

## OCCUPATIONAL RISK AND HEALTH STATUS OF WORKERS IN THE PRODUCTION OF HEAT

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### Summary

The health status of 1515 workers employed in heat production was investigated. The subjects studied were divided in four groups according to occupation and occupational risk factors: vibration, noise, dust, metal aerosols, overloading of the musculoskeletal and peripheral nervous system, and organic solvents. The control group included 152 administrative staff members. High prevalence of socially significant diseases – cardiovascular, endocrine and metabolic was detected in all the groups surveyed. The frequency of diseases of the cardiovascular system and the respiratory system was 2.7 times higher than that in the control group. Statistically reliable higher prevalence of lung diseases in the studied risk groups was found, especially in the group of welders and chemists: 45.3% и 17.4% respectively, as compared to 4.3% in the controls. These finding corresponded to the occupational risk. The following occupation diseases were diagnosed: pneumoconiosis in 26.6% and toxic pneumofibrosis in 5.1% of electric welders. As regards the group of chemists, toxic pneumofibrosis was found in 6.5%. toxic effects of irritants - in 6.5 %, and chronic intoxication with organic radicals - in 0.7 % of them. Occupational auditory neuritis was diagnosed in 1% of the turbine operators and crane operators. The relative share of workers with peripheral nervous system pathology (radiculopathies, polyneuropathies, distal sympathetic neuropathy, mononeuropathy) was reliably higher than that in the control group, and the frequency increased among the workers with more than ten years of service and older than 40.

**Key words:** occupational risk, occupational diseases, toxic pneumofibrosis, hepatitis

### Introduction

According to data from the National Social Security Institute of Bulgaria, the numbers of cases of occupational diseases are very few and so rare that they seem accidental.

Socioeconomic conditions discourage doctors working in general practice and in hospitals submit timely information about suspected occupational diseases. This impedes the resolution of potential cases and distorts the information concerning the true rates of occupational diseases. Presently, regular

check ups are one of the reliable sources of information regarding the health status of employees. The check ups for employees working exposed to occupational hazards are regulated by Ordinance No. 3 of the Ministry of Health – State Gazette, No. 16/1987 (amended and supplemented, No. 102/1994). The objectives of these periodic medical examinations include early diagnosis of both socially relevant and occupational diseases, monitoring the dynamic changes in chronic diseases, assessment of capacity for work, referral for diagnosis in hospital conditions, transfer to other jobs and/or expertise assessment.

Working in an thermo-electric power-station involves exposure to dust, gases, metal aerosols, solvents, vibration, noise, overstrain of the musculoskeletal system, adverse microclimate etc., all of which associate with a number of diseases related to work and occupation [1,2].

The study aimed to analyse the health status of workers at a thermo-electric power station in Sofia, detect early signs of occupational diseases and design a program to eliminate or reduce the impact of adverse risk factors on the working environment.

## Materials and Methods

We examined and investigated 1515 employees of the thermo-electric power-station in Sofia. The control group included 152 members of administrative staff, employed by Siemens. The study group and the control group were matched by age, sex and length of service.

The workers we investigated were divided into four risk groups according to concrete occupational hazards: dust, gases, metal aerosols, organic solvents, vibration, noise, overload of the musculoskeletal system, adverse microclimate, etc. The distribution of the subjects included in the study by occupation, risk factors, medical examinations and investigations is presented on Table 1.

### Statistical methods

Data analyses were made using EXCEL and SPSS software packages. To summarize and classify the data, we used methods of descriptive statistics, parametric and non-parametric analyses. Comparisons were made by the t-criterion of Student. The  $\chi^2$  method was applied to process the independent data in 2x2 contingency tables. P-values <0.05 were regarded as statistically significant.

**Table 1.** Distribution by occupational groups and completed medical examinations

No.	Number	Working positions (type of activity)	Risk factors	Medical examinations	Tests
I	64	electric welders	gases, vapors, fumes, metal aerosols	pulmonologist toxicologist ENT neurologist	ECG, Pulmonary function testing (PFT) Lung X-ray
II	138	chemists	acids, alkalis org. solvents (benzene, gasoline, chloroform, oils)	toxicologist neurologist ENT	ECG, PFT, lung X-ray complete blood count (CBC), differential blood count (DBC), erythrocyte sedimentation rate (ESR) ASAT, ALAT, GGTP, cholesterol and 3-glycerides, threshold and suprathreshold audiometry
III	98	crane operators excavator operators front loader operators drivers	excessive vibration levels, noise > 85 dB	therapeutist ENT neurologist	ECG, cold test alternating dynamometrics capillaroscopy, vibration perception threshold, threshold and suprathreshold audiometry
IV	1215	operators and fitters of steam turbines	Noise 85-102 dB, physical load, adverse microclimate	therapeutist ENT neurologist	ECG threshold and suprathreshold audiometry alternating dynamometrics

**Table 2.** Distribution of individuals by sex, age and length of service

Group	Total number	Sex		Age		Specialized length of service	
		males	females	Up to 40 years	over 40 years	Up to 10 years	over 10 years
I	64	64	–	15	49	22	42
II	138	57	81	19	119	19	119
III	98	93	5	15	83	21	77
IV	1215	902	313	347	868	402	813
Total number	1515	1116	399	396	1119	464	1051
%	100	73.7	26.3	26.1	73.9	30.6	69.4

## Results

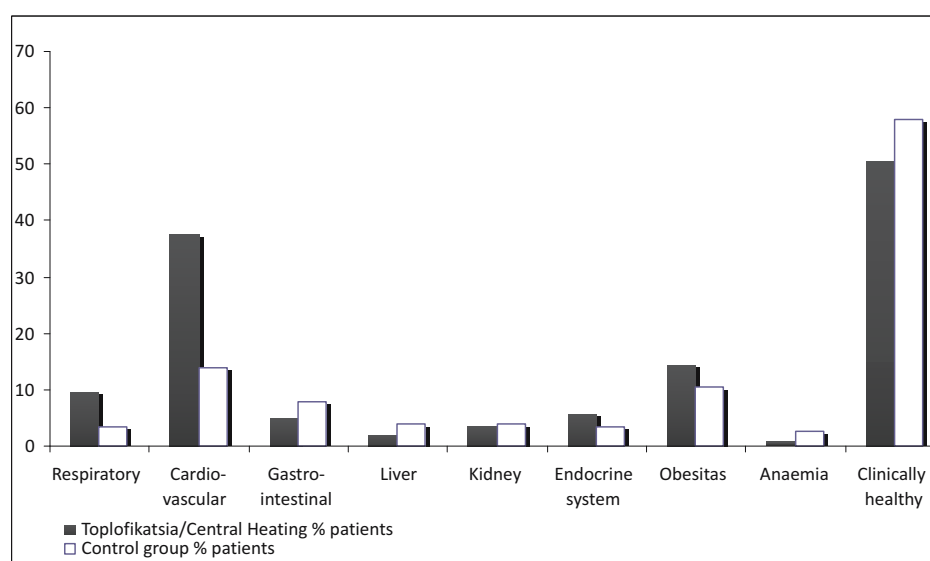
Table 2 presents data about sex, age and length of service of the subjects studied. The males outnumbered the females, accounting for 73.7% versus 26.3% of the subjects. Those aged over 40 were 74%, and 69.4% had specialized service over ten years. In the group investigated, length of service varied from a few months to 30 years.

Figure 1 presents the results from medical examinations of both the study and the control group, performed by specialists in internal diseases and the conditions identified by systems. In both groups, prevalence of socially relevant diseases (cardiovascular, endocrine and metabolic) prevailed. It should be noted that the incidence of cardiovascular and respiratory diseases was 2.7 times higher in the study group, as compared to the controls. We did not find statistically reliable differences between the risk groups and the control group regarding the

incidence of all other diseases. (Figure 1)

Of the internal diseases diagnosed, those of the cardiovascular system ranked first – 37.4%, represented mainly by arterial hypertension (35.5%) and ischaemic heart disease (1.9%). Pronounced hypertension and mild hypertension was found in 28% and 7.5%, respectively. The majority of the workers with cardiovascular diseases were men aged over 40, obese and with a family history, with poorly controlled blood pressure and not abiding to any dietary regimen. Regarding the incidence of cardiovascular diseases, there were no statistically reliable differences between the four risk groups.

The pattern of respiratory diseases in the risk groups was different in each group and correlated with the occupational risks (Figure 2). In groups I and II, the incidence rate of respiratory diseases was significantly higher (45.3% and 17.4%, respectively) than that in the control group (4.3%), and higher than the rates in groups III and IV (8.2% и 6.9%, respectively).



**Figure 1.** Registered diseases in study groups and controls (%)

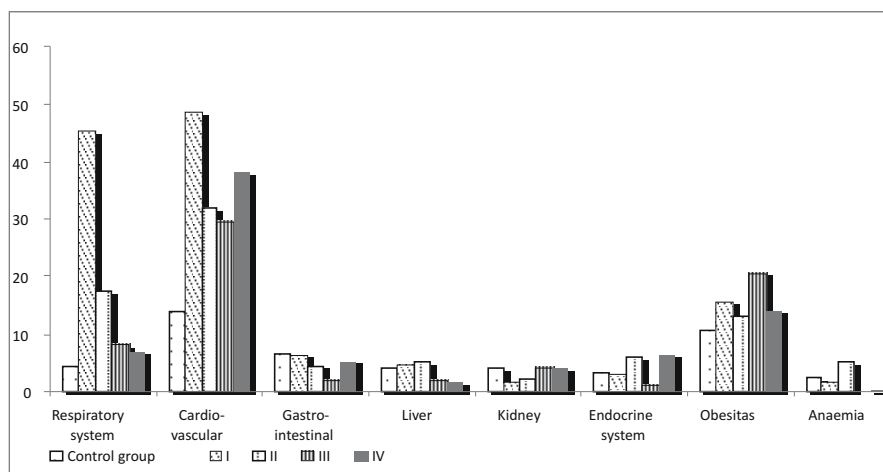


Figure 2. Registered diseases by risk groups and systems

The lung diseases registered in 45.3% of the subjects in the group of welders were mainly presented by pneumofibrosis and chronic bronchitis. Radiographic evidence of the pneumofibrosis was found in 32.7% of the subjects. Initial pulmonary fibrosis was diagnosed in 4 workers with shorter length of service and most likely it was post-pneumonic fibrosis. In 17 subjects (26.6%) occupation-induced genesis of the fibrosis was considered, i.e. – pneumoconiosis in electric welders due to prolonged exposure (over 10 years) to welding gases in the absence of other fibrogenic factors. Clinical evidence of chronic bronchitis with mixed etiopathogenesis was found in 12.5%, as a result of working with metal aerosols and systematic smoking.

In the group of chemists, the highest prevalence was that of cardiovascular diseases (32%), followed by respiratory diseases (17.4%). Toxic pneumofibrosis was discussed in 5.1% of them. In 5.8%, mixed etiology of pneumofibrosis was revealed as a result of former pneumonia and irritative action of acids and bases. Clinical and laboratory evidences of chronic bronchitis were present in 5.8%, of acute bronchitis – in 0.7% and asthma – in 0.7%. Although it was supposed that the causes of these conditions were related to living conditions and infections, the irritants present in the working environment were suspected as contributing to worsening and protraction of the diseases. Toxic effects of irritants in chronic pharyngolaryngitis, anaemia and bronchitis were diagnosed in 6.5% of the studied workers.

We detected liver disorders in 5.1% of the

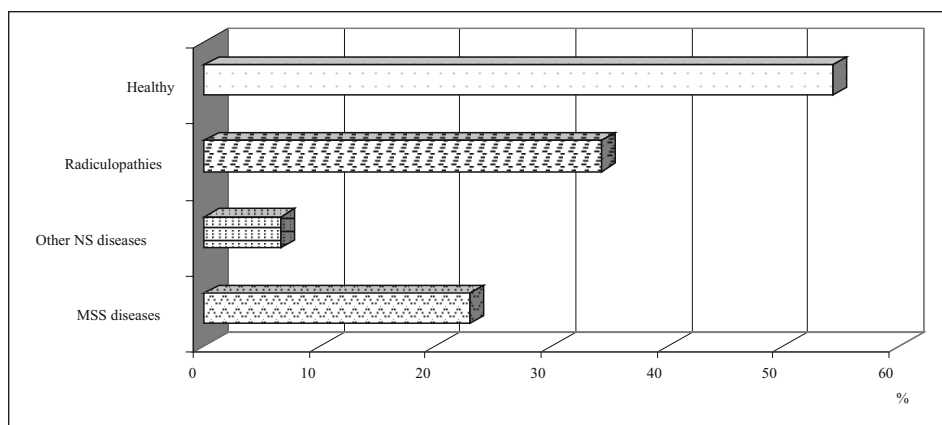
chemists. In most of the cases, they were related to steatosis, corresponding with concomitant obesity and dyslipidemia. Chronic hepatitis was diagnosed in chemists: one with ethylic, the other with toxic genesis due to chronic intoxication with organic solvents manifested by the following syndrome complex: toxic anaemia, chronic pharyngitis and toxic hepatitis.

In risk groups III and IV cardiovascular (29.6% and 38.1%, respectively) and metabolic diseases (20.4% and 13.9%, respectively) also dominated.

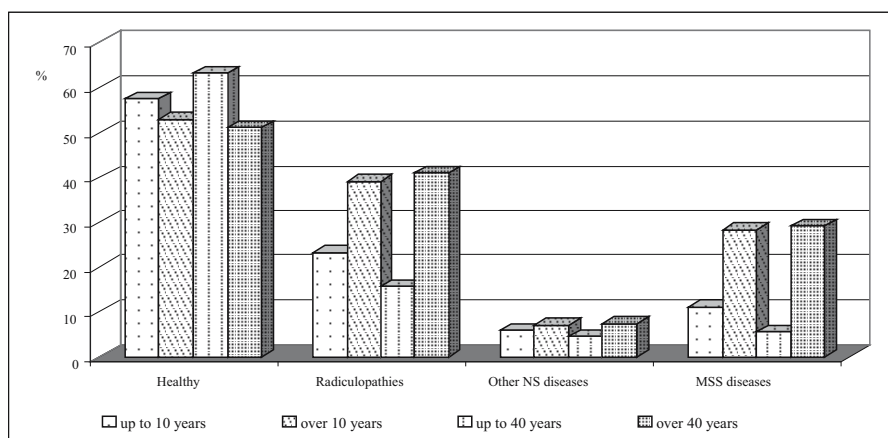
Pathological disorders of the nervous (NS) and musculoskeletal systems (MSS) were registered in 45.8% (Figure 3). Lesions of spinal roots in the lumbar and cervical spine prevailed – 34.06% (lumbar radiculopathies in 19% and 15% cervical radiculopathies, respectively). These were mostly found in electric welders (Group I (39.06 and among the boiler and turbine equipment operators and fitters (Group IV, 39.01%), followed by crane, excavator and front loader operators (Group III, 29.49%) and corresponded to the risk factors (Figure 4).

The lowest percentage of radiculopathies (21.7%) was found in chemists (group II). In 2.2% of the examined workers distal autonomic neuropathy of the upper limbs with angiodystonic disorders was found, probably due to occupational exposure to vibration and overload.

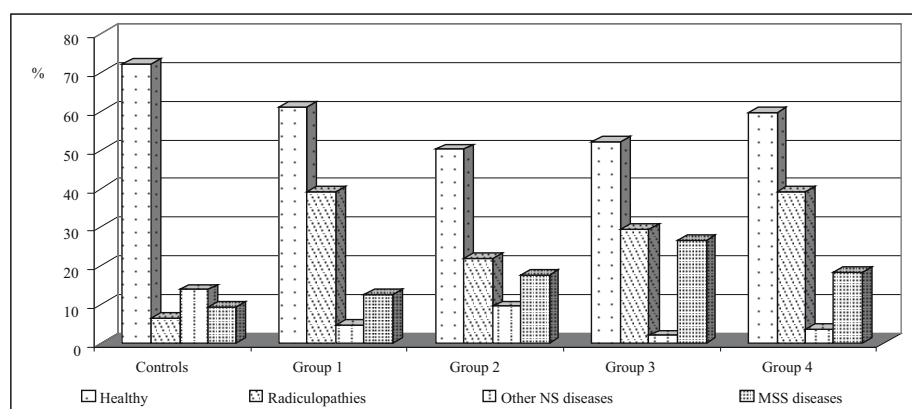
Diseases involving the musculoskeletal system were diagnosed in 21.6% of the workers. Bone and joint degenerative changes were found in 10.8% of them, the highest prevalence being that of spondylosis and osteochondrosis (9.31%), particularly in its lumbar part (8.2%). Articular



**Figure 3.** Prevalence of nervous and musculoskeletal system pathology



**Figure 4.** Prevalence of nervous and musculoskeletal systems pathology according to length of service and age



**Figure 5.** Prevalence of nervous and musculoskeletal systems pathology by groups

and periarticular diseases (humeroscapular periartthritis, radial and/or ulnar epicondylitis of the humerus, gonarthrosis, coxarthrosis, etc.) accounted for 6.7% of the degenerative changes.

The highest prevalence of musculoskeletal diseases was found in crane operators in Group III (26.53%), followed by the operators of turbines in Group IV (18.44%) and the chemists



in Group II (17.39%), and the lowest being among the electric welders in Group I (12.5%) (Figure 4). The prevalence of nervous and musculoskeletal disorders was significantly higher in workers with length of specialized service with occupational risk factors over 10 years and aged over 40 (Figure 5).

Regarding ENT diseases, those affecting the auditory analyzer were prevalent. Among these, bilateral auditory neuritis ranked first (5%), with prevalence of mild forms (4.5%) and a relatively small share of the moderate and severe forms (0.3% and 0.2%, respectively). In 1% of the cases, a causal relationship was found, and hearing problems were diagnosed mostly in crane operators (9.1%) and fitters (7.1%).

## Discussion

In the literature available there are no publications regarding the health status of workers in a thermo-electric power-station. It is well known that they are exposed to occupational hazards such as dust, gases, metal aerosols, solvents, vibration, noise, overstrain and physical static and dynamic overload of the musculoskeletal and peripheral nervous systems, adverse microclimate etc., which are associated with a number of occupational diseases [1-3].

The study analyses the health status of subjects employed in a station in Sofia. The majority of the subjects were found to be clinically healthy, although many of the disorders could be occupational or work-related. Socially significant diseases – cardiovascular diseases, endocrine and metabolic, were prevalent in both the study groups and the controls. Arterial hypertension and ischemic heart disease accounted for 35.5 % and 1.9 %, respectively. Dyslipidemia, obesity, age, sex, presence of diabetes, unhealthy habits and family history have been proved to be contributing factors in arterial hypertension [4]. Undoubtedly, the excessive noise to which fitters, turbine operators and drivers are exposed, has an effect on cardiac function but noise itself does not cause hypertension.

Therefore, the hypertension registered could not be linked to occupational risk factors only: except for two of them, all the subjects with hypertension were over 40 years of age, with obesity and a family history. The pulmonary diseases (chronic bronchitis and pneumofibrosis), however, were etiologically

associated with exposure to toxic gases and organic solvents.

Liubchenko and Vinnitskaia have reported that of the occupational diseases diagnosed in 323 welders, the most common was pneumoconiosis, followed by sensorineural deafness, chronic toxic dust bronchitis and chronic manganese intoxication [5, 6]. In 17 welders (26.6%) we established occupation-related etiology of the fibrosis diagnosed – pneumoconiosis due to over ten years of exposure mostly to gases in the absence of other risk factors associated with fibrosis. Toxic pneumofibrosis was found in 10%, and toxic effects of irritants – in 5% of them. Chronic intoxication with organic solvents was found in 0.7% of the chemists. Clinical data of chronic bronchitis with mixed etiopathogenesis (exposure to metal aerosols and regular smoking) was found in 12.5%. Toxic effects of irritants, resulting in chronic pharyngolaryngitis, anemia and bronchitis were established in 12.5% of the subjects investigated. Although factors for these conditions are mainly linked to living conditions, life-styles and infections, the presence of irritants in the working environment definitely contribute to more frequent exacerbations and longer periods of sickness.

It was concluded that welders diagnosed with pneumofibrosis were subject to prompt labour readjustment to avoid exposure to dust and irritants, in view of the irreversibility of the process and progression to chronic respiratory insufficiency.

Hepatotoxic and myelotoxic effects of organic solvents have long been known [7-9]. However, the steatosis diagnosed in the majority of the chemists was more likely due to obesity and dyslipidemia.

Noise and vibration have non-specific effects on many internal organs (ptosis of stomach, liver, kidneys, etc.) but in this study no such disorders were found in either of these two groups. Occupational auditory neuritis was detected in only 1% of crane operators and fitters.

The highest prevalence of peripheral nervous and musculoskeletal disorders was established in electric welders, excavator operators and crane operators. Reliably higher prevalence of cervical and/or lumbosacral radiculopathes was associated with service longer than 10 years and over 40. So their etiology was complex and mixed due to both occupational risk factors (vibration, static and dynamic overload and overstrain) and also to age-related vertebral

degeneration (spondylosis) and/or intervertebral changes (disc herniation, osteochondrosis, spondylolisthesis) [10-12]. Therefore, most of the musculoskeletal and nervous changes are work-related, and some of them are occupational, but should be further discussed.

## Conclusion

Occupational risk for workers in a thermo-electric power-station involves the respiratory, nervous and musculoskeletal systems, the liver and the auditory analyser. Our findings suggest that strict monitoring of the health status is needed to provide early diagnosis and prevention of occupational and work-related diseases. Further investigation could help to better estimate the association between hazardous risks at the workplace and the diseases of workers exposed to different occupational risk factors.

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