

# HEALTH RISK MANAGEMENT IN OCCUPATIONAL MEDICINE

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## RISK OF ARTERIAL HYPERTENSION IN WORKERS EMPLOYED AT COAL-MINING ENTERPRISES: SOCIAL AND HYGIENIC ASSESSMENT

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*We analyzed risks of arterial hypertension development in occupational groups employed at coal-mining enterprises in Kemerovo region (1,915 workers). We used data on arterial hypertension development in Kemerovo region as our reference group; these data were obtained within the framework of ESSE-RF epidemiologic research (700 people aged 25–64 were examined). We noted that work at coal-mining enterprises involved several factors which could have negative influence on workers' health. Working conditions for those workers who had to stay in a mine during the whole working shift meant that workers were under negative impacts caused by unfavorable microclimate and heavy dust loads. To eliminate age discrepancies between workers employed at coal-mining enterprises and the reference group, we performed standardization as per age (data on the reference group were taken as our standard). We calculated arterial hypertension frequencies in the chosen occupational groups and determined relative risks of arterial hypertension via creation of contingency tables. To exclude any influence that might be exerted on relative risks of arterial hypertension by occupational selection, we corrected the obtained results as per "healthy recruitment effect". Miners had lower arterial hypertension prevalence among them than unorganized sampling made of ordinary Kemerovo region population, 28.46 % and 53.29 % ( $p < 0.001$ ). We showed that statistically significant low risks of arterial hypertension among workers were due to occupational selection they had to undergo when being recruited. As we performed this correction as per "healthy recruitment effect" arterial hypertension risks for miners and drifters changed from statistically significant low to statistically significant high, from 0.55 (95 % CI 0.48–0.64) to 1.14 (95 % CI 1.04–1.26). So, if we want to assess arterial hypertension prevalence and risks in occupational groups where occupational selection can't be excluded we should perform this additional correction to remove "healthy recruitment effect".*

**Key words:** risk assessment techniques, arterial hypertension, working population, occupational selection, a healthy worker effect, healthy recruitment effect, hygienic assessment of working conditions, ESSE-RF.

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Nowadays arterial hypertension (AH) which causes great employers' losses [11, 13, 17]. Arterial hypertension is known to be a multi-factor disease with genetic predisposition. Today occupational factors

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apart from conventional ones are more and more frequently considered as AH predictors [11, 14].

Work at coal-mining enterprises involves several conditions which have adverse effects on people health. We can mention such adverse factors as industrial microclimate (drastic thermal gradients and increased air humidity), mine dust, vibration, apparent physical and emotional loads [1]. All the mentioned factors exist at miners' workplaces in most cases and their levels exceed any permissible values. 58.4% of workers employed in coal industry have to work under excessive dustiness; 14.9%, increased humidity; 15.0%, adverse temperature conditions; 14.5% workers have to contact toxic chemicals [10]. There are high requirements to body functional reserves in occupational selection. It in its turn leads to the situation when only people who are fit in terms of health are allowed to occupy workplaces in this industry. In literature, this organized or unorganized occupational selection of more healthy employees among people working under adverse working conditions is called "a healthy worker effect" [3, 6, 19]. This effect becomes apparent via better health parameters of such workers in comparison with those working in more favorable conditions; thus, it creates an inadequate impression that adverse industrial factors may have protective influence on a body [6]. "Healthy recruitment effect" is a significant components of "a healthy worker effect". "Healthy recruitment effect" characterizes "a healthy worker effect" during an initial period of workers' occupational activities due to the fact that healthier people apply for a job with adverse industrial conditions or for a job in general in comparison with people who have poorer health or lower functional capabilities [6, 15]. Examination of morbidity in junior age

groups allows to detect occupational selection occurrence and assess impacts exerted by adverse factors - AH predictors - on workers' health. So, it seems vital to analyze AH prevalence in miners' occupational groups as well as to calculate AH risks allowing for "healthy recruitment effect".

Our research goal was to assess arterial hypertension prevalence and risks of its evolution among coal-mining workers.

**Data and methods.** We performed our research on workers employed at two large coal mines in Kemerovo region (2009-2011). Data on health state of 1,915 male workers were obtained in the course of annual preventive examinations. Working conditions were assessed as per workplaces certification results [9]. 3 separate groups to be examined were created as per hygienic characteristics. The first group was made up of middle and senior management, controllers, fitters, and other employees who worked "on the surface" (43.08%). The second group included mining devices drivers and underground devices drivers as well as electricians-fitters and underground mounters (25.9%). The third group was made up of underground miners and drifters (31.02%). Adverse factors had only slight influence on workers from the first group; their working activity involved only emotional loads. Occupational activities of workers from the second and the third group directly involved staying in a mine during the whole working shift and they had to undergo adverse impacts by unfavorable microclimate, heavy dustiness, noise, vibration, as well as labor hardness and intensity [2, 18]. Workers from the second group had to maintain mining devices and electrical equipment. The third group comprised occupations with unskilled labor as well as occupations which involved a worker's staying in a forced posture during his working shift [7].

We used data obtained during ESSE-RF research (Epidemiology of cardiovascular diseases in the RF regions, 2012-2013) as our reference group (the fourth group) [12]. We chose 700 men aged 25-64 out of a population sampling which was randomly created among working population of Kemerovo region. Occupational structure of our reference group was as follows: 32.38% workers with physical labor, 36.93%, with mental work, 23.44% were operators, and 7.25% were retired.

We measured blood pressure, put a diagnose and determined AH degree of people with blood pressure  $\geq 140/90$  mmHg or those who took anti-hypertension drugs during our research as they suffered from previously diagnosed AH in conformity with the recommendations by Russian Medical Society on Arterial Hypertension / Russian Scientific Society of Cardiologists.

The age of men was different in different groups: it was equal to  $40.22 \pm 10.82$  in the first group;  $39.87 \pm 9.51$ , in the second group;  $37.75 \pm 9.76$  in the third group;  $45.87 \pm 11.45$  in the fourth group ( $p < 0.001$ ). We determined the following age structure among miners: 36.61% were younger than 35 (24.43% in the fourth group); 30.34% were 36-45 (21.86% in the fourth group); 33.05% were older than 46 (53.71% in the fourth group).

Data were statistically treated with descriptive statistic techniques and distribution-free statistics (Pearson's  $X^2$  criterion). Critical level of statistic significance was set as being equal to 0.05. We compared actual AH prevalence among miners with the same parameters in the reference group, calculated relative risk (RR) and 95% confidence interval (CI). To eliminate age discrepancies between miners and the reference group, we performed direct standardization as per age (reference group data were taken as standard) [4, 5]. We

calculated AH frequencies in the examined occupational groups; to calculate relative AH risk, we drew up contingency tables [8]. It is known that decrease in cardiovascular diseases risks occurs in occupational groups with working conditions involving adverse factors influence due to "healthy recruitment effect" and it leads to inadequate conclusions on good health state. To identify and eliminate "healthy recruitment effect" influence, we applied a technique created by experts from Scientific Research Institute for Complex Issues of Cardiovascular Diseases (S.A. Maksimov et al) [3, 8]. We determined if there was "healthy recruitment effect" and how apparent it was at the first stage; to do that, we studied AH prevalence in the youngest age group (younger than 35). At the second stage AH prevalence parameters standardized as per age were adjusted by a ratio between AH frequency in the youngest occupational age groups (younger than 35) and the youngest age group in the reference one (younger than 35) [3].

**Results and discussion.** Workers employed at mining enterprises really have lower AH prevalence in comparison with non-organized sampling of Kemerovo region population, 28.46% and 53.29%, correspondingly ( $p < 0.001$ ). The specific weight of people with AH in the occupational groups was as follows: 33.82% in the first group; 24.6%, in the second one; 24.24%, in the third one. Statistically significantly low AH risks were detected for miners in comparison with the reference group. Thus, RR was equal to 0.63 in the first group (95% CI 0.56-0.71); 0.46, in the second group (95% CI 0.39-0.55); 0.45, in the third group (95% CI 0.39-0.53).

As we eliminated structural age discrepancies with standardization, it only slightly changed initial values of occupa-

tional risks in the examined groups (Table 1).

We detected AH frequency increase by 16% in the first group; by 15% and 19% in the second and third group correspondingly; but AH risks remained statistically sig-

nificantly low in all the occupational groups. Thus, RR amounted to 0.71 in the first group (95% CI 0.63-0.79); 0.50, in the second group (95% CI 0.43-0.59); 0.55, in the third group (95% CI 0.48-0.64).

AH prevalence and risks in the occupational groups: initial data standardized as per age and adjusted by "a healthy worker effect"

The examined parameters		Occupational group			
		1 group	2 group	3 group	4 group
A share of people older than 50, %		21,21	11,09	9,76	39,71
Initial AH frequency and risk	Frequency, %	33,82	24,6	24,24	53,29
	RR	0,63	0,46	0,45	–
	95% CI	0,5–0,71	0,39–0,55	0,39–0,53	–
Standardized AH risk and frequency	Frequency, %	37,57	26,71	29,57	–
	RR	0,71	0,50	0,55	–
	95% CI	0,63–0,79	0,43–0,59	0,48–0,64	–
Standardized AH risk and frequency, adjusted by "healthy recruitment effect"	Frequency, %	51,77	48,99	60,96	–
	RR	0,97	0,92	1,14	–
	95% CI	0,88–1,07	0,82–1,03	1,04–1,26	–

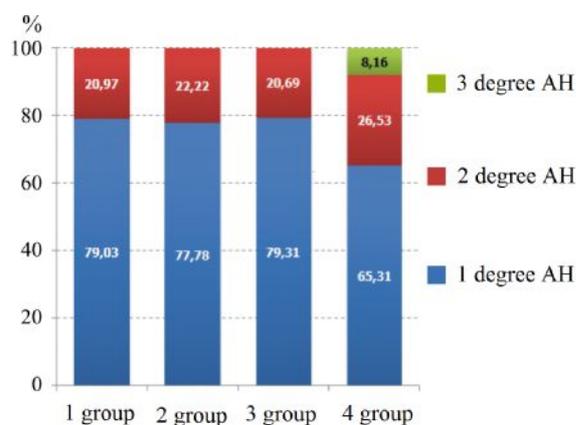


Figure. Prevalence of arterial hypertension as per degrees (%) in occupational groups among people younger than 35

AH frequency in workers younger 35 was equal to 16.83% on average and it was statistically significantly lower than in the reference group where it was equal to 28.65% ( $p=0.0004$ ). AH prevalence in the age group younger than 35 was as follows: 21.16% in the first group; 16.67%, in the second group; 11.79%, in the third group.

We should also note that no miner younger than 35 had 3 degree AH while this parameter was equal to 8.16 in the reference group. meanwhile, frequency of 1degree and 2 degree AH among all the examined people younger than 35 was comparable (Figure).

The obtained data allow us to consider young workers employed at coal-mining enterprises (younger than 35) to be the healthiest population group in comparison with the non-organized sampling of Kemerovo region population of the same age; it confirms that "healthy recruitment effect" really exists.

To eliminate "healthy recruitment effect" influence, we adjusted AH prevalence by a ratio between AH frequency in miners' groups who were younger than 35. As a result, AH frequency grew in all the examined groups, however, statistically significant discrepancies were detected only in the third occupational group: 60.96%

and 53.29%, correspondingly ( $p=0.005$ ) (Table 1). AH prevalence was equal to 51.77% and 48.99% in the first and second groups correspondingly ( $p<0.05$ ). As a result of adjusting the obtained data by "healthy recruitment effect" AH risks changed in the third occupational group from statistically significantly low to statistically significantly high, from 0.55 (95% CI 0.48-0.64) to 1.14 (95% CI 1.04-1.26). However, AH probability in two other groups was comparable with the reference group: RR was equal to 0.71 in the first group (95% CI 0.63-0.79) before the adjustment and 0.97 (95% CI 0.88-1.07) after allowing for "healthy recruitment effect"; 0.50 (95% CI 0.43-0.59) and 0.92 (95% CI 0.82-1.03) in the second group, correspondingly. So, AH risks for miners increased by 14% in the first group; by 22%, in the second one; by 31%, in the third one.

According to the obtained data AH probability grew most in the third occupational group among underground miners and drifters. Initially, people with these occupations tended to have quite low values of AG prevalence which could be explained through occupational selection effects which took place during recruitment. However, as workers became older and

their working experience grew longer, they faced the same regularities of gradual AH frequency growth as did people from an unorganized population sampling. And here influence exerted by adverse factors which were AH predictors [1, 16] led to additional increase in AH risk. So, when assessing AH prevalence and AH risks in the occupational groups where occupational selection occurrence can't be omitted, it is necessary to perform additional adjustment to eliminate influence exerted by "health recruitment effect".

### Conclusion:

Arterial hypertension prevalence among workers employed at coal-mining enterprises is lower in comparison with an unorganized sampling of Kemerovo region population and amounts to 28.46% and 53.29% correspondingly.

Lower arterial hypertension probability among miners is determined by occupational selection.

When "healthy recruitment effect" influence is eliminated, arterial hypertension risks grows considerably among underground miners and drifters in comparison with a general population sampling.

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