

OCCUPATIONAL REPRODUCTIVE SYSTEM DISEASES IN FEMALE WORKERS EMPLOYED AT WORKPLACES WITH HARMFUL WORKING CONDITIONS

M.A. Fesenko¹, O.V. Sivochalova¹, E.V. Fedorova²

¹Izmerov Research Institute of Occupational Health, 31 Budennogo Av., Moscow, 105275, Russian Federation

²National Research University "MEI", 14 Krasnokazarmennaya Str., Moscow, 111250, Russian Federation

The paper outlines the data obtained in the course of long-term research dedicated to studying the extent to which reproductive system pathologies in workers with high-risk occupations are occupationally induced. Their peculiarity is joint impacts of various occupational factors (for example, impacts exerted by chemicals together with physical and biological factors, and labor hardness and intensity as well) on a female body.

Our research goal was to examine the extent to which reproductive system pathologies in workers with high-risk occupations were occupationally induced. To achieve it, we applied statistical estimate of correlation between health disorders and work.

Our occupational group included a number of occupations with harmful or hazardous working conditions in civil engineering, metallurgy, chemical industry, polymer-processing industry, and health care as well. As a rule, working conditions class of workers from the examined groups varied from 3.1 to 3.3; and occupation with permissible working conditions were used as a comparative group.

The research results revealed that there are certain occupations with high risk of reproductive health disorders evolution and infants development pathologies evolution. They are:

- model makers and checkers in civil engineering and crane operators at a metallurgic plant;*
- analysts at chemical analysis laboratories, chemical engineers in chemical industry (including petrochemical plants, polymer-processing plants, and organic synthesis plants);*
- surgeons, obstetrician-gynecologists, midwives, surgical nurses working in in-patient departments.*

Estimate of correlation and occupational dependence of reproductive system diseases on working conditions revealed that women with harmful working conditions (3.1–3.3 hazard class) had defective pregnancies or labor pathologies which had strong and average correlation with working conditions. Health disorders in newborns were estimated as per very strong correlation with mother's work. Thus, we can state that a mother occupational risk induction for a child health is fundamentally proved. On the basis of the obtained results we rank female workers with 3 class 2 harm degree working conditions as having an occupation with high risks of reproductive health disorders.

We worked out an algorithm aimed at managing these risks; it should be applied in order to lower occupational risks for reproduction in female workers.

Key words: *female workers, working conditions class, reproductive health, newborns' health, occupational risk, statistic estimate of correlation.*

Introduction. An issue of estimating damage to workers' health caused by unfavorable production factors has been attracting experts' attention for several decades; however, for the first time such concepts as "occupational risk" and "occupational risks management" appeared in the RF Labor Code only in 2011 (Federal Law No. 238 issued on July 18, 2011 "On making alterations into the Russian Federation Labor Code). Occupational risk is a probability of

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Marina A. Fesenko – Doctor of Medical Sciences, Head of Laboratory for Reproductive Health Disorders Prevention (e-mail: fesenkoma@niimt.ru; tel.: +7 (495) 365-29-81)

Olga V. Sivochalova – Doctor of Medical Sciences, Professor (e-mail: reprlab@mail.ru; tel.: +7 (495) 365-29-81).

Elena V. Fedorova – Candidate of Medical Sciences, Associate Professor at Engineering Ecology and Labor Protection Department (e-mail: fev2012@list.ru; tel.: +7-910-418-43-71).

damage to health resulting from impacts exerted by hazardous and (or) dangerous production factors when a worker fulfils his or her working tasks in conformity with a labor contract or in any other cases; a procedure of its assessment is set forth by a federal executive authority.

Occupational risks management is a set of interrelated activities which are elements of labor safety management system and which include measures aimed at detecting, assessing and lowering occupational risks (Federal Law No. 421 issued on December 28, 2013).

Actually nowadays each employer is to assess occupational risks for employees and implement efficient measures aimed at its elimination or reduction. However, only highly qualified experts in occupational medicine can solve such a task and even they sometimes don't allow for all the aspects related to occupational risks.

Assessment of a risk for the reproductive system is one of such aspects; such assessment is truly vital for the Russian Federation as approximately 49% of all working population are women [11].

Maternity is the most important mission in a life of any woman. Unfortunately, great occupational risks can prevent female workers from fulfilling their reproductive functions.

Given all the above mentioned, we see an issue of preserving and improving workers' reproductive health as one of top priority tasks as it creates conditions for the country economic development. Actuality of this issue is confirmed by Russian and international documents. In particular, in 2004 the WHO adopted "Reproductive health strategy" and "Resolution on the family and health", and in 2007, "Global plan of action on workers' health" (2008-2017). The ILO issued a number of conventions on the issues:

Convention No. 156 on workers with family responsibilities (1981), Convention No. 183 on maternity protection (2000), Convention No. 187 Promotional framework for occupational safety and health (2006), etc.

The RF Government issued an order dated March 08, 2017 which adopted the National strategy on action in the interests of women (2017-2022); it mentions the importance of reproductive health protection development, especially for working women due to the fact that approximately one million women are employed at working places with hazardous and/or dangerous conditions (1,145.1 thousand as per data collected in 2015).

A great number of the reproductive system diseases are proven to be occupationally induced; they cause problems with conception and child-bearing and may even lead to infertility [2, 7, 8, 14]. Experts are especially concerned about occupations with high risks as women having them are under joint effects exerted by various production factors (for example, chemical impacts together with physical and biological factors, labor hardness and intensity etc.) [12,15]. Unfavorable effects can occur in case of chemicals concentrations being equal to or even lower than permissible levels due to the fact that if various factors impacts are unidirectional, either additive or synergy effects can be observed.

Our goal was to examine occupational causality of the reproductive system pathology in workers with risky occupations calculated with the technique of statistic estimation of correlations between health disorders and work which was created by professor E.I. Denisov [1] basing on data taken from literature and our own long-term research.

We made up a group of risky occupations which comprised a number of occupations with hazardous or dangerous working conditions from civil engineering, metallurgy, chemical industry, polymer-processing industry, and public healthcare as well.

Results. We detected that workers employed at metallurgic productions and in public healthcare had the most unfavorable working conditions (3.2-3.3 danger category as per P. 2.2.2006-05 [10]); workers employed at petrochemical production and polymer-processing productions had 3.1 danger category of working conditions.

We analyzed reproductive disorders in workers employed at civil engineering productions as galvanizing workers, patternmakers, and checkers [3]. We detected average and high correlation between reproduction pathology and occupational activity.

Increased occupational risk of inflammatory processes involvement in internal genital organs was detected in patternmakers (OR=4.67 (95% CI, 1.31–16.59) and checkers (OR=3.45 (95% CI, 1.13–10.55)). Moderately high risk of spontaneous miscarriages was detected among checkers and was equal to OR=3.24 (95% CI, 1.06–9.90) (Table1).

Table 1

Occupational risk (OR odds relation) of reproductive disorders in female workers employed at civil engineering productions

Reproductive system diseases	Basic occupations					
	Galvanizing workers		Patternmakers		Checkers	
	OR	95 % CI	OR	95 % CI	OR	95 % CI
Inflammations in female pelvis organs	0,77	0,18–3,41	4,67*	1,31–16,59	3,45*	1,13–10,55
Genital organs descent	0,61	0,17–2,26	1,43	0,44–4,70	1,34	0,51–3,59
Spontaneous miscarriages	1,78	0,48–6,66	1,11	0,27–4,62	3,24*	1,06–9,90
Gestosis of the second half of pregnancy	2,08	0,49–8,93	3,26	0,79–13,55	1,46	0,40–5,30
Threat of miscarriage	1,27	0,39–4,13	1,03	0,30–3,52	1,62	0,61–4,28

Note: * – changes are statistically significant, P < 0.05

Such an occupation as a crane driver is the most unfavorable for women in metallurgy (3.3 danger category) as it is characterized with joint effects exerted by labor hardness, local vibrations, and heating microclimate. When we examined occupational causality of reproductive system pathology among such workers, we chose office workers with working conditions belonging to 2 danger category as our control group.

As we analyzed occupational causality of the detected gynecological pathology in female crane drivers, we revealed

that an etiological share of production factors in infertility involvement was equal to more than 50%; it allowed us to consider occupational causality to be high, and female infertility to be occupationally induced pathology.

As we studied health state of pregnant female workers, pregnancy and birth complications, as well as newborns health, we revealed that pregnancy problems were closely related to unfavorable working conditions; the highest occupational causality was observed for threat of miscarriage, gestosis of the first half of

pregnancy, intrauterine hypoxia and a fetus arrested development (Table 2).

Similar data were obtained when health state and reproductive function of female workers employed at chemical productions were analyzed; we assigned oil processing industry, polymers production and processing, and organic synthesis to such productions [4,5,9]. Such chemical production occupations as chemical analy-

sis laboratory workers and chemical engineers were considered to be highly risky as they were characterized with joint effects exerted by chemical factors, labor hardness, and heating microclimate (Table 3).

As per data obtained by A.A. Potapenko и M.R. Alex [6, 13], public healthcare is one of the spheres with the biggest number of problems for female health. Thus,

Table 2

Occupational risk of reproductive health disorders in female crane drivers

Reproductive system diseases	Frequency, $M \pm m, \%$	OR	CI 95 %	EF, %
Inflammations in female pelvis organs	53, $\pm 2,5$	1,44	0,77–2,70	23,08
Menstrual cycle disorders	24,3 $\pm 3,39$	2,16	1,04–4,46	46,67
Hysteromyoma	26,5 $\pm 3,48$	2,02	1,0–4,04	42,86
Mammary gland diseases	7,5 $\pm 2,08$	1,95	0,4–8,6	46,67
Infertility	17,5 $\pm 3,0$	2,44	1,0–4,76	54,29
Threat of miscarriage during the 1st half of pregnancy	84,7 $\pm 3,95$	15,53*	8,0–30,14	68,89
Threat of miscarriage during the 2nd half of pregnancy	66,6 $\pm 3,89$	20,75	9,9–43,18	86,81
Gestosis of the 1st half of pregnancy (toxicosis)	39,04 $\pm 3,39$	3,84*	1,8–7,8	63,41
Gestosis of the 2nd half of pregnancy	26,6 $\pm 2,92$	1,84	0,8–3,9	38,19
Iron deficiency anemia of pregnant	53,3 $\pm 3,72$	2,57	1,39–7,7	42,31
Chronic intrauterine hypoxia	37,1 $\pm 3,33$	7,09*	3,12–16,09	79,29
Intrauterine arrested development of a fetus	20,0 $\pm 2,61$	7,33*	2,2–23,6	83,52

Note: * – changes are statistically significant, $P < 0.05$.

Table 3

Occupational risk of reproductive health disorders in female workers employed at petrochemical productions

Reproductive system diseases	Frequency, $M \pm m, \%$	OR	CI 95 %	EF, %
Inflammations	53,9 $\pm 2,5$	2,1*	1,14–3,79	33,3
Benign neoplasms in uterus and uterine adnexa	29,1 $\pm 2,3$	2,00	1,29–3,12	41,1
Fibrous-cystic mastopathy	24,8 $\pm 2,2$	2,23*	1,01–4,9	48,0
Menstrual function disorders	9,5 $\pm 1,5$	2,06	0,95–4,47	49,1
Infertility	6,3 $\pm 1,2$	3,10	0,4–24,6	66,7
Spontaneous miscarriages	8,9 $\pm 1,4$	2,22	1,00–5,10	52,3

Note: * – changes are statistically significant, $P < 0.05$

danger category of working conditions of surgeons, dentists, obstetrician-gynecologists, phthisiologists, nurses, and workers employed at clinical-diagnostic and bacteriological laboratories was assessed as 3.3; radiologists, physical therapists, and functional diagnostics experts, as 3.2. We should also highlight joint effects exerted by chemical and biological factors together with labor hardness and intensity which occur in these occupations.

We detected high gynecological morbidity among public healthcare workers especially such ones as menstrual health

disorders, inflammations, and genital organs descent.

We revealed occupational causality of reproductive disorders practically for all the examined occupations, especially for obstetrician-gynecologists and surgical nurses (Table 4).

As we analyzed pregnancy and birth pathologies in medical workers we revealed that all the birth complications occurred in them authentically more frequently ($p < 0.001$), than in the control group (94.5 ± 0.79 against 59.31 ± 4.08 in the control group).

Table 4

Occupational risk of reproductive disorders in medical workers

Reproductive system diseases (ICD 10)	Obstetrician-gynecologists				Surgical nurses			
	$M \pm m, \%$	OR	CI 95 %	EF, %	$M \pm m, \%$	OR	CI 95 %	EF, %
Menstrual cycle disorders	$22,4 \pm 3,5$	2,28	1,21–4,30	63	$32,5 \pm 3,7$	2,58	1,47–4,53	61
Inflammations in female pelvis organs	$28,8 \pm 4,1$	2,23	1,13–3,65	55	$32,5 \pm 3,7$	2,10	1,34–3,29	53
Genital organs descent	$12,0 \pm 2,9$	2,65	1,11–6,31	63	$32,5 \pm 3,7$	2,22	1,0–4,93	54
Threat of miscarriage	$34,5 \pm 4,5$	2,82	1,90–4,19	46,5	$32,5 \pm 3,7$	2,35	1,66–3,33	57,6
Gestosis of the 2nd half of pregnancy	$20,0 \pm 3,8$	2,07	1,25–3,43	25,0	$32,5 \pm 3,7$	1,87	1,24–2,84	46,8

Note: * – ICD 10 is international classification of diseases, the 10th review

Discussion. As a result of the performed research we detected that occupations with high risks related to reproductive health disorders in workers and pathologies in children during their first year of life were the following:

- patternmakers and checkers in civil engineering and crane drivers in metallurgy;

- chemical analysis laboratory workers and chemical engineers in chemical industry (including petrochemical production, polymer processing, and organic synthesis);

- surgeons, obstetrician-gynecologists, midwives, and surgical nurses employed at in-patient hospitals.

Our assessment of correlations between reproductive system diseases and working conditions and occupational causality of such diseases revealed that women who had to work under hazardous conditions (3.1-3.3 danger category) had pregnancy complications and birth pathologies which were highly and averagely correlated to their working conditions. Health disorders in newborns were assessed as being greatly correlated to a mother's work. So, we can consider a fact of a mother's occu-

occupational risk inducing health disorders in a newborn to be fundamentally proven. Basing on the obtained results, we assigned certain occupations into highly risky one as per reproductive health disorders; those were occupations with 3.2 danger category as per hazardous working conditions. Summary data on occupational causality of reproduction disorders and degree of correlation between these disorders and work of females employed in the examined industries are given in Table 5.

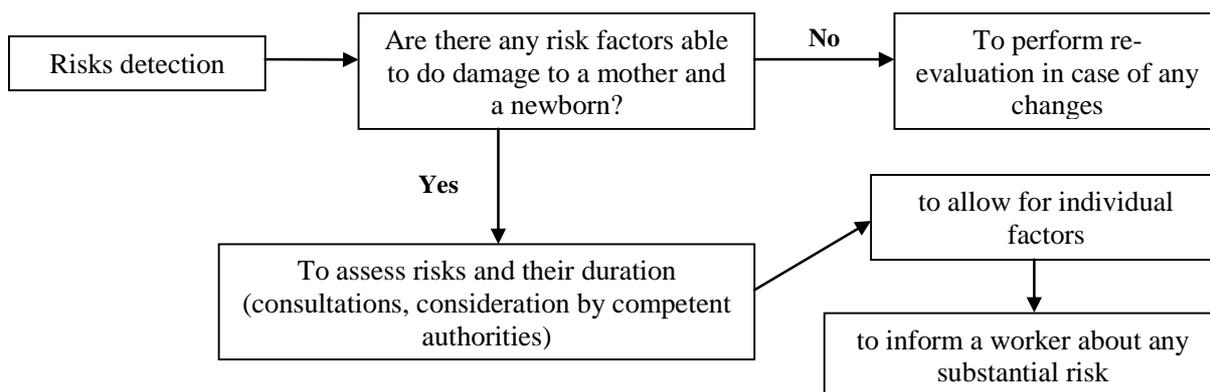
To decrease occupational risks for reproduction in female workers, we created an algorithm of actions aimed at managing this risk (Figure). A primary assessment of the risk for all the women of childbearing age is performed at the first stage; it can be a re-assessment in case any changes occur, for example, pregnancy, recent childbirth, or breastfeeding. It is also necessary to give female workers complete information on a potential risk both for their own health and for health of a newborn.

Table 5

Occupational causality of reproductive health disorders in a number of occupations from some industries

Reproductive health parameters	Public healthcare	Metallurgy	Chemical industry	Petrochemical industry	Civil engineering
Menstrual cycle disorders	high		very high	high	
Benign neoplasms	high	average	high	average	
Infertility		high	high	high	
Metroptosis and colpoptosis	very high			average	average
Inflammation in pelvis organs				high	very high
Anemia of pregnant	average	average			
Threat of miscarriage during the 1st half of pregnancy	high	very high	average	high	average
Threat of miscarriage during the 2nd half of pregnancy	high	almost full	average	high	average
Gestosis of the 1st half of pregnancy		high			
Gestosis of the 2nd half of pregnancy	average	average	average	very high	very high
Intrauterine hypoxia of a fetus		very high	very high		
Congenital malformations of a fetus			high		
Intrauterine arrested development of a fetus		almost full			
Stillbirths			average		
Perinatal damage to central nervous system			high		
Preterm delivery			high		
Miscarriages				high	average

Stage 1



Stage 2

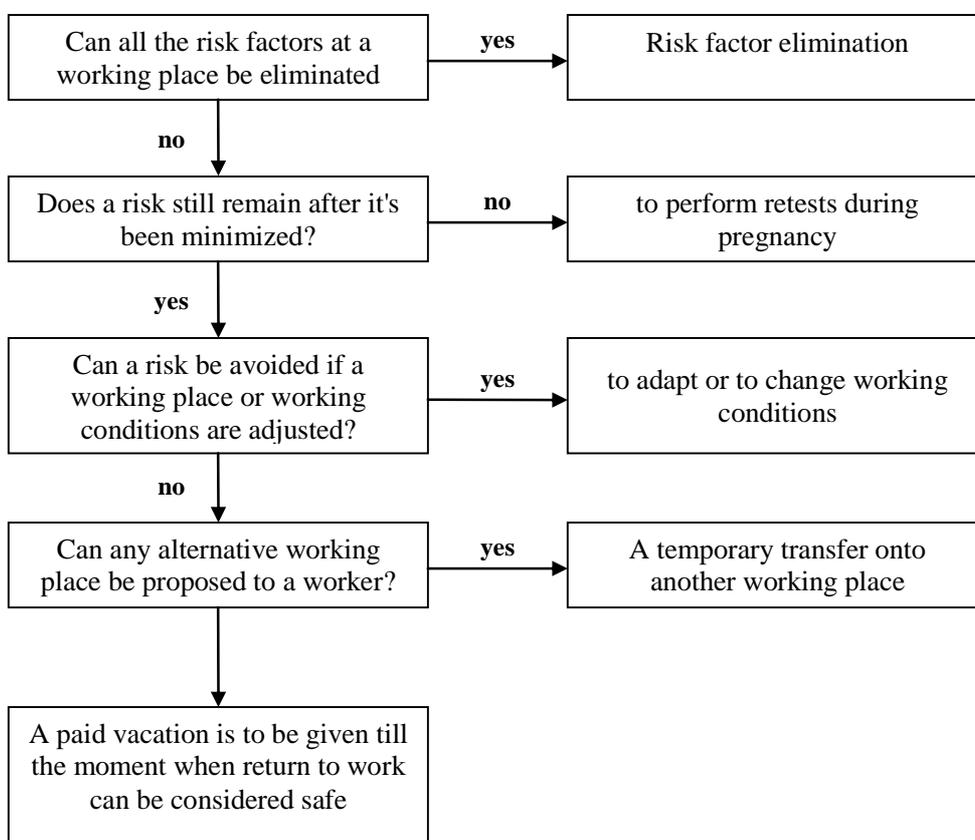


Figure. An algorithm for managing occupational risks for the reproductive system

The second stage in risk management comprises issues of eliminating risk factors at a working place. It is obvious that a situation in which risk factors can be eliminated and permissible working conditions are created is the most preferable.

But if a risk still remains after its minimization it is necessary to take further steps aimed at a working place adjustment (for example, to apply up-to-date engineering and design solutions, improved equipment and technological processes), and working conditions improvement.

If even a minimal risk for a female worker's reproductive health still exists, it is necessary to offer a temporary transfer to an alternative working place, or in case there isn't any, to grant a paid vacation till the moment when return to work is considered to be completely safe.

This created algorithm can be applied in any sphere of activity where women are employed.

References

1. Denisov E.I., Stepanyan I.V., Chelishcheva M.Yu. Professional'nyi risk: direktorii-spravochnik (svid. o gos. registratsii № 2011610345 ot 11.01.2011) [Occupational risk: directory (State registration certificate No. 2011610345 issued on January 11, 2011)]. Available at: http://medtrud.com/#collapse_One (18.03.2016) (in Russian).
2. Ivanova M.K., Sitdikova I.D., Vaziev I.K., Sitdikov A.R. Reproduktivnoe zdorov'e rabotnikov s pozitsii tekhnogeneza [Reproductive health of workers from a position of technogenesis]. *Sovremennoe iskusstvo meditsiny*, 2011, no. 1, pp. 81–84 (in Russian).
3. Makarova-Zemlyanskaya E.N., Potapenko A.A. Reproduktivnoe zdorov'e rabotnits gal'vanicheskogo tsekha [Reproductive health of female workers employed at a electroplating shop]. *Gigienicheskaya nauka i sanitarnaya praktika v tvorchestve molodykh: Nauchno-prakticheskaya konferentsiya [Hygienic science and sanitary practices in youth creative work: brief outlines of reports made at a theory and practice conference]*. Mytishchi, 2005, pp. 87–90 (in Russian).
4. Morozova T.V., Fesenko M.A. Professional'nyi risk i reproduktivnaya patologiya rabotnikov polimerpererabatyvayushchei promyshlennosti [Occupational risk and reproductive pathology in workers employed at polymer-processing plants]. *Zhizn' bez opasnosti. Zdorov'e. Profilaktika. Dolgoletie*, 2012, vol. 7, no. 3, pp. 76–81 (in Russian).
5. Sivochalova O.V., Gainullina M.K., Yakupova A.Kh., Karimova L.K., Irmyakova A.R. Otsenka urovnya ginekologicheskoi zaboлеваemosti, etiologicheskii obuslovlennaya vozdeistviem na rabotnits toksicheskikh veshchestv [Evaluation of the level of gynecological morbidity, etiological caused by the impact on workers of toxic substances]. *Meditsina truda i ekologiya cheloveka*, 2015, no. 2, pp. 33–38 (in Russian).
6. Potapenko A.A. Reproduktivnoe zdorov'e meditsinskikh rabotnikov – zhenshchin [Reproductive health of medical workers-women]. *Zdravookhranenie*, 2013, no. 2, pp. 80–85 (in Russian).
7. Izmerov N.F., Sivochalova O.V., Fesenko M.A., Denisov E.I., Golovaneva G.V. Problema sokhraneniya reproduktivnogo zdorov'ya rabotnikov pri vozdeistvii vrednykh faktorov proizvodstvennoi i okruzhayushchei sredy [The issues of workers reproductive health protection from harmful occupational and environmental exposures]. *Vestnik Rossiiskoi akademii meditsinskikh nauk*, 2012, no. 12, pp. 47–53 (in Russian).
8. Babanov S.A., Agarkova I.A., Lipatov I.S., Tezиков Yu.V. Professional'nye porazheniya reproduktivnoi sistemy [Occupational damage to reproductive system]. *RMZh*, 2013, no. 17, pp. 917–920 (in Russian).
9. Sivochalova O.V., Fesenko M.A., Gainullina M.K., Denisov E.I., Golovaneva G.V. Professional'nyi risk reproduktivnykh narushenii, problemy i printsipy prognozirovaniya ikh u rabotnikov pri vozdeistvii khimicheskikh faktorov [Occupational risk for reproductive disturbances, problems and principles of their prediction in workers exposed to chemical factors]. *Sov-*

remennye problemy gigieny i meditsiny truda: Nauchno-prakticheskaya konferentsiya, Ufa, 2015, pp. 422–428 (in Russian).

10. Rukovodstvo po gigenicheskoj otsenke faktorov rabochei sredy i trudovogo protsessa. Kriterii i klassifikatsiya uslovii truda [Guidelines on hygienic assessment of working environment and working process factors. Working conditions criteria and classification. P. 2.2.2006-05]. Moscow, Federal'nyi tsentr gigieny i epidemiologii Rospotrebnadzora Publ., 2005, 142 p. (in Russian).

11. Sivochalova O.V., Fesenko M.A., Golovaneva G.V., Denisov E.I. Sokhranenie i ukreplenie reproduktivnogo zdorov'ya rabotnikov professii vysokogo riska: problemy i perspektivy [Protection and Improvement of Reproductive Health of Workers with High Risk Professions]. *Vestnik Rossiiskogo gosudarstvennogo meditsinskogo universiteta*, 2013, no. 5–6, pp. 73–77 (in Russian).

12. Alex M.R. Occupational hazards for pregnant nurses. *American Journal of Nursing*. 2011, vol. 111, no. 1, pp. 28–37. DOI: 10.1097/01.NAJ.0000393056.01687.40

13. Henrotin J.B., Vaissière M., Etaix M., Dziurla M., Radauceanu A., Malard S., Lafon D. Deprivation, occupational hazards and perinatal outcomes in pregnant workers. *Occup Med (Lond)*, 2017, vol. 67, no. 1, pp. 44–51. DOI: 10.1093/occmed/kqw148.

14. Henrotin J.B., Vaissière M., Etaix M., Dziurla M., Malard S., Lafon D. Exposure to occupational hazards for pregnancy and sick leave in pregnant workers: a cross-sectional study. *Ann Occup Environ Med*, 2017, vol. 29, pp. 12. DOI: 10.1186/s40557-017-0170-3.

15. Salihu H.M., Myers J., August E.M. Pregnancy in the workplace. *Occup Med (Lond)*, 2012, vol. 62, no. 2, pp. 88–97. DOI: 10.1093/occmed/kqr198.

Fesenko M.A., Sivochalova O.V., Fedorova E.V. Occupational reproductive system diseases in female workers employed at workplaces with harmful working conditions. Health Risk Analysis, 2017, no. 3, pp. 92–100. DOI: 10.21668/health.risk/2017.3.11.eng

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