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Research article

WORKING CONDITIONS AND WORK-RELATED PATHOLOGIES AT ENTERPRISES LOCATED IN CHUKOTKA AUTONOMOUS AREA

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For many years, morbidity with work-related diseases has been higher in Chukotka Autonomous Area (ChAA) than on average in Russia.

Our research objects were working conditions and morbidity with work-related diseases. Our research goal was to examine reasons for work-related pathology occurrence, its structure, and prevalence in ChAA in 2008–2018. We examined data obtained via social-hygienic monitoring in 2008–2018 in Chukotka, paying close attention to a section entitled «Working conditions and work-related pathology».

We established that noise (17.4 %) and cooling microclimate (11.8 %) were the most widely spread hazardous occupational factors in ChAA. 20.1 % workers were exposed to a combination of hazardous factors. 13.5 % workers were employed at industrial objects that belonged to the 1st surveillance group (the highest risks); 31.9 % worked at economic entities from the 3rd surveillance group (average risks). In 2008–2018 216 work-related diseases were first diagnosed in Chukotka, mostly among workers employed at mining enterprises (81.5 %). Sensorineural hearing loss / noise effects in the internal ear (35.2 %) and respiratory diseases (31.9 %) prevailed in their structure. 73.6 % diseases were detected due to patients applying for medical aid themselves. In 2008–2015 there was a steady growth in work-related morbidity (from 1.94 to 13.5 per 10,000 workers), but there was a decrease in it in 2016–2018 (down to 5.11 per 10,000 workers) with considerable fluctuations in numbers of first diagnosed diseases. Risks of work-related pathology occurrence were higher in Chukotka in 2018 than in 2008: OR=2.37; CI 1.82–3.09; χ^2=43.8; p<0.001.

To prevent work-related pathology in Chukotka, it is necessary to continue activities aimed at working conditions improvement, in particular, reducing exposure to noise and aerosols with predominantly fibrogenic effects in mining industry in the region.

Key words: *social-hygienic monitoring, working conditions, work-related morbidity, Chukotka Autonomous Area (ChAA), occupational factors, noise, cooling microclimate.*

According to the RF President Order issued on May 02, 2014 No. 296 (last edited on May 13, 2019) the Chukotka Autonomous Area (ChAA) that is located in the in the north-east of the country is included into the Arctic zone of the Russian Federation. The region has some specific features such as extreme climatic conditions, low population number (49.3 thousand people in 2018) and density (0.07 person per 1 square kilometer), and poorly developed social and economic infrastructure. Basic economic activities in ChAA are mining (black and brown coal, gold, and silver), construction, energy production and distribution [1, 2]. It is well known that workers employed in mining, a leading branch in ChAA, are among those occupational groups that run elevated risks of occupational pathology occurrence [3–5]. Arctic climatic conditions make an additional contribution into probability of health disorders [6, 7]. Such disorders are caused by overall and local exposure to cold, high humidity, apparent seasonal photoperiodicity, strained ion-magnetic re-

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gime, and other factors [8–10]. It is proven that combined exposure to these factors creates a so called «northern or arctic stress» that results in untimely decrease in adaptive resources of a body or even their depletion [10, 11].

In 2008–2018 ChAA was among RF regions with occupational morbidity levels being higher than on average in the country; they varied from 1.92 (2008) to 13.5 (2015) cases per 10 thousand people[1, 2]. Arctic zones are usually poorly inhibited and labor resources there are scarce; therefore, when people cease their working activity too early due to occupational diseases while still being of employable age, it creates additional social and economic problems for regional development [12, 13]. The document entitled «The Basics of the RF State Policy in the Arctic zone for a period up to 2020 and further on»[3] set a task that scientists have to solve, namely, to achieve proper functioning of life support systems and occupational conditions in Arctic regions. A part of this task is to examine influence exerted on a human body by adverse environmental factors, including occupational ones. Industrial objects in ChAA are located far away from cities where medical theory and practice are most developed and it makes examining health of workers employed at hazardous productions in remote districts in the Polar zone even more vital.

Our research goal was to examine reasons, structure, and prevalence of occupational pathology in ChAA.

Data and methods. We examined data obtained via «Working conditions and occupational pathology» social and hygienic monitoring program in ChAA in 2008–2018. All the data were provided by the Federal Center for Hygiene and Epidemiology of the Federal Service for Surveillance over Consumer Rights Protection and Human Well-being (Moscow).

We processed research data with Microsoft Excel 2010 and Epi Info, v. 6.04; we also calculated Student's t-test for independent samplings, relative risk (RR), 95 % confidence interval (CI), and test of fit χ^2. Numeric data were given as simple mean and error of the mean ($M \pm m$). Critical significance of a zero hypothesis was taken as 0.05.

Results and discussion. In 2008–2018 several adverse occupational factors prevailed at workplaces at most industrial enterprises (each having a share that exceeded 7 %) and workers were exposed to them; they included elevated noise levels, cooling microclimate, aerosols with fibrogenic effects, labor hardness being higher than permissible levels, overall vibration, non-ionizing electromagnetic fields (EMF) and electromagnetic radiation (EMR). More than one fifth of workers were exposed to more than one adverse factor. Attention should be paid to drastic (2 times and higher) annual fluctuations in number of workers exposed to aerosols with fibrogenic effects, labor hardness, unfavorable lighting environment, and other adverse occupational factors. And there were both rises and falls in their levels without any apparent regularities (Table 1).

As compared with 2008, in 2018 there was greater risks of workers being exposed to elevated local vibrations (RR = 2.15; CI 1.82–2.54; $\chi^2 = 83.6$; $p < 0.001$), labor intensity (RR = 1.45; CI 1.20–1.75; $\chi^2 = 15.3$; $p < 0.001$), non-ionizing EMF and EMR (RR = 1.22; CI 1.12–1.34; $\chi^2 = 19.4$; $p < 0.001$), unfavorable lighting environment (RR = 3.15; CI 2.71–3.66; $\chi^2 = 249.9$; $p < 0.001$), and several adverse factors combined (RR = 1.91; CI 1.80–2.02; $\chi^2 = 514.9$; $p < 0.001$). And on the contrary, in 2008 as opposed to 2018, there was greater probability of exposure to aerosols with fibrogenic effects (RR = 2.33; CI 2.11–2.58;

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$\chi^2 = 293.7$; $p < 0.001$), noise (RR = 1.19; CI 1.12–1.26; $\chi^2 = 33.7$; $p < 0.001$), chemical factors (RR = 2.42; CI 2.18–2.67; $\chi^2 = 320.7$; $p < 0.001$), labor hardness being higher than permissible levels (RR = 1.39; CI 1.27–1.52; $\chi^2 = 52.2$; $p < 0.001$), biological factors (RR = 1.69; CI 1.42–2.00; $\chi^2 = 37.3$; $p < 0.001$), ionizing radiation (RR = 2.37; CI 1.45–3.88; $\chi^2 = 12.7$; $p < 0.001$), cooling microclimate (RR = 1.31; CI 1.20–1.42; $\chi^2 = 40.1$; $p < 0.001$). Therefore, in 2008–2018 there was both increase and decrease in prevalence of certain adverse occupational factors on enterprises in ChAA and we can't state that working conditions have improved there.

We also performed a complex assessment of working conditions based on data obtained via surveillance over workers distributed into three groups according to sanitary-epidemiologic welfare at their workplaces. It was established that on average in 2008–2018 more than half workers in CAA were employed at industrial objects belonging to the 2nd group (unsatisfactory conditions at workplaces), almost one third were employed at industrial objects form the 3rd group (with extremely unsatisfactory conditions), and only 13.5 % workers were employed at industrial objects from the 1st group (satisfactory conditions). Overall number of workers employed at objects under surveillance in ChAA decreased by more than 5 thousand people or 38.3 % over the examined period of time.

During 11 years (in 2008 against 2018) there was a decrease in absolute number of workers employed at industrial objects belonging to the 1st and 2nd groups, but their shares among all employed workers increased ($p < 0.001$). As for the 3rd group, there was a decrease both in absolute number of workers employed there and their share as well ($p < 0.001$). Therefore, this re-distribution of workers employed at industrial objects under surveillance belonging to three groups indicated that working conditions improved at industrial enterprises in ChAA in 2008–2018 (Table 2).

In 2008–2018 in ChAA occupational pathology was first diagnosed in 171 workers, 170 of them being males (99.4 %) and only one woman (0.6 %). Overall, 216 occupational diseases were diagnosed or 1.26 cases per one worker. Their average age was 55.3 ± 0.5 and their average working experience amounted to 26.9 ± 0.6 years. 110 people (64.3 %) lived in Anadyr district; 44 people (25.7 %), Bilibinskiy district; 10 people (5.8 %), Iul'tinskiy district (Egvekinot municipal district); and 7 people (4.1 %), Chaunskiy district (Pevek municipal district).

Table 1

Number of workers exposed to adverse occupational factors

Adverse occupational factor	Year						Average annual value
	2008	2010	2012	2014	2016	2018	
Noise	2,223	2,427	1,549	2,257	1,282	1,666	1,900.7 (17.4 %)
Cooling microclimate	1,254	1,914	1,167	1,673	887	860	1,292.5 (11.8 %)
Fibrogenic aerosols	1,321	1,386	639	664	479	488	829.5 (7.6 %)
Labor hardness	1,124	611	313	1,503	582	723	809.3 (7.4 %)
Overall vibration	727	1,091	711	916	603	731	796.5 (7.3 %)
Non-ionizing EMF and EMR	835	281	661	874	959	953	760.5 (7.0 %)
Chemical factors	1,359	644	623	943	394	483	741.0 (6.8 %)
Lighting environment	218	346	347	1,389	499	658	576.2 (5.3 %)
Local vibration	198	227	201	604	209	399	306.3 (2.8 %)
Labor intensity	186	26	190	986	157	250	299.2 (2.7 %)
Biological factors	372	466	202	282	204	202	288.0 (2.6 %)
Infrasound	67	71	161	123	64	44	77.2 (0.7 %)
Ionizing radiation	57	27	18	68	39	22	38.5 (0.4 %)
Combined exposure to several factors	1,426	1,718	1,665	2,234	3,109	2965	2,197.3 (20.1 %)
All factors	11,367	11,235	8,447	1,4516	9,467	10,444	10,912.7

Table 2

Number and share (%) of workers employed at objects from three groups with different sanitary-epidemiologic welfare

Surveillance group	Year						Average annual value
	2008	2010	2012	2014	2016	2018	
1st	2,348 (12.0)	2,145 (10.7)	2,401 (14.8)	2,081 (14.1)	1,728 (12.1)	2,048 (14.5)	2,125 (13.5)
2nd	9,333 (47.7)	10,384 (52.0)	8,080 (49.8)	7,479 (50.5)	8,258 (58.0)	7,827 (55.3)	8,560 (54.5)
3rd	7,895 (40.3)	7,446 (37.3)	5,728 (35.3)	5,249 (35.4)	4,258 (29.9)	4,275 (30.2)	5,009 (31.9)
Overall	19,576 (100.0)	17,500 (100.0)	16,209 (100.0)	14,809 (100.0)	14,244 (100.0)	14,150 (100.0)	15,694 (100.0)

Table 3

Reasons for occupational diseases occurrence at enterprises in CAA

Parameter	Occupational diseases (cases)
Factors causing occupational diseases:	
noise	76 (35.2 %)
aerosols with fibrogenic effects	68 (31.5 %)
local vibration	27 (12.5 %)
labor hardness	25 (11.6 %)
overall vibration	16 (7.4 %)
chemical factors	2 (0.9 %)
cooling microclimate	2 (0.9 %)
Circumstances causing occupational diseases occurrence:	
underdeveloped technological processes	139 (64.4 %)
design defects of machinery, mechanisms, equipment, appliances, and tools	53 (24.5 %)
malfunction of machinery, mechanisms, equipment, appliances, and tools	24 (11.1 %)

Occupational pathology occurred in workers employed in three brunches. 176 disease cases (81.5 %) were diagnosed in workers employed in mining including 106 coal miners and 70 mineral ore miners. 38 disease cases (17.6 %) were revealed in workers employed in transportation including 33 cases among air transport workers. 2 occupational diseases (0.9 %) were diagnosed in workers dealing with energy production and distribution.

7 out of 13 adverse occupational factors which workers contacted at their workplaces in ChAA were related to occupational pathology occurrence. In-plant noise and aerosols with fibrogenic effects had the greatest etiological significance. Physical factors (noise, local and overall vibration) prevailed (55.1 %) in the structure of adverse occupational factors that caused occupational diseases.

In most cases occupational pathology occurred due to technological processes being underdeveloped. A much smaller contribution was made by design defects and malfunctions in machinery, mechanisms, equipment, appliances, and tools (Table 3).

Diseases of the ear, respiratory organs, nervous and musculoskeletal system prevailed in the structure of occupational pathology diagnosed in workers employed at industrial enterprises in ChAA. Injuries, poisonings, and some other consequences of external causes were much less frequent. The most widely spread nosologies were such occupational pathologies as noise effects in the internal ear (sensorineural hearing loss), chronic bronchitis, mono- and polyneuropathy. Respiratory diseases (chronic bronchitis, pneumoconiosis) were predominantly diagnosed in coal miners. All occupational disorders were chronic diseases. Occupational pathology was much more frequently diagnosed when workers applied for medical aid themselves in case they felt sick rather than during obligatory medical examinations (Table 4).

Table 4

Clinical features of occupational pathology

Parameter	Occupational diseases (cases)
Nosologic groups including diseases of	
ear and mastoid	76 (35.2 %)
respiratory organs	69 (31.9 %)
nervous system	28 (13.0 %)
musculoskeletal system and connective tissue	26 (12.0 %)
injuries, poisonings, and some other external causes	16 (7.4 %)
malignant neoplasms	1 (0.5 %)
Most widely spread diseases:	
noise effects in the internal ear (sensorineural hearing loss)	76 (35.2 %)
chronic bronchitis	50 (23.1 %)
mono- and polyneuropathy	27 (12.5 %)
pneumoconiosis	19 (8.8 %)
vibration disease	16 (7.4 %)
radiculopathy	15 (6.9 %)
An occupational disease revealed via:	
patients applying for a medical aid on their own initiative	159 (73.6 %)
periodical medical examination	57 (26.4 %)

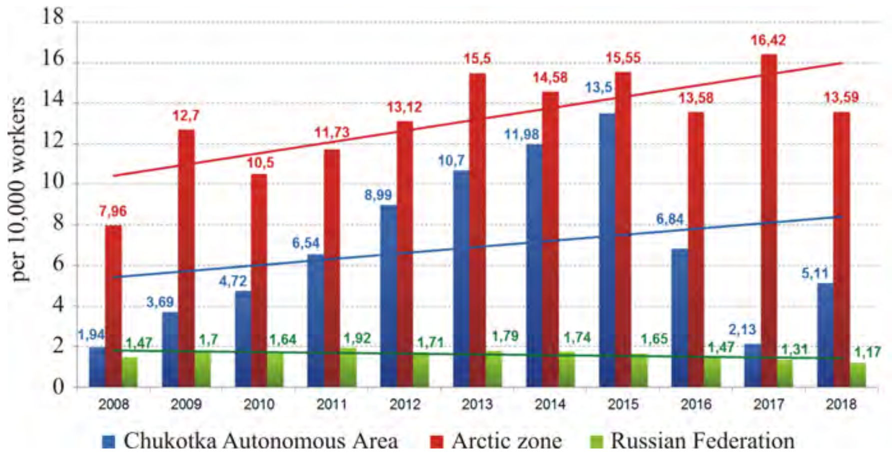

Figure. Occupational morbidity in Chukotka Autonomous Area, Arctic zone in the RF, and the country as a whole (per 10,000 workers)

Annual number of occupational diseases that were diagnosed for the first time varied within a wide range from 6 (2008 and 2017) up to 37 (2015) people. It led to significant changes in occupational morbidity levels among workers employed at industrial enterprises in ChAA. The parameter grew steadily in 2008–2015 and it went down in 2016–2018. As opposed to ChAA, in 2008–2018 overall there was an ascending trend in occupational morbidity in the Arctic zone in the Russian Federation. In Russia as a whole the parameter leveled off in 2008–2013 and then decreased in 2014–2018 (the trend was descending). In 2008–2015 dynamics of occupational morbidity in the Arctic zone as a whole and ChAA in particular was rather similar. There were significant discrepancies in 2016–2018 and it was impossible to detect any relation between drastic fluctuations in a number of first detected occupational pathology cases in ChAA and any objective factors, primarily, changes in working conditions existing at industrial enterprises in the region. Occupational pathology risk in ChAA was higher in 2018 than in 2008: RR = 2.37; CI 1.82–3.09; $\chi^2 = 43.8$; $p < 0.001$ (Figure).

It could be assumed a priori that higher occupational morbidity in ChAA occurred, first of all, due to peculiar economic structure in the region and its natural and climatic specificity. The present work quite logically revealed that more than 80 % occupational pathology cases were detected among miners. Occupational pathologies were similarly distributed as per economic activities in other Arctic regions with developed mining industry such as Murmansk region, polar zones in Krasnoyarsk region, and Komi Republic [5, 14, 15]. It is well-known that it is prohibited to employ women at mining enterprises or mines or their labor is strictly limited at such industrial objects[4]. Very few cases of occupational diseases among women in ChAA can be explained with mining industry prevailing in ChAA as their share is only 0.6 % whereas it amounts to 14.24 %[2] in Russia as a whole and is rather high in such regions as Samara region (29.1 %)[5], Leningrad region (43.2 %)[6], and Buryatia (21.6 %) [16].

Almost all work-related pathology cases (98.2 %) were etiologically related to five adverse occupational factors, namely, in-plant noise that was higher than permissible levels, aerosols with fibrogenic effects, labor hardness, local and overall vibration. Drastic fluctuations in adverse factors prevalence detected over the 11-year observation period were probably cue to methodical defects distorting their assessment. Only 2 (0.9 %) occupational pathology cases were related to cooling microclimate that was typical for extreme climatic conditions in Chukotka. Therefore, local and overall exposure to cold seems underestimated but we should remember that these adverse factors can cause reduction in physical and mental working capacity, coordination disorders, pathologies in the musculoskeletal system, and greater risks of occupational injuries [17–19]. Assumed underestimated impacts exerted by cold on workers' bodies can be due to peculiarities of methodology applied to perform specific assessment of working conditions.

As for positive changes in working conditions, we should mention that in 2008–2018 there was a descending trend in exposure to two most significant adverse factors, namely elevated noise levels and aerosols with fibrogenic effects that accounted for 35.2 % and 31.9 % occupational pathology cases accordingly. There was also a decrease in a share of workers employed at industrial objects belonging to the 3rd hazard group with extremely unfavorable sanitary-epidemiologic situation; and there was a simultaneous increase in number of workers employed at industrial objects form the 1st group (satisfactory working conditions). But at the same time, in spite of all these improvements, a share of workers employed at industrial objects with extremely unfavorable working conditions (31.9 %) in ChAA was significantly higher that on average in the country where the figure was equal to 7.13 %–9.44 % in 2013–2018. And on the contrary, a share of workers employed at industrial objects with satisfactory working conditions was 2 times lower in ChAA than on average in the country (13.5 % against 26.03–27.59 %)[2].

Another alerting fact was a significant change (up to 6 times) in annual number of first diagnosed occupational diseases and it allows assuming that performed medical examinations were not qualitative enough [20, 21]. Other possible evidence here can be an unusually high number of occupational diseases that were diagnosed as a result of workers applying for medical aid themselves (73.6 %). For example, the same parameter amounted to 40.7 % in Krasnoyarsk region [14] and to 12.0 % in Nenets Autonomous Area [22].

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Conclusion. Occupational morbidity in ChAA is steadily higher than on average in the country due to poorer working conditions than in the country in general. Occupational pathology predominantly occurs in workers employed at mining enterprises; noise effects in the internal ear (sensorineural hearing loss) and respiratory diseases prevail in the structure of occupational morbidity. Occupational pathology prevention requires continuous activates aimed at working conditions improvements; first of all, there should be a considerable reduction in exposure to noise and aerosols with fibrogenic effects at mining enterprises in the region.

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