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THE USE OF SCREENING METHODS AS ELEMENT ARRAY SYSTEM IMPROVEMENT PUBLIC HEALTH.

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ABSTRACT

The priority pollutants of the environment in industrial cities are such reproductive toxic substances as benzo(a)pyrene, formaldehyde, phenol and nitrogen dioxide [1]. Chemical substances, which a person confronts in the course of professional activity, may cause mutagenic and genotoxic effects and hereditary disorders. The exposure to physical factors of production environment may result in pathology. The study of harmful factor impact on the reproductive health of workers, the development of study screening methods and prevention activities is an important one. The tiered screening system was used, including socio-sanitary, physical, chemical, clinical, biochemical and cytogenetic studies. 318 men were observed - the workers of the machine-building enterprise who deal with harmful chemical and physical factors during their work and 148 workers without a contact (control group). Questionnaire screening showed that almost 70% of respondents work in contact with a chemical factor, 2/3 of respondents work in a noisy atmosphere, about 40% work with local vibration, at that 8.5% of the patients consulted a doctor concerning reproductive function disorders. The measurements of physical factors at workplaces revealed the excess of maximum permissible levels of noise and local vibration. The exceeding of maximum permissible concentrations (MPC) of benz(a)pyrene, mineral oil aerosols, nitrogen dioxide, epichlorohydrin were also revealed in the working area. The results of testosterone, lutropin and follitropin levels showed that abnormalities were found among 25.5% of the employees, including 21% of workers exposed to a local vibration. The mathematical model is developed for the estimation of reproductive disorder occurrence probability, significantly influencing factors were determined. These factors are presented by vibration impact, the experienced diseases, the activator of which could have the affinity for seminiferous epithelium, the changes of testosterone levels, the miscarriages among women in history. The noise at workplaces (87.7 + 4.5 dB) significantly affects the blood levels of testosterone ($r = 0,51$, $p<0.04$), which may be associated with the influence on Leydig cells and hypothalamic-hypophysial system. The impact of reprotoxicants (benz(a)pyrene, mineral oil aerosols, nitrogen dioxide), may cause reproductive health damage. In order to study the reproductive health status, to determine risk groups and the development of preventive measures it is advisable to use a multi-level screening system, including questioning, the hygienic assessment of industrial environmental factors, hormonal status determination, mathematical modeling.

Keywords: screening studies, reproductive health, industrial ecology, occupational risk.

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INTRODUCTION

Environmental pollution in major industrial cities, the work at manufacture, the impact of social and everyday factors are considered by modern sanitary science as potential risk factors which contribute to the growth of non-infectious diseases, the deterioration of population health and lead to life expectancy reduction. Performed prevention events are the measures of secondary and tertiary prevention most often, rather than the primary activities that could lead to an adequate improvement of habitat quality and make a healing effect on the population of high-risk groups.

According to official data, the level of air pollution is characterized as very high and high in 123 large cities, where 52% of urban population resides. The fact that such priority pollutants are carcinogenic and reproductive dangerous substances as benz(a)pyrene, formaldehyde, phenol, nitrogen dioxide is of particular concern [1]. These substances are able not only to cause abnormalities in health status, but also may lead to long-term effects, affecting the health of future generations through mutagenic and genotoxic effects [2, 3, 4, 5].

Almost 90 million of people in 48 Russian regions are exposed to complex chemical load, in 37 regions the disease rates are influenced by production factors [1]. In this regard, the preventive events and the development of preventive measures aimed at the maintaining of working population health are particularly relevant ones. The development and the implementation of health study screening methods among reproductive population, especially among the persons employed in manufacturing is an important one. The main aim of these studies will be the determination of high-risk groups, the development and implementation of preventive measures aimed at reproductive health and healthy heredity protection, since the reproductive system is one of the most sensitive to the effects of environmental factors in man's body systems [6, 7].

The literature data suggest that in the course of life a person has contact with more than 100 thousand of xenobiotics, of which more than 1,000 have toxic properties for the reproductive system. A number of foreign authors indicate that more than 50% of the European gene pool is not reproduced in subsequent generations. Thus, the depopulation increase may be observed in some regions [8, 9, 10, 11].

The organism of men working at the mechanical engineering enterprises is influenced by a number reproductive dangerous production factors, such as the exposure to chemical substances (carbon monoxide, heavy metals, benz(a)pyrene, etc.) And physical factors (noise, vibration, thermal radiation) [2, 6, 7].

The exposure of whole vibration leads to impaired spermatogenesis, ejaculate volume and the portion of motile sperm cells decrease [12, 13]. Local vibration causes such functional changes of the reproductive system, as the damage of spermatogenesis and the reduction of prostate secretory function. The patients with vibration disease demonstrate testosterone level decrease, especially among people with a long work experience. The impact of noise on a man's body is revealed in ejaculate viscosity change and sperm motility reduction [12, 13, 14].

Heavy metals (mercury, lead, cadmium and other metals), neurotropic poisons (phenol, toluene, benzene, ammonia chloride), carcinogenic substances (such as benz(a)pyrene and its metabolites) make a toxic effect on spermatogenic cells, Leydig cells, hypothalamus, pituitary gland, disrupting the feedback mechanisms in hypothalamus - pituitary gland - testes system [6, 14].

The aim of the research was the study of the working conditions among men engaged in mechanical engineering, the revealing of reproductive health violations with the use of screening methods and the development of preventive measures.

METHODS

Modern methods of social hygiene, physical, chemical, clinical, biochemical, cytogenetic studies are used in this study. The methods of parametric and nonparametric statistics are applied for statistical data processing.

The working conditions of 318 men were studied - the leading profession workers of engineering enterprise for the production of military equipment who have professional contact with harmful production factors (caster, chipper, molder, electric and gas welder, fitter, turner, miller, grinder, heat-treater, assembler - riveter). The control group consisted of 148 workers, whose professions do not involve the harmful factors of work environment (controller, work distributor, setter, etc.).

The hygienic assessment of production factors was carried out in accordance with the P 2.2.2006-05 "Guidelines on the hygienic assessment of working environment factors and labor process. The criteria and classification of working conditions", the classes of working conditions were determined.

Questionnaire screening was conducted according to a specially designed questionnaire and included questions on the state of health, the social status of workers, bad habits and working conditions.

The levels of main hormones responsible for male reproductive function (testosterone, lutropin, follitropin) were determined by enzyme-linked immunosorbent assay using the kits "Gonadotropin ISA-LG", "Gonadotropin ISA-FSG", "steroid ISA testosterone-01".

The statistical analysis of data was performed using a standard software package, using parametric and non-parametric statistical methods. We used the methods of correlation and regression analysis.

RESULTS

It was found during the survey that a third of respondents suffered the diseases at which the pathogen may have the affinity for the tissues of reproductive organs and cause disturbances, 8.5% consulted a doctor about reproductive disorders, 4.2% of respondents noted that their wives had miscarriages.

The distribution of respondents by professional experience showed that the largest group - 30% - is composed of employees with the work experience of 30-39 years, the group with the work experience of 9 years makes 24%, the group with the work experience of 10-19 years makes 22%, the group with the work experience of 20-29 years makes 20% and 4% of workers are referred group with the work experience of 40-49 years.

Questionnaire screening allowed us to estimate not only the social and domestic, but also harmful factors of industrial environment affecting the health of mechanical engineering workers. 68.2% of the respondents work in contact with cutting fluids, 24.3% of respondents work in contact with a chemical factor, 14.4% of respondents work with heavy metals, 66.2% of respondents work in contact with noise, 40.1% of respondents work in contact with local vibration, 14.4% of respondents work in the conditions of overheating, 22.3% of respondents work in hypothermia conditions.

Hygienic evaluation of industrial environment factors helped to determine the excess of maximum permissible concentrations of benz(a)pyrene, mineral oils aerosols, nitrogen dioxide, epichlorohydrin in the working area air. The average concentrations of carbon oxide in the shops made 5.7 + 1.41 mg / m3 during the observation period; nitrogen dioxide - 1.43 + 0.19 mg/m3; mineral oil 3.6 + 1.22 mg/m3; epichlorohydrin - 1.96 + 0.77 mg/m3; benz(a)pyrene - 0.001334 +/- 0.08 mg/m3. The excesses of the maximum allowable levels (MAL) of noise by 4 - 29 DbA are noted. The indicators of thermal radiation intensity exceed the permitted levels, at that the excesses are directly dependent on the technological process phases and range from 1.17 to 13.69 MAL.

The study of testosterone, lutropin, follitropin levels among 291 employees of the experimental group showed testosterone level decrease and the levels of lutropin and follitropin increase as compared with the control group (148 employees): 25.5 men per 100 workers. 17.02 men per 100 employees showed the deviations of one hormone and 6.38 men per 100 workers had the deviations of two hormones, 2.12 men per 100 employees had the deviations in all three defined parameters. The comparison of hormone levels was conducted with the age norm.

21% of workers who have contact with the local vibration levels corrected by the frequency of 114 ± 1,7 dB, showed the violations of hormonal status. The deviations of testosterone levels from standard ones in the direction of indicator decrease were determined among 14.9% of patients.

It was found that the noise at workplaces within sound pressure levels of 87.7 + 4,5 DbA significantly affects the testosterone levels in blood ($r = 0,51$, at $p < 0.04$).

The analysis of results, taking into account the professional experience of 10-19 years showed that the persons with 10-19 years of work experience are in a high risk group in respect of testosterone level decrease.

The excesses of lutropin levels as compared with the age norm are revealed in all professional groups with work experience, but the largest number of deviations is recorded for the workers with the professional experience of 20-29 years.

High levels of follitropin were found in professional groups with the work experience from 0-9 years and 10-19 years.

According to the study results, a mathematical model was developed in order to estimate the probability of reproductive disorder appearance. The model includes such reliably influencing factors as vibration impact, experienced diseases in which a pathogen may have the affinity for seminiferous epithelium, revealed previously or proposed changes in testosterone levels, miscarriages of wifes in the anamnesis. According to the results of factor point evaluation the scale consisting of 4 risk groups was developed: very high risk (the examination and treatment by a doctor is necessary), high risk (medical supervision and medical check-ups are required at least 1 time in half a year), medium risk (health state monitoring is required at least 1 time per year), low risk (recommended monitoring the health status).

DISCUSSION

The analysis of research results showed that the reproductive health of men engaged in mechanical engineering, is influenced by physical and chemical factors of the industrial environment. The change in hormonal status contributes to reproductive health violations. According to the results of hygienic assessment concerning industrial environmental factors the classes of working conditions were determined. In general, the working conditions in mechanical engineering are characterized as hazardous ones and are presented by classes 3.1. - 3.3. They constitute 57.5%.

With the increase of professional experience the decline of testosterone level and lutropin and follitropin level increase are observed. The work experience of 10-19 years for testosterone and follitropin level change shall be considered as a critical one and the work experience of 20-29 years for lutropin shall also be considered as a critical one.

Thermal radiation and noise significantly influence the likelihood of reproductive health violation among men working as engineering workers. The noise at the workplaces within the sound level of 87.7 + 4,5 DbA makes a significant influence on testosterone levels in blood ($r = 0,51$, $p < 0.04$), which may be associated with the exposure on Leydig cells and hypothalamic-hypophysial system. Thermal radiation significantly affects the levels of testosterone ($r = - 0,53$, $p<0.05$). The reason for this may be the overheating of reproductive organs. The impact reprotoxicants (benz(a)pyrene, mineral oils aerosols, nitrogen dioxide), may cause reproductive health damage.

The excess reproductive dangerous concentrations in the air of a working area, hypothermia and hyperthermia, the excess of noise and vibration levels require constant monitoring and optimization measures. The reduction of adverse effects is possible due to the carrying out of technological, sanitary, medical and preventive measures.

The developed mathematical model for the estimation of reproductive disorder occurrence probability, helped to identify the individuals at risk. The use of the model allowed to increase the efficiency of risk group development by 18%. The measures for the prevention of reproductive health violation among men

for each risk group and the improvement of professional selections during the work at the enterprises for the production of military equipment. During the application of measures minimizing the impact of one or more controllable factors in the model, you can reduce the resulting value up to 2 times, which allows to increase the effectiveness of primary prevention concerning reproductive health problems by 15%.

The system of multi-level screening should be used to study the reproductive health of employees, to identify risk groups and to develop preventive measures.

CONCLUSIONS

1. The working conditions of mechanical engineering workers are characterized as harmful ones. Work condition classes 3.1. - 3.3 constitute 57.5%. The decrease in testosterone levels and the increase of lutropin and follitropin levels is observed with work experience increase. The work experience of 10-19 years and 20-29 years for lutropin shall be considered as critical one to the change of testosterone and follitropin levels.
2. It was found that the factors which significantly influence the likelihood of reproductive health violations among men working as engineering employees are the effects of thermal radiation ($r = -0,53$, $p<0.05$), and the noise at workplaces ($r = 0,51$ at $p<0.04$).
3. The factors which significantly influence the likelihood of reproductive health disorders are the effects of vibration, experienced diseases, the causative agent of which could have the affinity to the seminiferous epithelium, the changes in testosterone levels, the miscarriages among wives in past medical history.
4. The use of screening tests should be used to study the reproductive health status of employees, improve the efficiency of high-risk groups (18%) development and the development of preventive measures. The proposed preventive measures allow a 15% increase of primary prevention effectiveness concerning the violations of reproductive health among men working as engineering workers.

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