in regions with unfavorable ecological conditions.

2. Materials and methods

115 respondents participated in this research on voluntary basis (48 people; age 22-60 years, 42 people; age 61-96 years). As a control group of comparison the Russian students have been chosen (25 people; age 18-20 years). The consent of those who participated in this exercise was reached by informing them about the conditions of carrying out the research with the use of techniques and a guarantee of nondisclosure of the obtained information.

The analysis of accordance of the calendar and biological age is executed on the basis of complex researches on the function of the external respiration by methods of the usual and forced spirometry. The research included the assessment of physical development and anthropometrical data with the use of the standard indicators for calculating individual physiological norm, registration of pulmonary volumes when performing respiratory maneuver (the respiratory volume (RV, dm³), the vital capacity of lungs (VC, dm³), the forced vital capacity of lungs (FVC, dm³), reserve volume of an exhalation (RVE, dm³) and the forced reserve volume of an exhalation (FRVE, dm³).

The main research was conducted in the first half of the day indoors with optimum conditions of a microclimate.

The statistical analysis of data was carried out by means of "SPSS 17". Results are presented in form: \( M \pm m \), where \( M \) – the arithmetic mean, \( m \) – arithmetic mean error. Statistical significant level of distinctions was accepted at the level \( p \leq 0.05 \).

3. Results and discussion

As control parameters, indicators of pulmonary volumes of young people (18-20 years) at which development of respiratory system is complete were used and pulmonary volumes correspond to the adult. Results of researches of function of external respiration are presented in figure 1.

The main expiratory pulmonary volumes were below age standards at respondents of 1 group that testifies to small volumes of pulmonary ventilation. However, values of the forced vital capacity of lungs exceeded values of vital capacity of lungs, and values of the forced reserve volume of an exhalation exceeded the volume of a reserve exhalation. Thus, the permeability of a tracheobronchial system and force of internal intercostal muscles provided sufficient ventilation of lungs.

The volume of vital lung capacity was lowered by 11.9% (\( p = 0.07 \)) in respondents of the 2nd group which demonstrates restriction of amplitude of excursions of a thorax and difficulty of performance of a deep breath necessary for obtaining the maximum pulmonary volumes. However, the permeability of a tracheobronchial system and force of expiratory muscles in them practically did not change.

Results of researches on the function of external respiration in persons of older and the old age are presented in table 2.

It is established that in persons 61 – 70 years indicators of the forced respiration are much lower in comparison with individual physiological norms (FVC at 16.54%; FVC on the 2nd sec. – 32.11%; FRVE on the 2nd sec. – 48.63%).

Getting to age of 71-80 years, decrease in all indicators by 39% is observed. In elderly persons the forced vital capacity of the lungs is reduced by 57.33%, the forced vital capacity on the 2nd second to 70.72%, the forced reserve volume of exhalation on the 2nd second to 81.53%.
Figure 1 – The main pulmonary volumes reflecting functions of external respiration (1 group – men of 22-35 years; 2 group – women of 22-35 years; control – young people of 18-20 years)

Table 1 – Pulmonary volumes at the forced exhalation in people of the senior age groups (M ± m)

| Age  | n  | FVC, dm³ | FVC on the 2nd sec., dm³ | FRVE on the 2nd sec., dm³ |
|------|----|----------|--------------------------|---------------------------|
| 61–70| 11 | 2.12 ± 0.17 | 1.72 ± 0.21              | 0.60 ± 0.07               |
| 71–80| 14 | 1.55 ± 0.10 | 1.05 ± 0.08              | 0.28 ± 0.03               |
| 81–90| 11 | 1.38 ± 0.15 | 0.91 ± 0.12              | 0.31 ± 0.06               |
| 91–94| 6  | 1.10 ± 0.11 | 0.71 ± 0.11              | 0.15 ± 0.04               |

Reduction of indicators is observed at further increase in age (90 – 94 years). It is established that old age individuals are characterized by the smallest indicators of the forced respiration (FVC – 1.10 dm³, FVC on the 2nd sec. – 0.708 dm³, FRVE on the 2nd sec. – 0.145 dm³).

The algorithm of carrying out researches on the compliance of the biological age to the calendar age in various age groups of an able-bodied population of the Volgograd region is presented in figure 2.
Figure 2 – Algorithm of carrying out researches on the accordance of the biological age to the calendar age in various age groups

These researches have to be conducted taking into account the influence of unfavorable factors of the ecological system.

4. Conclusion

In people of older and the old age, decrease in indicators of forced expiration can be caused by deterioration in the permeability of airways, reduction of the speed of contraction of the intercostal muscles of the thorax participating in the forced exhalation.
The correlation analysis for determining the interrelation of the calendar age with indicators of the forced respiration is carried out. The calendar age was inversely correlated with indicators of the forced expiration. The significance of the coefficient of correlation is established in relation to the parameter of the forced vital capacity of the lungs reflecting speed characteristics of auxiliary respiratory muscles.

The determination of the biological age and its compliance to the calendar age needs to be carried out in age groups of 22-35 years and 36-40 years. During these periods, changes in the life and social status of an individual occur and are more vulnerable to ecological-environmental factors.

On the basis of modeling the influence of ecological factors on the health of the population, perhaps could help in the timely identification of environmental risks of development of the accelerated aging of the persons in the middle age group which the labor potential of the Russian Federation.

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