The ratio of immune reactions in female employees of cellulose production plant

N P Gechavez¹, O S Morosova², M V Nekrasova³

¹Higher School of Life Sciences and Technology, M.V. Lomonosov NArFU, 4 Lomonosov Ave., Arkhangelsk
²Federal Agency of Research Organizations (FANO, Russia), Federal State-Financed Research Institution “Russian Academy of Sciences’ Academician Laverov Research Center for Integrated Study of the Arctic”, 249 Lomonosov Ave., Arkhangelsk

E-mail: olia.morozow2011@yandex.ru

Abstract. The study covered 17 women, considered at the time of examination to be healthy, aged between 20 and 39, employed by JSC "Arkhangelsk Pulp and Paper Mill" (2012). It involved the analysis of clinical and laboratory data. The series of immunological tests were conducted in the laboratory of physiology of immunocompetent cells at the Russian Academy of Sciences’ Academician Laverov Research Center for Integrated Study of the Arctic (Arkhangelsk). The ulnar vein blood was taken in the amount of 6 ml. at 9-10 o’clock in the morning, on empty stomach. Blood sampling made use of IMPROVACUTER lithium-heparin vacutainers. Our comprehensive analysis of the immune status targeted to determine the content in the peripheral blood of lymphocyte phenotypes CD5+, CD8+, CD16+, CD20+, CD71+, CD95+; phagocytic activity; and phagocytic number. The content of lymphocyte phenotypes was determined through indirect immunoperoxidase reaction using monoclonal antibodies (NPC “Medbiospectr”, Russia) on preparations of lymphocytes of the "dried drop" type. The percentage of active phagocytes and the phagocytic number were calculated in blood smears according to Romanovsky-Gimza. In processing the data, we made use of Statistica 6.0 software for mathematical statistics. The surveyed group of female employees of JSC "Arkhangelsk Pulp and Paper Mill" appear to have deficit of CD5+ T-lymphocytes (in 100% of the surveyed female employees) and increased cytotoxic activity (CD8+) (in 11,76% of the surveyed female employees).

1. Introduction

Being a core sector of Arkhangelsk Region’s economy, pulp and paper industry is characterized by exposure to a whole set of adverse occupational factors, such as excessive concentrations of chemical substances, including dust and aerosols; vapors (including substances of Hazard Class 1 and 2) with highly toxic, irritating, allergic and carcinogenic effect; noise pollution; vibration; and physical overload combined excessive strain in upper limbs and thoracic girdle [1]. Also, pulp and paper mills are known to be sources of dioxin pollution that use chlorine as an ingredient for pulp bleaching technology and dioxin-containing preparation as an antiseptic [2]. The main component posing human health to carcinogenic risk is chromium oxide. The largest contributor to respiratory pathology development, caused by the severe exposure, is sodium sulfate, while systemic disorders are largely contributed by power plant-generated oil ash [3].
The impact of adverse factors inherent in this type of industry, cannot but affect the health of employees [1]. It should be noted that not only are the harmful occupational factors likely to cause occupational diseases, they may well serve as a pathogenetic mechanism for the development and progression of common diseases that are not classified as professional. About 80%-85% of the diseases are resultant from occupational and environmental stress, whereas work-related health damage and the losses associated with it cause the country to lose 4%-5% of its gross national product [4].

The harsh climate of the North inhibits the self-regulation processes that bring the human body systems back to normal, which, in turn, leads to cellular and humoral immunity being over-strained and, ultimately, to a reduced reserve capacity of the body. The specific features of the immune response the human body develops when adapting to the cold climate of the North are defined by the significant shortage of heat and UV radiation. In the severe, human-unfriendly conditions of the North, the optimization processes are accompanied by compensatory reactions, indicating the increased stress levels in energy-generation and tectonic processes, leading in some cases to decompensation [5, 6, 7, 8].

2. Materials and methods
A total of 17 female workers of JSC "Arkhangelsk Pulp and Paper Mill", considered to be healthy at the time of our survey, aged between 20 and 39 (2012), were surveyed. Of them 2 work in the drying shop; 3 in quality control; 3 in heat power generation; 2 are environmental engineers; 1 in transportation dispatch; and 6 are office workers. The study involved the analysis of clinical and laboratory data. The series of immunological tests were conducted in the laboratory of physiology of immunocompetent cells at the Russian Academy of Sciences’ Academician Laverov Research Center for Integrated Study of the Arctic (Arkhangelsk). The ulnar vein blood was taken in the amount of 6 ml. at 9-10 o’clock in the morning, on empty stomach. Blood sampling made use of IMPROVACUTER lithium-heparin vacutainers. Our comprehensive analysis of the immune status targeted to determine the content in the peripheral blood of lymphocyte phenotypes CD5+, CD8+, CD16+, CD20+, CD71+, CD95+; phagocytic activity; and phagocytic number. The content of lymphocyte phenotypes was determined through indirect immunoperoxidase reaction using monoclonal antibodies (NPC "Medbiospectr", Russia) on preparations of lymphocytes of the "dried drop" type. The percentage of active phagocytes and the phagocytic number were calculated in blood smears according to Romanovsky-Gimza. In processing the data, we made use of Statistica 6.0 software for mathematical statistics.

3. Main results
The analysis has shown the deficit in the surveyed female employees of JSC "Arkhangelsk Pulp and Paper Mill" (aged 18-39) of CD5+ T-lymphocytes (average 0.28±0.02×10⁹ cell/l), which is significantly lower than the generally accepted physiological norms. The T-cell deficiency was found in 100.00±3.31% of the surveyed. Concentrations of cytotoxic lymphocytes (CD8+) average 0.28±0.02×10⁹ cell/l, natural killers (CD16+) – 0.23±0.01×10⁹, being within the accepted physiological boundaries. Excessive levels (CD8+) were found in 11.76±1.13% of the surveyed. The content of phenotypes with transferrin receptors (CD71+) average 0.26±0.01×10⁹ cell/l, which is within the accepted physiological norm, and have not been found excessive in any of the surveyed. The average level of cells with receptors for apoptosis (CD95+) in the surveyed female employees of JSC "Arkhangelsk Pulp and Paper Mill" is found to equal 0.26±0.01×10⁹ cell/l, while 94.11% of the surveyed show low average values of apoptosis. Concentrations of mature forms of b-lymphocytes (CD20+) were calculated 0.24±0.02×10⁹ cell/l. The percentage of active phagocytes in the surveyed individuals averaged 77.88±1.85%, which is within the generally accepted physiological norm. The phagocytic number averaged 8.06±0.48 microorganisms/cell, approaching the upper limit of the generally accepted physiological norm (Figure 1).
The analysis revealed statistically significant, direct correlation in the group of female employees of JSC "Arkhangelsk Pulp and Paper Mill" (aged 18-39) between CD5+ and CD95+ (r = 0.60; p < 0.05); CD71+ and CD95+ (r = 0.70; p < 0.05); CD71+ and CD16+(r = 0.72; p < 0.05); CD71+ and CD8+(r = 0.56; p < 0.05); CD8+ and CD95+(r = 0.54; p < 0.05); CD95+ and CD71+(r = 0.70; p < 0.05).

Thus, against the background of pronounced deficiency of T-cells (CD5+), low activity of apoptosis processes (CD95+), the concentrations of cytotoxic cells (CD8+) remain extremely high, which in our opinion is a compensatory reaction. The manifest correlation between the processes of apoptosis, deficiency of T-cells and increased immunosuppression is seen to be an indirect indication of the failing immune homeostasis reserve capacity in females working in most hazardous shops of the pulp and paper mill.

References
[1] Dubel E V and Ungureanu T N Prevalence of diseases among workers of a large pulp and paper complex // human Ecology. 2013. No. 5. P. 40-46.
[2] Akimov V A, Kozlov K A and Kosorukov O A Modern problems of the Arctic zone of the Russian Federation. – M.: fgbu VNII GOCHS (FC). 2014. 308s.
[3] Zaitseva N V, Shlyapnikov D M, Shur P Z, Alekseev V B, Ungureanu T N and Buzinov PV in the Study of the health of the population living in the zone of influence of a large industrial enterprise, using risk assessment and epidemiological research methods// human Ecology. 2013. No. 12. P. 33-39.
[4] Trofimova E A and Kireeva V V In particular thyroid pathology in workers of cellulose production// Siberian medical journal. Volume 97. 2010. No. 6. P. 211-214
[5] Morozova O S, Filippova O E and Shashkova E Yu reactions of adaptive immunity of residents of the Far North /// Bulletin of the Ural medical Academic Science. 2018. Volume 15. No. 2. P. 285-290.
[6] Shchegoleva L S with Reserve capacity of immune homeostasis in humans in the North. Ekaterinburg: Uroran, 2007. 207s.
[7] Gelfand E W and Dosch A M Biological basis of immunodeficiency. New York: Pover press, 1980. 302 p.
[8] Gan L, Fagerholm P and Kim H J Effect of leukocytes on corneal cellular proliferation and wound healing// Invest. Ophthalmology. Vis. Sci., 1999. Vol. 40. P. 575-581