Occupational health problems in modern work environment

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Key words: *work environment, morbidity, psychophysiology, transport, video display terminal work.*

Summary. *Analysis of occupational health problems in Lithuania and their relation to factors of modern work environment is presented. The article analyses the health of transport workers, airlines pilots and stewards, video display terminal workers and its relation to work environment.*

Objective. To investigate and evaluate influence of changing occupational environment to workers' health.

Material and methods. Complex evaluation including several enterprises with different work profile and conditions. Evaluation of work environment, assessment of psychophysiological and ophthalmological data of workers as well as morbidity studies were performed.

Results. Occupational environment of transport workers is related with high levels of noise, vibration, mercury, carbon monoxide, welding aerosols, and dust. Main diseases for transport workers are upper respiratory tract and lung diseases, accidents, cardiovascular and musculoskeletal disorders. Cases of temporal morbidity for pilots and stewards are upper respiratory tract and lung diseases, accidents, intoxications and nervous system diseases. The main effects of video display terminal on operators' health are vision fatigue and musculoskeletal disorders. Ophthalmologic symptoms and vision fatigue are related to changes in eyes and central nervous system fatigue, as well as syndrome of "dry eyes".

Conclusions. Changeable work environment is affecting employees' health with specific changes, which depend upon work character, experience and worker's age.

Introduction

During the recent years, much attention on the global scale is paid to the concept of sustainable development; which should guarantee a harmonious compatibility of a person, technology, and the environment, the usage of harmless (both with respect to people and the environment) technologies, optimal usage of industrial resources, and the healthy work environment (1). According to the WHO directive "Health for all in the 21st century", public health and its strengthening is the priority direction, one of the aims of which is securing health-friendly conditions in workplaces, and prevention of occupational disorders.

The growth of urbanization, the emergence of new branches of industry, and the automatization, mechanization, and computerization of work resulted in new problems in workers' health care, and changed the character and the development mechanisms of occupational diseases. The changing character of work significantly decreased the number of "traditional" occupations and raised a new problem – the prevalence of work-related pathologies. This includes disorders of the musculo-skeletal system, stress-related diseases, and occupational oncologic diseases.

The article analyzes the present health problems among Lithuanian workers, and the relation of these problems with the work environment. The workers' health is evaluated in the following occupational groups: transport employees, airline pilots, and computer operators. These people's health disorders ant their relationship with the work environment raise new problems of the prophylaxis of occupational disorders, and new possibilities for their prevention.

The aim of the study was to assess the influence of the modern work environment on the workers' health and the factors influencing their health status.

The objectives of the study were: (1) to analyze the transport employees' work conditions, occupational,

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lifestyle, and psychosocial factors, and their health; (2) to analyze the morbidity of the flying staff – the pilots' and the stewards' of the airline company "Lithuanian airlines" (LAL) in cases of temporary disability; and (3) to investigate the computer operators' main health disorders and the influencing ophthalmologic, psycho-physiological, and ergonomic factors.

Material and methods

The complex study included people who worked in several enterprises of Lithuania that differed in their work profile and the conditions of the work environment.

The study of the transport employees' health was performed during 2001-2003 in 4 city enterprises, including 2 bus enterprises, 1 - trolleybus, and 1 - railway enterprise. For the study of work conditions, lifestyle, and health-influencing factors, only the main (most numerous) groups of transport employees were selected. During the study we used a self-designed questionnaire (2) consisting of 78 questions about a person's documentary data, health status and health complaints, the lifestyle and socio-psychological factors, and the subjective evaluation of working conditions. In total, 1000 "Questionnaires on the investigation of the transport employees' work conditions and health" were distributed. The response rate was 78.8% (788 employees). The chemical, physical, and psycho-physiological (ergonomic) factors were measured and evaluated in accordance with the legislation of the Republic of Lithuania (3).

We analyzed the morbidity of LAL pilots and stewards in the presence of temporary disability. An analysis of the data on the flying staff, stored at the Aviation Medicine Division of the Civil Aviation Administration was performed. The period of the study was 1999-2001.

The third group of subjects was composed of people working at the computer for the whole workday, i.e. not less than 8 hours per day. This group included 104 people who underwent detailed psycho-physiological, clinical, ophthalmologic, and questionnaire studies (4). During the psycho-physiological studies, the changes in the working capacity and fatigue were evaluated; the evaluation was performed according to the main parameters of the central nervous system and analyzer activity. The evaluation of the working capacity and fatigue of the computer operators was performed when using the tests of data processing speed (Weston's test), the speed of the senso-motoric reactions of sight and hearing, the constancy of clear vision, and the fluctuation of the clear and unclear vision periods. Each person was examined three times a day (before, during, and after work) during the five-day workweek. When analyzing the results of the psycho-physiological studies, the results obtained before work were equaled to 100%. Ophthalmologic studies were used to examine the following data: vision acuity, refraction, binocular vision, absolute and relative accommodation, anterior ocular segment, and the stability of the lachrymal film.

The findings of the study were stored in a personal computer using the Microsoft Excel software. The mathematical-statistical analysis was performed with the help of the Statistica 5.0 software. The epidemiological analysis of the data was performed with the help of the Epi-info 6.0 software.

Results and discussion

The health, working capacity, and professional reliability of transport employees, as well as the safety of the traffic participants are influenced by work conditions, and ergonomic, lifestyle, psychological, and social factors. During professional activity, the transport employees are influenced by physical factors – vibration affecting hands and the whole body, noise, infrasound, etc., as well as by unfavorable microclimate (high and low air temperature, draughts, solar radiation, etc.), chemical agents (carbon monoxide, sulfur dioxide, nitrogen oxides, aliphatic hydrocarbons, formaldehyde, and ozone), and other harmful substances (5,6,7).

In the studied transport enterprises, 85.4% of employees were men, and 14.6% - women. The absolute majority of employees (85.9%) were young (aged 30-39 years) and middle-aged (40-49 years of age). The work experience of 54.2% of employees was 10-29 years.

The highest allowed levels of harmful factors indicated in hygiene norms in workplaces of some professions were exceeded in cases of noise, vibration, lead, welding aerosol, dissolvent, carbon monoxide, and dust of non-differentiated origin. Concerning the ergonomic factors, the allowed parameters were exceeded in cases of strains of attention and vision, work being some work difficulty criteria, and a too long workday.

The integral evaluation of the hygienic working conditions, work difficulty, and strain showed that the factual harmfulness to health of all factors (harmless up to 1.0 point) in points for workers of separate professions amounted to: drivers:– 0.93, welders – 1.26, battery operators – 1.23, tuners – 0.86, electro-

mechanics– 0.20, motor-metalworkers – 0.37, locomotive drivers – 0.75, and road-menders – 0.51.

The analysis of the subjective evaluation of working conditions showed that motor transport workers are most dissatisfied with the following factors (which they also consider to be harmful to their health): low air temperature, draughts, noise, vibration, air pollution, and contact with diesel fuel and antifreeze. Of the ergonomic factors, the most unfavorable are considered to be high strain of attention, sight, and the musculo-skeletal system, and long duration of the workday.

The analysis of psycho-social factors showed that 3.8% of workers were highly satisfied with their material and household conditions, 63.5% were satisfied, and 32.8% - dissatisfied ($p<0.05$-0.002). The workers who were dissatisfied with their material and working conditions statistically reliably more frequently evaluated their health as "not fully healthy" or "ill".

The duration of the workday for 60.5% of drivers was 9-10 hours. It turned out that the duration of the workday exceeding 8 hours was closely associated with poor evaluation of one's health ($p<0.002$), more frequent health complaints ($p<0.05$), and stress at work ($p<0.001$).

The lifestyle of motor transport drivers was not healthy: 46.0% of the workers smoked, 83.8% used more than 2 units of alcohol not less that 2 times a week, and 53.0% were insufficiently physically active.

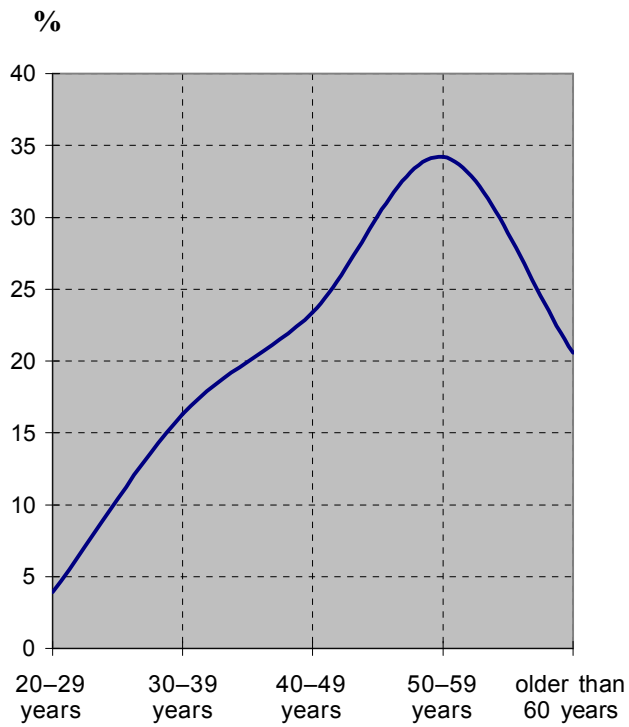

Fig.1. **Statistical interrelationship between age and musculoskeletal disorders**

The evaluation of the subjective opinion on the evaluation of one's health within the last 12 months showed that 69.9% of subjects stated that they were "in good health", 28.6% - "not totally healthy", and 2.3% - "ill" ($p<0.05$). The predominant health complaints were musculo-skeletal (46.2%), respiratory (22.7%), alimentary (17.3%) and functional central nervous system (32.7%) disorders. Statistical interrelationship of the indications shows the musculo-skeletal disorders among drivers are closely related to the professions of drivers and motor-metalworkers ($p<0.02$), unsuitable ergonomic working conditions ($p<0.04$), older age and longer work experience ($p<0.002$) (Fig. 1).

The predominant disorders in the structure of the morbidity of transport employees are respiratory organ disorders, traumas and poisonings, cardiovascular disorders, and diseases of the musculo-skeletal and the peripheral nervous system (Table 1). The prevalence of these diseases among transport employees is several times higher than that among the employees of textile enterprises (8). The indices of morbidity with temporary disability during the period of the study were ca. two times higher than those among all insured workers in Lithuania (9). Long-term and complex influence of the negative environmental factors affects the transport employees' health, working capacity, and professional reliability. All this influences the safety of traffic, traumatism, and related psychological, moral, and economic consequences (2, 10).

When analyzing health problems among pilots, it is convenient to differentiate them into acute problems that resulted in the worsening of health during flight, problems that resulted in temporary disability, and medical causes that forced the pilots to end their professional career. The influence of unfavorable working conditions is reflected by temporary disability, which is discussed in this paper.

In 1999 and 2000, 133 pilots and 114 stewards (in total – 247 people) worked for LAL. In 2001 - 130 pilots and 95 stewards – in total, 225 people. During this period, 444 cases of disability and 5061 missed workdays were registered. Data of LAL were compared to the data of the health statistics of Lithuania. The comparative data are presented in Table 2. As seen from the data presented in the table, morbidity of the flying staff of LAL is 1.38 times higher than that of the able-bodied population of Lithuania.

In Lithuania, the mean number of days of temporary disability per one worker is 6.095, while in LAL –

Table 1. **Comparative characteristics of morbidity between transport and textile industry employees**

Diseases and their groups	Transport employees		Textile industry employees	
	Cases for 100 employees	Out of work days for 100 employees	Cases for 100 employees	Out of work days for 100 employees
Diseases of respiratory tract	24.0*	244.7*	13.5	127.3
Diseases of peripheral nervous system	10.9*	100.1*	3.6	56.6
Skin diseases	2.1	19.9	0.6	10.5
Cardiovascular diseases	10.5*	135.1*	2.5	43.5
Digestive tract diseases	5.6*	90.8*	3.2	52.9
Musculoskeletal diseases	9.3*	179.8*	1.0	15.7
Accidents and poisonings	17.6*	433.6*	3.3	69.0

*$p<0.05$.

Table 2. **The comparative data of temporary disability between "LAL" and health statistics of Lithuania (1999 - 2000 years)**

Causes of temporary disability	Disability cases for 1000 employees	
	Lithuanian statistics	LAL employees
Diseases and accidents	474.9	655.9
Child and patient care	53.9	20.2

7.0. This shows that the representatives of professions who face specific requirements for health – pilots and stewards – become ill more frequently compared to the general population of Lithuania.

The analysis of the structure of morbidity showed that the most common diseases during the aforementioned period were those of the respiratory tract (213 cases) and the nervous system (29 cases). The number of cases of traumas, poisonings, and other effects of external factors amounted to 69. These groups of diseases were also predominant in the structure of the missed workdays: 1950 missed workdays because of the diseases of the respiratory tract, 1031 – because of poisonings and other effects of external factors, and 404 – because of the diseases of the nervous system.

The cause of the higher frequency of respiratory diseases is unfavorable microclimate on airplanes, and especially the periods when the airplane is being prepared for the flight and is standing unheated and unventilated with open doors. This is a common cause of health problems in airway companies; the prevention of this problem is given much attention, including airplane service at the "sleeves", external heating, etc. According to our data, 30% of stewards have experienced traumas during flight. Among pilots, sports traumas sustained during the free time are more prevalent.

The determination of the "most unfavorable diseases" was based on the duration of the disease. During the studied period, the duration of one disease was 11.4 days. The diseases that resulted in the highest number of missed workdays (except from pregnancy, childbirth, and the postpartum period) are presented in Fig. 2.

Child care has nothing in common with occupational activity. Meanwhile other disease groups, especially endocrine, nutritional, and metabolic diseases, as well as diseases of the nervous system and mental disorders are related to work in airlines. It is this group of diseases that should receive attention when striving for early identification, treatment, and suitable prevention.

One of the rapidly spreading elements of the work environment is a personal computer; it changes the ergonomic conditions of the workplace and the basics of work organization. The health studies of the professional computer operators show that the main health complaints emerging during the work time are sight disorders of various character (89.5% in men and 87.9% in women), and disorders of the musculo-skeletal system (76.0% in men and 87.8% in women).

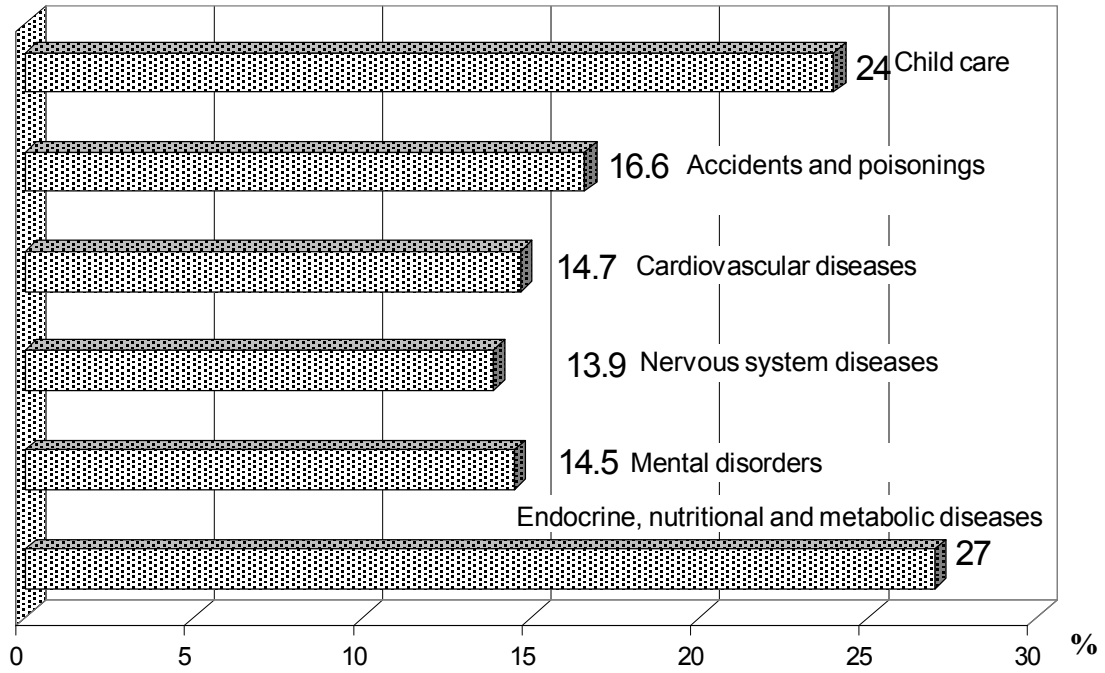

Fig. 2. **Diseases that caused the highest number of missed workdays**

Computer work is one of the risk factors for the development of short-term functional sight disorders that later result in the lasting damage of the sight functions. During detailed clinical-experimental trials that included 104 people working with the computer (the mean age of the subjects was 33.8 years), the main sight disorders during work were the following: deteriorated vision (85.6%), reddened eyes (42.3%) and eyestrain (46.1%). These symptoms and the impairment of the optic function define the syndrome of the strain or fatigue of the vision analyzer, called asthenopia. The stability of asthenopia is characterized by time during which the indicated symptoms disappear and the optic function is reestablished. According to the findings of the performed studies, in 44% of all the subjects the symptoms disappear after the discontinuation of the computer work, in 44% of cases they remain for several hours after work, and in 12% cases they are felt the next day. A part of the aforementioned symptoms are typical only of computer operators – the representatives of other professions do not indicate them at all. The comparison of the obtained results with those presented by foreign researchers shows that the frequency of the complaints varies within the range of 45-70 % (11, 12). However, these studies were performed in economically developed

Table 3. **Data of ophthalmological investigation**

Investigation	Computer workers $X \pm S^x$	Control group $X \pm S^x$	p
Vision acuity OD	0.62±0.36	0.78±0.34	<0.05
Vision acuity OS	0.65±0.29	0.77±0.30	<0.05
Refraction OD, DM	2.34±1.99	3.54±1.36	<0.05
Refraction OS, DM	2.17±1.82	3.85±1.31	<0.05
Relative accommodation OD, D	3.99±2.39	7.55±2.95	<0.01
Relative accommodation OS, D	4.20±2.35	7.15±2.91	<0.01
Proximal convergency point, cm	9.96±3.02	8.43±2.16	<0.01
Tear film stability time OD, s	6.42±0.66	19.66±2.09	<0.01
Tear film stability time OS, s	6.28±0.65	20.6±1.96	<0.01

countries that have a greater experience in both the ergonomic equipment of workplaces and the prophylaxis of health disorders among employees.

Ophthalmologic studies showed differences in the objective study, confirming lasting and irreversible changes in vision damage. As seen from the data presented in Table 3, the relative accommodation and the time of the rupture of the lachrymal film are the main indicators that prove the negative effect of computer work on the employees' health. Relative accommodation shows decreased reserve resources of the eye for accommodation to the changes in the distance of the seen object, and significantly decreased time of the rupture of the lachrymal film results in the "dry eye" syndrome that, according to many authors (13), is common among the representatives of this occupational group and conditions a part of subjective complaints, eye redness, and eyestrain.

The investigation of the workplaces allowed for the identification of the main factors that condition the sight disorders among computer operators. The development of asthenopia is influenced by a long-lasting fatigue of the sight analyzer, unsuitable ergonomic working conditions (insufficient illumination of the workplace (RR=2.2; p<0.01)), lateral flashes in the computer monitor (RR=1.54; p<0.01)), increased electromagnetic radiation of monitors (r=0.43)), the intensity of the electrostatic load (r=0.47)), and individual factors – insufficient or, in case of presbyopia, unsuitable vision correction, and insufficient distance between the worker's eyes and the monitor.

The findings of psycho-physiological studies show that computer work results in a significant fatigue of the central nervous system, impairs attention, observation and thinking, and decreases the flexibility of the intercentral connections of the higher neural activity. This is reflected by more pronounced functional indices of the cardiovascular system, and more acute changes in the optic (13.3%) and hearing (7.5%) senso-motoric reactions in the group of computer operators compared to controls (accordingly, 3.9% and 3.7%). The speed of information processing when working with the computer drops by 0.42 bit/s (24.1%), compared to 0.15 bit/s (8.8%) in the control group. The stability of acute vision decreases by 35.2%, and the fluctuation of the acute/blurred vision periods increases to 20.0 times/min, while the respective values in the control group were, accordingly, 10.4% and 6.7 times/min. The differences between the main psycho-physiological indicators reflecting the dynamics of fatigue and working capacity in the computer operators and the control group are presented in Table 4. The

Table 4. **Workday dynamics of psycho-physiological indicators**

Psycho-physiological indicator	Computer operators			Control group			p
	Before work	In the middle of work	After work	Before work	In the middle of work	After work	
Optic senso-motoric reaction, ms	243.5±28.6	257.6±28.5	275.2±31.2	241.5±22.1	245.5±22.2	250.9±22.8	<0.05
Optic senso-motoric reaction changes, %	100	105.9	113.3	100	101.7	103.9	<0.01
Hearing senso-motoric reaction, ms	187.9±22.3	193.7±21.8	201.8±21.5	178.0±18.9	180.8±19.2	184.6±18.9	<0.05
Hearing senso-motoric reaction changes, %	100	103.1	107.5	100	101.6	103.7	<0.01
Stability of acute vision changes, %	97.1±1.5	82.1±3.2	61.9±4.2	99.5±0.3	94.5±0.6	89.1±0.5	<0.01
Fluctuation of the acute/ blurred vision periods, times/min	3.2±1.0	10.9±2.3	20.0±3.0	2.5±0.6	4.4±0.7	6.7±0.7	<0.01
Veston's test, bit/s	1.79±0.28	1.58±0.26	1.37±0.27	1.66±0.25	1.59±0.24	1.51±0.24	<0.01
Veston's test changes, %	100	88.2	75.9	100	96.2	91.2	<0.01

Note: p is established comparing data of investigated and control groups at the same period of time.

psycho-physiological indicators of computer operators were statistically more reliably worse than those of the control group.

Musculo-skeletal disorders are among the main complaints when working with computers. Their frequency increases together with the work experience (14). The main complaint is pain that occurs during or at the end of the work. The evaluation of the odds ratio [OR] for the development of the aforementioned symptoms according to the localization of pains shows that most commonly pain is located in the shoulder girdle and neck: OR = 16.55 (4.65 – 91.53), $p<0.01$. The odds ratio for pain in the lumbar area is OR=7.33 (1.68 – 67.04), $p<0.05$, and for carpal pain OR = 6.02 (1.07 – 261.47) $p<0.01$.

Another important factor that characterizes musculo-skeletal disorders when working with computers is the frequency of the occurrence of the mentioned complaints and its relationship with work time. In all inquired computer operators who were complaining of pain of various localization and character, pain appeared in the second half of the workday and lasted until its end. 22.6% of the questioned people felt pain several hours after work.

Summing up the obtained findings, it can be said that musculo-skeletal disorders when working with computers were not specific symptoms typical only of this kind of work. However, these disorders are also possible in other types of work. Musculo-skeletal disorders, their frequency and localization (shoulder girdle, neck, spinal column) are significantly more frequent when working with computers. According to the findings of our study, the frequency of complaints about disorders of the musculo-skeletal system is rather high (83.7%). This shows that much more attention should be paid to the issues of the ergonomic equipment of the workplace and ergonomic training of workers (15,16).

Conclusions

1. Changing conditions of the work environment result in changes of the occupational morbidity of the workers.
2. The predominating disorders in the morbidity structure of transport employees are those of the respiratory organs, as well as traumas and poisonings, cardiovascular diseases, and diseases of the musculo-skeletal and the peripheral nervous systems.
3. Musculo-skeletal disorders among transport employees are closely related to the professions of drivers and motor-metalworkers, unsuitable ergonomic working conditions, older age, and greater professional experience.
4. The morbidity of the LAL flying staff is 1.38 times greater than that of the able-bodied population of Lithuania.
5. The most common causes of missed working days are respiratory diseases, traumas, poisonings and other consequences of the effects of external factors, and diseases of the nervous system.
6. The main health disorders among computer operators are disorders of sight and the musculo-skeletal system.
7. Ophthalmologic changes and subjective symptoms among people working with computers result from the strain of the vision analyzer and the central nervous system, asthenopia, and the "dry eye" syndrome.

Dirbančiųjų sveikata ir šiuolaikinės darbo sąlygos

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Raktažodžiai: darbo aplinka, laikinas nedarbingumas, psichofiziologiniai tyrimai, transportas, darbas kompiuteriu.

Santrauka. Straipsnyje nagrinėjama Lietuvos darbuotojų sveikata ir jos ryšys su darbo aplinkos sąlygomis. Tirtųjų kontingentą sudarė kelios profesinės grupės: transporto sferos darbuotojai, avialinijų pilotai ir dirbantieji kompiuteriu.

Darbo tikslas. Darbo aplinkos poveikis dirbančiųjų sveikatai ir ją lemiantys veiksniai.

Tyrimo medžiaga ir metodai. Kompleksinio tyrimo metu buvo tiriami asmenys, dirbantys keliose Lietuvos įmonėse, kurios skiriasi pagal darbo profilį bei darbo aplinkos sąlygas. Atlikti darbo aplinkos, dirbančiųjų anketiniai, psichofiziologiniai ir oftalmologiniai tyrimai bei laikino nedarbingumo analizė.

Rezultatai. Transporto darbuotojų darbo vietose leistinus parametrus viršijo triukšmas, vibracija, švinas, suvirinimo aerozolis, vaitspiritas, anglies monoksidas bei nediferecijuotos kilmės dulkės. Transporto darbuotojų sergamumo struktūroje vyrauja kvėpavimo organų ligos, traumos ir apsinuodijimai, kraujotakos sistemos ligos, kaulų ir raumenų bei periferinės nervų sistemos ligos. Lėktuvų pilotų bei palydovų dažniausios nedarbingumo priežastys: kvėpavimo ligos, traumos, apsinuodijimai ir kitos išorinių veiksnių pasekmės, taip pat nervų sistemos ligos. Pagrindiniai dirbančiųjų kompiuteriu sveikatos pažeidimai yra regos bei kaulų ir raumenų sistemos ligos. Oftalmologinius pokyčius bei subjektyvius simptomus dirbantiesiems kompiuteriu lemia regos analizatoriaus ir centrinės nervų sistemos nuovargis, astenopija bei „sausos akies“ sindromas.

Išvada. Kintančios darbo aplinkos sąlygos turi įtakos dirbančiųjų sveikatai, kurios pažeidimai yra specifiniai – tai priklauso nuo darbo pobūdžio, darbo stažo bei dirbančiųjų amžiaus.

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