AGE AND EXPERIENCE FEATURES OF DEVELOPMENT AND STRUCTURE OF HEALTH DISORDERS IN KOLA POLAR MINERS

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ABSTRACT

Introduction. The health status of a working person is determined mainly by his age, as well as by the intensity and duration of exposure to harmful production factors.
The aim of the study was to assess the age and seniority characteristics of health disorders development in underground miners of the Kola Polar region.
The material of the study included data from periodic medical examinations of 1828 miners who carried out underground mining of apatite-nepheline and copper-nickel ores. All of them had harmful working conditions of hazard classes 3.1-3.3.
Results. It was found that at the beginning of their labor activity, miners have high rates of diseases of the eyes, respiratory and digestive organs, skin, and infectious pathology. During working life, there is an increase in the likelihood of developing musculoskeletal, nervous systems, circulatory, and ear diseases. At the same time, the importance of diseases of the eye and its appendages, respiratory and digestive organs, skin, infectious and parasitic diseases decrease with increasing age and length of service. The most significant negative changes in the health of miners occur at the age of 30-49 years and with a length of service of 6-15 years. During the labor activity, the number of diseases diagnosed in one worker increases 3.14-4.15 times, and the number of practically healthy persons among miners decreases from 20.9-22.0% to zero.
Conclusion. The study of the health status of miners, taking into account changes in age and experience, makes it possible to predict age and seniority periods of increased risk of developing various classes of chronic pathology and to determine the periods of the most effective preventive measures.

KEYWORDS miners, age, experience, health risks, chronic diseases, Kola Polar region

Introduction

It is common knowledge that the health condition of a working person is determined mainly by his/her age, as well as by intensity and duration of exposure to harmful industrial factors [1]. Human biological ageing is a natural genetically determined process of functional and morphological changes in organs and systems, which leads to limitation of organism adaptation to the ambient and occupational environment [2, 3]. Ageing results inage-related pathology, which is more or less clearly associated with certain biologicalperiods of human body development [4, 5].

Constant improvement of working conditions and personal protective equipment does not prevent exposure of almost all underground mining workers to harmful industrial impacts [6-8].

These include, first of all, general and local vibration, noise, coal and gas mixtures, physical overwork, work in constrained and uncomfortable postures, unfavourable parameters of workplace environment [9-11].

Musculoskeletal disorders prevail among miners' health problems caused by exposure to harmful working conditions. However, vibration disease, hearing disorders, respiratory and nervous system diseases are also widespread [12-15].

It has been demonstrated that increased duration of work in hazardous conditions (length of service) significantly raises the risk of musculoskeletal, nervous, circulatory and respiratory disorders [16, 17], and recently, high rates of occupational disease are accompanied by increment in age and working life of sick persons [18].

In practice, to minimize occupational health risks it is important to consider miners' age and length of service. Measures applied include establishing of a minimum age for admission to underground mining; reduction of age and employment period required to get retirement benefits; increase of annual paid leave duration; and periodic changes of operations involving different harmful industrial factors. However, the critical thresholds of age and work experience, at which high (very high) risks of general and occupational diseases arise, as well as age and experience features of development and structure of chronic pathology and prevalence among miners remain largely unknown. The answer to these questions will allow to differentiate health improving programs at various stages of miners' professional career.

The research objective was to study age and experience features of development of health disorders among miners of the underground mines in the Kola Peninsula.

Materials and methods

The data of periodic medical examinations of 1828 workers who perform deep mining of apatite-nephelinic and copper-nickel ores in the Kola Peninsula have been studied. The scope and procedure for examinations conformed to the provisions of Order No. 302n of the Ministry of Health and Social Development of the Russian Federation of 12.04.2011, ed. on 18.05.20[1]. To achieve the objective, six age groups (under 20 years, 20-29 years, 30-39 years, 40-49 years, 50-59 years, 60 years and more) and six age and experience groups (under 6 years, 6-10 years, 11-15 years, 16-20 years, 21-25 years, 26 years and more) of workers were identified. Miners' health condition was assessed by extensive and intensive indicators (absolute number of diseases, proportion of diseases of one category in the total pathology structure, number of diseases per 100 workers).

The statistics of the examination results was processed using Microsoft Excel 2010 and Epi Info, v. 7.0. Student t-criterion, $\chi 2$ agreement criterion, relative risk (RR) and 95% confidence interval (CI), Pearson correlation coefficient (r) were calculated. Numerical data are presented as absolute values, percentages, arithmetic mean and standard error of arithmetic mean (M±m). Significance level of null hypothesis was 0.05.

Results of the Study

One thousand eight hundred twenty eight miners of underground apatite-nepheline and copper-nickel mines in the Kola Peninsula were examined. They were all male, with a mean age of 38.8±0.3 years, and 11.7±0.2 years of work experience in the mines. There was a high value of correlation between age and work experience according to Chaddock scale (r = 0.824).

The individuals examined included 473 (26.0%) underground wiremen (electric fitters), 209 (11.5%) underground electric locomotive drivers, 182 (10.0%) shotfirers, 149 (8.2%) underground

1 *Order of the Ministry of Health and Social Development of Russia dated 04/12/2011 No. 302n (ed. on 05/18/2020) «On approval of the lists of harmful and (or) hazardous production factors and works, during which mandatory preliminary and periodic medical examinations (examinations) are carried out, and the Procedure conducting mandatory preliminary and periodic medical examinations (examinations) of workers engaged in heavy work and in work with harmful and (or) dangerous working conditions.»*

miners, 143 (7.9 %) load-haul-dumper drivers, 133 (7.3%) electric and gas welders, 97 (5.3%) shaftmen, 94 (5.2%) borehole and drilling machine operators, 71 (3.9%) timbermen and 267 (14.7%) other workers.

Workers of all qualifications were engaged in underground work with hazardous working conditions. Shaftmen, borehole drillers, underground miners, timbermen, shotfirers, underground electric locomotive drivers and crusher operators had final grade of working conditions 3.3 (3rd grade hazardous working conditions). Working conditions of drilling machine operators, load-haul-dumper drivers, underground self-propelled machine drivers, underground electric locomotive drivers, electric and gas welders, underground wiremen, chute drawers and explosive distributors were rated as 3.2 (2nd grade hazardous working conditions), and as for the working conditions of bottom men, hoisting machine operators, lampmen, mine foreman, they were rated as 3.1 (1st grade hazardous working conditions).

Medical examination of miners based on their age has revealed significant differences in the structure and prevalence of chronic pathology in the six identified groups, as well as a number of patterns in their development while workers grow older (Table 1). Age group of maximum 20 years old (mean age 18.9±0.1 years) appeared to be few due to a sharp restriction in the number of miners of this age.

However, a comparison of the group of maximum 20 years old and 20-29-years age group (mean age 25.0±0.1 years) showed no significant differences between them. This afforded ground to use the 20-29-years age group as the baseline health condition of miners in the statistical processing of the study materials, rather than the fewer age group of maximum 20 years old.

A peculiarity of the above two groups was that they were characterized by predominantly "accumulated" pre-employment diseases. Diseases of eye and its appendages (23.3% in the total pathology structure and 32.3 cases per 100 workers), followed by respiratory diseases, musculoskeletal and digestive systems, skin, infectious and parasitic diseases, prevailed in their structure. Diseases of other categories were significantly less prevalent, 0.9%-4.7% in the total pathology structure at 3.2-9.7 cases per 100 workers. According to medical examinations, one fifth of workers in the two groups were apparently healthy.

In the 30-39-years age group (mean age 34.1±0.1 years), compared with the 20-29-years group, there was an increase in the number of diseases diagnosed per one worker ($p<0.001$) and a decrease in the number of apparently healthy individuals ($p<0.001$). Prevalence of musculoskeletal diseases, which came first in the general pathology structure, increased ($p<0,001$), while diseases of the eye and its appendages ($p<0,001$), infectious and parasitic diseases ($p=0,039$) and skin diseases ($p=0,003$) decreased. The risk of health disorders at the age of 30-39 years old was higher than at age of 20-29: RR=1.13; CI 1.06-1.19; $\chi 2=16.4$; $p<0.001$.

At the age of 40-49 years old (mean age 44.9±0.1 years), there was a continued increase in the number of cases per worker ($p<0.001$) and a decrease in the number of apparently healthy individuals ($p<0.001$), both compared with the baseline and with the previous age group. Extensive and intensive prevalence rates for musculoskeletal diseases continued to rise ($p<0.001$), and were first found for the nervous system ($p=0.014$) and circulatory system ($p=0.003$) diseases. The opposite trend was observed for diseases of the eye ($p<0.001$), digestive ($p<0.001$) and respiratory ($p<0.001$) diseases. At the age of 40-49 years old, the proportion of ear and mastoid diseases for the first time exceeded the baseline ($p=0.019$).

The risk of health disorders in this group exceeded both the baseline level (RR=1.22; CI 1.16-1.28; $\chi 2=692$; $p<0.001$) and the level of 30-39 years old (RR=1.08; CI 1.04-1.12; $\chi 2=18.4$; $p<0.001$).

The increased number of diseases detected per worker ($p<0.001$) followed age increment to 50-59 years, while the number of apparently healthy individuals did not decrease ($p=0.456$). Pathology changes were less

Table 1

Health condition of miners of different age groups

Indicator	Age					
	< 20 years old (n=31)	**20-29 years old (n=474)**	**30-39 years old (n=429)**	**40–49 years old (n=532)**	**50–59 years old (n=323)**	**≥ 60 years old (n=39)**
Average age, y.o.	18,9±0,1	25,0±0,1	34,1±0,1[1]	44,9±0,1[1,2]	53,6±0,2[1,2]	60,9±0,2[1,2]
Average work experience, years	1,16±0,07	3,19±0,09	8,07±0,20[1]	16,7±0,3[1,2]	20,5±0,3[1,2]	21,1±1,0[1]
Number of diseases, cases	43	657	981	1901	1587	225
Number of diseases per worker, cases	1,39±0,19	1,39±0,05	2,30±0,09[1,2]	3,57±0,11[1,2]	4,93±0,16[1,2]	5,77±0,46[1]
Apparently healthy workers / %	6/19,4	99/20,9	47/11,0[2]	20/3,8[1,2]	9/2,9[1]	0[1]
Categories of diseases, cases /% of disease structure / per 100 employees						
diseases of eyes and their appendages	10/23,3/32,3	177/26,9/37,3	168/17,1[2]/39,2	238/12,5[1,2]/44,7	191/12,0[1]/59,1	27/12,0[1]/ 69,2
respiratory diseases	7/16,3/22,6	116/17,7/24,5	154/15,7/35,9	173/9,1[1,2]/32,5	128/8,1[1]/39,6	17/7,6[1]/43,6
musculoskeletal disorders	6/14,0/19,4	114/17,4/24,1	293/30,0[1]/68,3	843/44,3[1,2]/158,5	672/42,3[1]/ 208,0	76/33,8[1,2]/ 194,9
digestive system diseases	6/14,0/19,4	94/14,3/19,8	116/11,8[1]/27,0	131/6,9[1,2]/24,6	74/4,7[1,2]/22,9	9/4,0[1]/23,1
infectious diseases	3/7,0/9,7	30/4,6/6,3	27/2,8[1]/6,3	34/1,8[1]/6,4	23/1,5[1]/7,1	4/1,7[1]/10,3
diseases of the skin and subcutaneous tissue	3/7,0/9,7	28/4,3/5,9	17/1,9[1,2]/4,0	26/1,4[1]/4,9	20/1,3[1]/6,2	3/1,3[1,2]/7,7
diseases of the endocrine system, nutritional disorders and metabolic disorders	2/4,6/6,5	17/2,6/3,6	33/3,4/7,7	55/2,9/10,3	45/2,8/13,9	4/1,7/10,3
circulatory diseases	2/4,6/6,5	42/6,4/8,9	89/9,1[1]/20,7	197/10,4[1]/37,0	217/13,7[1,2]/67,2	45/20,0[1,2]/115,4
diseases of the genitourinary system	1/2,3/ 3,2	8/1,2/1,7	13/1,3/3,0	25/1,3/4,7	24/1,5/7,4	5/2,4/12,8
diseases of the ear and mastoid process	1/2,3/3,2	6/0,9/1,3	18/1,8/4,2	44/2,3[1]/8,3	64/4,0[1,2]/19,8	20/8,9[1,2]/51,3
nervous disorders	0	9/1,4/1,9	24/2,4/5,6	81/4,3[1,2]/15,2	78/4,9[1]/24,1	9/4,0[1]/23,1
other diseases	2/4,6/6,5	16/2,4/3,4	29/3,0/6,8	54/2,8/10,2	51/3,21/15,8	6/2,7/15,4

Note.

1- significant differences (p<0.05) between the age group ≤ 29 years and the rest groups;

2 - significant differences (p<0.05) with the previous worker group.

significant than in 30-39-years and 40-49-years age groups. There was an increase in the prevalence rate of circulatory system diseases (p=0.003), which came second after musculoskeletal system diseases and ear disorders (p=0.004), as well as a decrease in prevalence of digestive diseases (p=0.006). In the 50-59-years group, for the first time, there was no increase in the proportion of musculoskeletal diseases, on the contrary, there was a decreasing trend (p=0.236). The risk of disease at the age of 50-59 years old was higher than at the baseline (RR=1.23; CI 1.17-1.29; χ2=53.7; p<0.001), but did not differ significantly from the 40-49-years level (RR=1.01; CI 0.99-1.04; χ2=0.63; p=0.426).

Analysis of health changes among miners aged 60 or more was difficult because of their small number. There were no apparently healthy individuals among them, and the increase in the number of diseases per miner was statistically insignificant (p=0.085). Only in this group the proportion of musculoskeletal diseases decreased (p=0.015) due to the increased proportion of circulatory diseases (p=0.012) and ear diseases (p=0.002). The risk of chronic pathology among workers aged 60 years and over exceeded the initial level (RR=1.26; CI 1.21-1.32; χ2=10.1; p=0.002), but was not higher than in the 50-59 years age group (RR=1.03; CI 1.01-1.05; 2=1.11; p=0.292).

The rank position of disease categories in the allocated age groups is presented in Table 2. Age increment brought significant changes (by two or more positions) in 10 disease categories. Some diseases ranked higher: musculoskeletal diseases from third-fourth to first, circulatory diseases from seventh-eighth to second ear diseases from ninth-tenth to fourth, and nervous system diseases from eleventh to sixth- seventh. Eye, respiratory, digestive, skin, infectious and endocrine diseases ranked lower.

Thus, the first part of the study showed that a fifth of miners under the age of

Table 2

Ranking of disease categories by miners' age groups

Category of diseases:	Age					
	< 20 years old (n=31)	**20-29 years old (n=474)**	**30-39 years old (n=429)**	**40–49 years old (n=532)**	**50–59 years old (n=323)**	**≥ 60 years old (n=39)**
Disease of eyes and their appendages	1	1	2	2	3	3
Respiratory disease	2	2	3	4	4	5
Musculoskeletal disorders	3-4	3	1	1	1	1
Digestive system disease	3-4	4	4	5	6	6-7
Infections and parasitic disease	5-6	6	7	9	10	9-10
Diseases of the skin and subcutaneous tissue	5-6	7	10	10	11	11
Diseases of the endocrine system, nutritional disorders and metabolic disorders	7-8	8	6	7	8	9-10
Circulatory diseases	7-8	5	5	3	2	2
Diseases of the genitourinary system	9-10	10	11	11	9	8
Diseases of the ear and mastoid process	9-10	11	9	8	7	4
Nervous disorders	11	9	8	6	5	6-7

30 are apparently healthy individuals.
Eye, musculoskeletal, respiratory and digestive diseases prevail in the pathology structure. In the next 40 years the age increase by 10 years is accompanied by miners' health deterioration. Its distinctive manifestations are as follows: 1) increase by 4.15 times in the number of diseases diagnosed per worker; 2) reduction of apparently healthy people, up to their disappearance at the age of 60 years and more; 3) gradual increase in the prevalence and proportion of musculoskeletal, nervous, circulatory and ear diseases; 4) gradual proportion reduction of eye, respiratory, digestive, skin and sub-cutaneous tissue, infectious and parasitic diseases; 5) the most significant negative changes in miners' health occur at the age of 30-49 years, while at the age of 50 and more their severity decreases significantly.

The second part of the study concerned the study of changes in the miners' health with different work experience (Table 3). It was found that with less than 6 years of work experience, more than one fifth of miners do not have chronic diseases. Among pathologies, the most widespread are diseases of eye and its appendages, followed by musculoskeletal, respiratory and digestive diseases (15.0%-23.8% in general structure and 21.2-33.6 cases per 100 workers). Prevalence of other disease categories was considerably lower: from 1.2%-7.1% and 1.8-10.0 cases per 100 workers. The increase of work experience up to 6-10 years is followed by considerable deterioration of miners' health: the number of diseases per worker increased ($p<0.001$) and the number of apparently healthy persons decreased ($p<0.001$). Musculoskeletal diseases are in the first place in the pathology structure. Their proportion increased ($p<0,001$) when the proportion of eye diseases ($p<0,001$) and digestive diseases ($p=0,011$) decreased. The risk of disease was higher with work experience of 6-10 years than with work experience of less than 6 years: RR=1.18; CI 1.12-1.25; $\chi2=30.2$; $p<0.001$.

At experience of 11-15 years, there was a further increase in the number of diseases diagnosed per worker ($p<0.001$), but there was no significant decrease in the number of apparently healthy individuals ($p=0.251$). Extensive and intensive prevalence rates of musculoskeletal diseases ($p<0.001$) were reported to be significantly increased, and quite the opposite, prevalence rates of eye diseases ($p<0.001$), respiratory $p<0.001$) and digestive diseases ($p=0.002$), infectious and parasitic diseases ($p=0.022$) were identified to be decreased.

It is noteworthy that the prevalence rates for circulatory system diseases ($p=0.007$) and nervous system diseases ($p=0.002$) exceeded the baseline for the first time at 11-15 years of work experience. The risk of health problems in the work experience group exceeded the baseline (RR=1.21; CI 1.15-1.28; $\chi2=35.9$; $p<0.001$), but did not differ significantly from that in the previous group (RR=1.02; CI 0.98-1.07; $\chi2=1.12$; $p=0.290$).

In the age and experience groups of 16-20 years, 21-25 years, 26 years and more, the miners' health condition dynamics was much less significant than in the age and experience of 6-10 years and 11-15 years. Thus, there were no statistically significant changes in the number of diseases diagnosed per employee and the number of apparently healthy individuals. There were no changes in the chronic pathology structure, except for ear disease. This pathology baseline was first exceeded at work experience of 16-20 years ($p=0.026$), and rates continued to increase at work experience of 21-25 years ($p=0.002$) and at work experience more than 25 years ($p<0.001$). Compared with the baseline, the risk of chronic disease remained high at work experience of 16-20 years (RR=1.22; CI 1.16-1.29; $\chi2=37.6$; $p<0.001$), 21-25 years (RR=1.25; CI 1.19-1.31; $\chi2=55.5$; $p<0.001$), 26 years or more (RR=1.28; CI 1.23-1.34; $\chi2=26.0$; $p<0.001$), but there were no significant differences between the three age and experience groups.

The effect of work experience on the rank of miners' disease categories was less pronounced than that of age.

Prevalence of ear diseases suddenly increased along

Table 3

Miners' health condition with different work experience duration

Indicator	Work experience					
	< 6 years (n=599)	**6 - 10 years (n=324)**	**11 – 15 years (n=271)**	**16 – 20 years (n=253)**	**21- 25 years (n=285)**	**≥ 26 years (n=96)**
Average employment period, years	2,9±0,06	7,5±0,07[1]	12,8±0,1[1]	17,7±0,1[1]	22,7±0,1[1]	28,8±0,3[1]
Average age, y.o.	27,4±0,4	35,7±0,6[1]	43,7±0,4[1,2]	47,6±0,5[1,2]	49,5±0,3[1,2]	52,6±0,4[1,2]
Number of diseases, cases	844	771	1055	1071	1314	438
Number of diseases per worker, cases	1,41±0,08	2,38±0,10[1]	3,89±0,12[1,2]	4,23±0,19[1]	4,61±0,18[1]	4,56±0,26
Apparently healthy workers / %	132/22,0	25/7,7[1]	15/5,5[1]	12/4,7[1]	7/2,5[1]	0[1]
Categories of diseases, cases /% of the disease structure / per 100 employees						
diseases of eyes and their appendages	201/23,8/33,6	126/16,3/ 38,9[1]	115/10,9/ 42,4[1,2]	124/11,6/ 49,0[1]	157/11,9/ 55,1[1]	53/12,1/ 55,2[1]
musculoskeletal disorders	185/21,9/30,9	261/33,9/ 80,6[1]	504/47,8/ 186,0[1,2]	491/45,8/ 194,1[1]	559/42,5/ 196,1[1]	174/39,7/ 181,3[1]
respiratory disease	140/16,6/23,4	108/14,0/ 33,3	89/8,4/ 32,8[1,2]	90/8,4/ 35,6[1]	118/9,0/ 41,4[1]	41/9,4/ 41,4[1]
digestive system diseases	127/15,0/21,2	83/10,8/ 25,6[1]	69/6,5/ 25,5[1,2]	62/5,8/ 24,5[1]	69/5,3/ 24,2[1]	24/5,5/ 25,0[1]
circulatory diseases	60/7,1/10,0	72/9,3/ 22,2	113/10,7/ 41,7[1]	130/12,1/ 51,4[1]	158/12,0/ 55,4[1]	56/12,8/ 58,3[1]
diseases of the skin and subcutaneous tissue	35/4,1/5,8	22/2,9/6,8	23/2,2/8,5[1]	23/2,1/9,1[1]	21/1,7/7,4[1]	6/1,4/6,3[1]
infections and parasitic disease	27/3,2/4,5	25/3,2/ 7,7	17/1,6/ 6,3[1,2]	13/1,2/ 5,1[1]	29/2,2/ 10,2[1]	12/2,7/ 12,5
diseases of the endocrine system, nutritional disorders and metabolic disorders	22/2,6/3,7	24/3,1/ 7,4	31/2,9/ 11,4	37/3,5/ 14,6	32/2,4/ 11,2	14/3,2/ 14,6
diseases of the genitourinary system	14/1,7/2,3	9/1,2/2,8	10/0,9/ 3,7	14/1,3/ 5,5	24/1,8/ 8,4	10/2,3/ 10,4
nervous disorders	12/1,4/2,0	17/2,2/5,2	40/3,8/ 14,8[1]	46/4,3/ 18,2[1]	74/5,6/ 26,0[1]	16/3,7/ 16,71
diseases of the ear and mastoid process	10/1,2/1,7	11/1,4/ 3,4	25/2,4/ 9,2	28/2,6/ 11,1[1]	45/3,4/ 15,8[1]	22/5,0/ 22,9[1,2]
other diseases	11/1,3/1,8	13/1,7/4,0	19/1,8/ 7,0	13/1,2/ 5,1	28/2,1/ 9,8	10/2,3/ 10,4

Note.

[1]- significant differences (p<0.05) between work experience group ≤ 5 years and the rest groups;

[2] - significant differences (p<0.05) with the previous worker group.

with work experience (from eleventh to sixth place), as well as of circulatory diseases (from fifth to second place) and of nervous diseases (from tenth to seventh place). The rank level of musculo-skeletal, genitourinary, respiratory, digestive and endocrine diseases did not change significantly. It should be noted that the increase of musculoskeletal diseases was limited due to the initial second place. The rank level of eye, infectious and skin diseases was decreased (Table. 4).

Summing up the data on the miners' baseline health condition and its changes with different work experience, the following main points can be highlighted:

1) at work experience of less than 6 years, 22.0% of miners have no chronic diseases, and diseases of the eye and its appendages prevail in their structure;

2) increase of work experience (from < 6 years to ≥ 26 years) has a growing negative impact on miners' health, which manifests in 3.14 increase in the number of diseases diagnosed per worker and a decrease in the number of apparently healthy individuals, up to their absence at service over 25 years;

3) there is a gradual increase in prevalence and proportion of musculo-skeletal, nervous, ear and circulatory system diseases in the structure of chronic pathologies;

4) there is a gradual decrease in the prevalence and proportion of eye, respiratory, digestive, skin and subcutaneous tissue diseases;

5) main health changes in miners occur at work experience of 6-15 years;

6) there are no additional negative health changes at work experience of over 16 years, except for prevalence and increased proportion of ear diseases in the chronic pathology structure.

Results and discussion

The results obtained make discussion of additional possibilities of application of age and experience features of workers' health

Table 4

Ranking of disease categories by work experience groups

Category of diseases	Work experience					
	< 6 years (n=599)	6 - 10 years (n=324)	11 – 15 years (n=271)	16 – 20 years (n=253)	21- 25 years (n=285)	≥ 26 years (n=96)
Disease of eyes and their appendages	1	2	2	3	3	3
Musculoskeletal disorders	2	1	1	1	1	1
Respiratory disease	3	3	4	4	4	4
Digestive system disease	4	4	5	5	6	5
Circulatory diseases	5	5	3	2	2	2
Diseases of the skin and subcutaneous tissue	6	8	9	9	11	11
Infections and parasitic disease	7	6	11	11	9	9
Diseases of the endocrine system, nutritional disorders and metabolic disorders	8	7	7	7	8	8
Diseases of the genitourinary system	9	11	10	10	10	10
Nervous disorders	10	9	6	6	5	7
Diseases of the ear and mastoid process	11	10	8	8	7	6

condition reasonable. It is known that the analysis of these indicators in workers of enterprises with harmful working conditions is an obligatory element in the assessment of health condition and forecast of possible, mostly occupational diseases. At present, one of the urgent tasks of occupational healthcare is to preserve workers' health at mining enterprises [19-21], especially those located in the Far North [15, 22]. Health is threatened both by biological factors that determine the body's natural ageing processes and by harmful factors in the working environment and work process, which are aggravated by harsh climatic conditions [23, 24]. It can be assumed that health condition changes based on a worker's age assesses mostly the effect of biological (genetic) ageing factors, while health condition changes based on work experience characterizes harmful working factors. However, in real conditions, their combination have a simultaneous effect on a worker, which makes it extremely difficult or impossible to differentiate their biological effects [25-27].

A comparative assessment of miners' health changes, based on their age and work experience, showed similar results with the use of both methods. However, there is a higher frequency of miners' health changes when analysed by age than by work experience, which requires a scientific explanation.

Probably, similar results can be explained by high correlation level between age and work experience of the examined group of workers. In the absence or when lower correlation between these two parameters (e.g., work experience was intermittent, or change of work type), this similarity may weaken or be lost.

It was found that when being employed (at the beginning of employment), miners have high prevalence rates of eye, respiratory, digestive, skin and infectious diseases.

In the course of work experience period, there is an increase of prevalence and proportion of musculoskeletal, nervous, circulatory and ear diseases in the total pathology structure. However, with increasing age and employment period, significance of eye diseases, disorders of respiratory and digestive systems, skin, infectious and parasitic diseases decreases. It is important to note that the assessment of the health condition based on the staggered increase in employee age and work experience, makes it possible to make forecast for the short-term (5-10 years) and for the long-term (16 years or more). The age and work experience periods of increased risk of various disease, and consequently, the optimum time for preventive measures have been determined.

Development of the most expressed negative health changes at the age of 30-49 years with work experience of 6-15 years, while at the age of 50 years and more and with work experience of 16 years and more they are minimal, is also of scientific and practical interest. It is logical to assume that this is a consequence of forced early retirement of miners who have obtained diseases in the first 15 years of work experience.

On the other hand, this is preservation of longer working capacity by workers with better health (genetically determined) and with an increased resistance to harmful industrial factors.

Conclusion

The study of health conditions, based on age increment and work experience duration, showed an increased risk of musculo-skeletal, nervous, circulatory and ear diseases among miners in underground mines. However, with increase of age and employment period, significance of eye diseases, disorders of respiratory and digestive systems, skin, infectious and parasitic diseases decreases. The age and experience periods of increased risk of different disease categories, and hence the periods for the most effective preventive measures, have been identified.

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