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WOOD DUST: AN OCCUPATIONAL HAZARD WHICH INCREASES THE RISK OF RESPIRATORY DISEASE

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The main source of emission of harmful dust in the work place comes from technological processes. European legislation aims to minimize the health risks from dangerous substances in the workplace. European Directives are transferred into national legislation. Such matters as risk assessment, technical measures, and exposure limits are regulated by the law. In Poland, manufacturing processes in which hardwood dust is discharged, are considered as carcinogenic. Numerous studies have shown that occupational exposure to wood dust is strongly associated with the development of cancer of the nasal cavity and paranasal sinuses (NSC), but data regarding the development of lung cancer are conflicting and inconclusive. In the study, the exposure to inhalable wood dust was assessed among wood-workers in mid-west Poland. The assessment of occupational exposure was made on the basis of measurements of the concentration of dust in the work place. This was defined by exposure rates to dust in reference to daily work time and by comparing that to the maximum acceptable concentration values of dust defined by the regulation by the Minister of Work and Social Policy. The health assessment of workers was made on the basis of periodical medical check-ups, whose range and frequency is defined by the regulation of the Minister of Health and Social Security. The study did not show effects of wood dust exposure on the of lung cancer.

Key words: *occupational hazard, respiratory disease, wood dust*

INTRODUCTION

One of the basic exposure and occupational hazard factors is dust. The main sources of harmful dust emission at the workplace are technological processes. The properties of the dust emitted in the working environment are strongly connected with the properties of the substances from which it is generated. The

final result of the adverse influence of industrial dust depends on the type of the inhaled dust and the place in the respiratory tract where it lingers on, which is conditioned by the size of its particles, the structure of the respiratory tract, and the process of breathing itself. Wood is a material of uneven structure, whose crucial mechanical feature is its toughness, i.e., resistance to deformation caused by the forces acting on its surface (1). Wood classification by the cell structure divides wood into hardwoods (mostly deciduous trees), and softwoods (mostly conifers). Dust that arises during technological processes of hard wood processing (beech and oak) has been classified by the International Agency for Research on Cancer (IARC) as a carcinogenic factor, the most authoritative institution in the field of carcinogenicity assessment (2-4). The carcinogenicity of factors, i.e., the property that conditions cancer in people and in animals, can be established only on the basis of documented interdependence between exposure to a given factor and the increase of the frequency of cancer in exposed people or animals. The basis for the assessment of the carcinogenic effect of factors are epidemiological studies, long-term experimental tests on animals, short-term tests, which allow to assess genetic toxicity.

Numerous studies show that occupational exposition to wood dust is strongly connected with the induction of nasal cavity cancer and paranasal sinus cancer, but the data concerning lung cancer are varying and inconsistent (2, 5-8). The trials to establish how professional factors contribute to falling ill with lung cancer come mostly from epidemiological studies: clinically-controlled or cohort studies (2, 9). The most important parameter characterizing work conditions at the time of exposure to a harmful substance is the level of dust concentration in the air within the working environment. It is connected with the statutory approval of the maximum acceptable concentration values of harmful substances in the air at the workplace. The values should be safe for people employed in the time of a given production process. The maximum acceptable concentration values are hygienic norms legally binding for all branches of the national economy. The aim of this study was to evaluate the occupational exposure to the inhaled wood dust and the occurrence of lung cancer among the workers employed at the workplace exposed to the emission of dust.

MATERIAL AND METHODS

The research concerns 1100 workers employed by wood processing and by jobs connected with the risk of exposure to wood dust in mid-west Poland. The research was carried out in 9 wood-processing plants: 2 sawmills, 4 plants manufacturing frames for upholstered furniture, and 3 plants manufacturing ready-made (mostly upholstered) furniture. Among the employed, the majority were men (92%). The time of exposure to wood dust was established on the basis of the employment period in the researched plants. The previous place of employment of the researched workers was not taken into account, which would extend the time of exposure to wood dust of the workers with longer job seniority in the profession. With regards to the source of information about occupational

risk, only information collected in the researched plants was accepted as the most reliable due to the completeness of its analyzed data. The period of exposure of workers to wood dust was, then, connected with the period of functioning of the researched companies, usually lasting from 1 to 18 years. The job seniority of the majority of workers was from 5 to 10 years. Those employed for longer than 10 years made up 18% of the persons researched. Job seniority of about 30 % of workers was shorter than 5 years.

The assessment of exposure was carried out on the basis of: measurements of wood dust concentration at the workplace; establishment of indexes of exposure to dust in relation to the daily work time and their comparison to the maximum acceptable dust concentration as defined by the Ministry of Work and Social Policy (DZ.U. Nr 217, poz.1833, Dz.U. 2005r, Nr 212 poz.1769). The maximum acceptable concentration of a factor harmful to health in the air was established as the quantified average. Effects of such harmful factors during eight-hours', twenty-four-hours', or weekly work time of the worker's professional activity should not cause adverse changes in his and his future generations' health condition. The highest acceptable concentration index is the ratio of the exposure to the quantified average concentration to the maximum acceptable concentration. The quantified average of the average geometrical concentration is the sum of the products of the geometrical average of concentration and the time of its duration to the sum of the measurement time. The minimum and the maximum level of the trust range established the bracket in which, up to 95% of probability, is the average substance concentration in a given measurement time. Work conditions are considered as harmful if the hazard index is higher than the maximum acceptable concentration value for a given substance, and at the same time the coefficient of the joint hazard is higher than the single coefficient. On the other hand, work conditions may be considered as safe if the exposure index is not higher than the maximum acceptable concentration value for a given substance. It was accepted that breaks in work consist of 15 % of the work time. The average work time at given workplaces was established with the employer's representative. In measurements of wood dust concentration in the working environment filter and mass methods were used. Such methods make it possible to link the mass of dust precipitating on the measurement filters with the dimension fractions of dust particles, precipitating on various sections of the respiratory tract. The mixture of all particles surrounded by air in the established volume is accepted as the total dust.

The health condition of workers was assessed on the basis of the medical check-up of all workers employed in the researched plants since their establishment. The check-up was carried out on the basis of the referral issued by the employer in accordance with the regulations in force. Employees underwent general examination and depending on further instructions – laryngological and auxiliary examination – chest X-ray and spirometry. Prophylactic examination ends with the issuing of medical decisions stating the existence or lack of contraindications to working at a given workplace

RESULTS

The level of dust in the air in the measurements at a given workplace or a set of workplaces in the researched plants ranges from 0.59 mg/m^3 to 16.2 mg/m^3. The highest level was stated at the sanding workplaces (from 1.81 mg/m^3 to 16.2 mg/m^3), next to the band-saw and circular saw. The high level of dust was also found at the workplace of stokers (from 2.1 mg/m^3 up to 12.8 mg/m^3), the lowest level occurs at the assembly workplaces (from 0.59 mg/m^3 up to 3.2 mg/m^3). Dust from hardwoods (mostly beech, partially oak) made up about 80% of the

dust emitted during the production process. Remaining dust is from softwoods, mostly birch and pine. The level of dust concentration was measured for the total mixture of wood dust occurring at the workplaces in accordance with the directive 2004/37/EC of the European Union and prior directives. In the case of 5% of workplaces, it was stated that the maximum acceptable concentration level was exceeded. The maximum acceptable concentration of harmful substances can, by definition, be exceeded, on condition that it is compensated on the same workday with the equivalent lowering of the concentration below the maximum acceptable concentration level. In the researched plants at the workplaces of high dust concentration employers implemented the rotational work system. The aim of such a system is to limit the exposure to wood dust in favor of preparatory, transport, and cleaning works without exposure. The frequency of measurements was in accordance with the regulation of the Ministry of Health and Social Care (DZ.U. 2005 Nr 73, poz. 645). In the case of carcinogenic factors, the measurement was done at three-monthly intervals, when the level of the concentration exceeded 0.5 of the maximum acceptable concentration and at least once per 6 months when it was from 0.1 to 0.5 of the maximum acceptable concentration.

The range and frequency of the prophylactic check-up of workers was in accordance with the instructions defined by the Ministry of Health and Social Care (Dz.U. Nr 69, poz. 332). According to the regulation, the fatal organ in case of professional exposure to wood dust, especially to the classified as carcinogenic tough wood dust, is the respiratory tract and skin. Medical check-up was carried out in accordance with the regulation, every 4 years, or at shorter intervals, every 3, 2 years, or every year. The frequency depended on the assessment of the worker's health condition by the doctor responsible for the prophylactic examination. The short interval between medical examinations was dictated, firstly, by the professional exposure to the second harmful factor at the workplace connected with wood processing – noise. Two cases of issuing contraindication to further work in the workplace exposed to wood dust due to bronchial asthma were affirmed in the researched plants. Not a single case of lung cancer was affirmed. No case of occupational disease, caused by exposure to wood dust, was affirmed in the researched plants either.

DISCUSSION

Assessment of the occupational exposure is one of the most important activities aiming at the employee's health protection. The assessment of occupational risk and exposure to wood dust is difficult. This difficulty arises due to the inconsistency and controversy surrounding many factors. Firstly, the size and shape of dust particles, which decide where the particles precipitate in the respiratory tract, and about their adverse, particularly carcinogenic influence.

Secondly, differences in the structure, composition and influence of various types of wood, taking into account the division into hard- and softwood. Thirdly, the establishment of the safe maximum level of dust concentration in the air of the working environment. The above aspects require many legislative regulations, which impose on the employer a number of duties resulting from the adverse effects of wood dust on health. The particles which precipitate in the vicinity of the mouth and eyes, and get into the organism, are defined as the inhalable fraction, that is total dust. Smaller fractions, penetrating into the non-cartilage respiratory tract, are defined as respirable dust. Dust emitted in the wood industry is characterized by the dimensional disintegration of particles up to 5 μm, and that is why they precipitate mostly in the nasal cavity, increasing the risk of cancer of the upper respiratory tract. Reports show that the dust generated during the processing of hardwoods results in a higher proportion of smaller particle sizes, but the evidence is not consistent. Also, cellular mechanisms caused by various types of wood dust, for example cytokine and chemokine, are debatable and inconsistent. The aforementioned discrepancies consist of one the most crucial features of wood dust, its carcinogenicity (2, 8, 10-15). Controversy around the problem, particularly in the context of cancers of occupational origin, is additionally complicated by the multiple etiology of neoplastic diseases. The trials to assess the contribution of occupational factors to the etilogy of tumors of diverse location have been a subject of interest for a long time. The works on the classification of carcinogenic substances belong to continuous research. The results of such research, dispersed in world literature, have been compiled and assessed by the Working Groups brought into being by the International Agency for Research on Cancer (IARC) for over 30 years (2-4). On the basis of the criteria established to judge the evidence of carcinogenic effects (the survey of the data published in world literature, experiments on animals, and results of epidemiological studies), the IRAC has distinguished 4 categories of factors carcinogenic to people. Wood dust is classified as the first category, i.e., the category of factors or a set of factors with sufficient evidence of their carcinogenic effects on people. Numerous studies prove, first of all, that the exposure to hazard dust is clearly associated with adenocarcinoma of the nasal cavities and paranasal sinuses. However, research on the relationship between the exposure to wood dust and lung tumors is regarded as contradictory and inconsistent, with zero or very low risk assessment. Experimental tests on animals confirming the carcinogenicity of wood dust are considered as insufficient. Independently of the assessment by the IARC, many countries have established and published their own registers and lists of carcinogenic factors. In the USA, the lists of carcinogenic factors have been published by the American Conference of Governmental Industrial Hygienists (ACGIH), the Occupational Safety and Health Administration (OSHA), and the National Institute for Occupational Safety and Health (NIOSH). All the organisations recognize wood dust (without distinguishing between hard- and softwoods) as carcinogenic in relation to the

nasal cavities and paranasal sinuses. Carcinogenic influence on the lungs, in accordance with the stand taken by the IARC, has been recognized as inconsistent. In the EU, the list of substances recognised as carcinogenic can be found in the directive 67/548/EWG with subsequent amendments. According to the directive, hardwood dust is recognized as carcinogenic, first of all, for the upper respiratory tract. Particular member states of the European Union can interpret and implement directives in different ways. Directives determine the minimum level and contain the basic requirements which must be followed by all member states. In Poland, in accordance with the requirements of the EU, the Ministry of Health and Social Care drew up a decree according to which the dust generated during technological processes of hardwood is a carcinogenic factor (DZ.U. Nr 121, poz. 571). A crucial element in the work's prophylactic policy is the establishment and statutory approval of such a dust concentration at the workplace that would be safe for people. The measurement and assessment of dust concentration in the work environment is the most reliable method of professional exposure assessment. The acceptable concentration limits, consisting of OEL (Occupational Exposure Limits) value levels (defined as the permitted exposure limit-PEL, recommended exposure limit- REL, threshold limit value-TLV, maximum exposure limits –MEL) differ to a large extent from country to country. The stands taken by particular countries vary both with reference to the measurements of total dust, respirable fractions, presence of hard- and softwood dust, and are established at the level from 15 mg/m^3 to 1 mg/m^3 (8, 16-18).The most frequently accepted maximum value (also in the EU) is 5 mg/m^3. In Poland, the maximum accepted concentration value for total wood dust is 4 mg/m^3. By establishing or suggesting the permitted exposition levels for carcinogenic factors and also the concept of acceptable risk, generally accepted social and economic priority is used. In most countries, the value of the acceptable risk for carcinogenic factors is at the level of 10^{-3} , which means that the society accepts the occurrence of 1 tumor per 1000 exposed people. In Poland, the level of acceptable occupational risk is established between 10^{-3} and 10^{-4} for carcinogenic factors. The main goal of establishing the maximum acceptable concentration level of harmful substances is the lowering of their concentration at the workplace to the level of the acceptable risk. Statutory differences among countries in the recognition of the carcinogenic influence of various wood types, in discrepancies in the assessment of adverse effects of wood dust on particular parts of the respiratory tract (controversy around the carcinogenic effect on the lung tissue), and in establishing different limits of the maximum permitted value of total wood dust concentration at workplaces, the lack of limits for the respirable fraction emphasise the further need to carry out research over occupational exposure to wood dust and respiratory tract cancer collapse. The complexity of the assessment of the adverse effects of wood on the respiratory tract is even more difficult due to the biological fraction present in wood dust, especially gram(me)-negative bacteria and mould which are a source of allergens,

and endotoxins of multidirectional influence, also carcinogenic and mutagenic (5, 19). The present research has not proved the occurrence of lung cancer among wood industry workers, but it cannot be stated that it has excluded its occurrence, mostly due to the relatively short time of employment, in terms of the process of cancer development. Morbid changes may show after many years since the exposure to a given factor. The period of development in case of cancers lasts from 4 to 40 years. The number of the sick increases together with the seniority, the average period of cancer development is 20 years (4). The present research was completed with the information from the Central Register of Occupational Disease, kept by the Institute of Work Medicine in Łódź. Not a single case of lung cancer caused by the occupational exposure to wood dust has been affirmed in Poland. The lack of statistical evidence of the existence of occupational disease does not, however, sufficiently exclude the possibility of a causal link between lung cancer and the exposure to wood dust. In terms of tumors of occupational origin, the lack of their affirmation may result from a number of diagnostic and expertise difficulties.

The proper recognition of hazards in the working environment and of the health risks connected with them provides good reasons for undertaking various decisions and prophylactic actions, also as to the range and frequency of medical examination. The influence and mechanism of the adverse effect of wood dust on the respiratory tract should be the subject of further research and should be reflected in adequate legal regulations concerning occupational risk in order to eliminate or maximally limit health risk.

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