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Cardiac and vascular disorders as para-occupational diseases – a Polish perspective

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Abstract

Introduction. The study presents the difference between occupational and para-occupational diseases in terms of Polish law, and indicates the fact that cardiovascular diseases (CVDs) are considered to be work-related, and describes the latest reports on the prevalence of cardiovascular risk factors in workplaces.

Objective. The aim of this study is to present the difference between occupational and para-occupational diseases in terms of Polish law. Also indicated is the fact that cardiovascular diseases (CVDs) are considered to be work-related and the latest reports on the prevalence of cardiovascular risk factors in workplaces are described.

Brief description of the state of knowledge. Polish law distinguishes two groups of diseases that may arise in connection with work: occupational diseases and work-related diseases (so-called para-occupational diseases). Despite the fact that both groups are connected with the work environment they are not equivalent in legal terms. CVDs are one of the greatest threat to human life. The pathogenesis of these diseases is highly dependent on the compilation of adverse risk factors, which are typically divided into modifiable and non-modifiable. To-date, modifiable factors, i.a. excess weight and high blood pressure, were mainly associated with an unhealthy lifestyle. However, a shift in perspective has taken place and currently researchers focus more on the work environment as a possible factor affecting people's health. It is emphasized that an unhealthy work environment increases the risk of CVD. Research shows that workplaces are rich in risk factors specifically related to work, including psychosocial, physical and chemical factors.

Conclusions. Legal principles covering para-occupational diseases in Poland seem incomplete. It is suggested that providing detailed legal authorization and defining the bodies that will objectively and reliably engage in the diagnostic process of para-occupational diseases may be beneficial to employees.

Key words

occupational disease, paraoccupational disease, work-related disease, work-related stress, cardiovascular disease, risk factor

INTRODUCTION AND OBJECTIVE

Statistics show that cardiovascular diseases (CVD) are the leading cause of death worldwide [1]. For this reason, many countries strive to improve their health policy and reduce cardiovascular mortality. Actions aimed at limiting risk factors seem to be the most effective. To obtain maximal effect, factors related to both lifestyle and the external environment should be reduced. It is also crucial to search for and define new risk factors that have not been recognized before. In this context, the important role of the work environment in shaping the health of the population is increasingly emphasized. It is noteworthy that many professions are associated with various CVD risk factors. Moreover, work plays a significant role in creating specific habits and behaviours. However, finding a cause and effect relationship between the work environment and employees' health can be challenging.

Occupational and para-occupational diseases. Polish law distinguishes two main groups of diseases that can arise in connection with work. The first group, in accordance with art. 235 [1] of the Labour Code, includes occupational diseases and is covered by detailed legal authorization in the form of the Regulation of the Council of Ministers on occupational diseases of 4 September 2013.

In order to diagnose an occupational disease two main elements are needed:

1. The presence of the disease in the official list of occupational diseases contained in the Regulation of the Council of Ministers on occupational diseases of 4 September 2013.
2. An indisputable or highly probable cause and effect relationship between the disease and work environment or the manner the work is performed.

The above-mentioned Regulation systematizes the procedure for diagnosing and reporting occupational diseases. The diagnostic path is long and complicated; it covers both 1st and 2nd instance regulatory units as well as the institution of the state sanitary inspector. A detailed list of units involved in this procedure is provided in Table 1.

The legislator regulates the manner of action at every level because the diagnosis of an occupational disease is associated with favourable social security benefits. The current list of occupational diseases is closed and includes 26 groups of diseases that were last updated in 2009 [2]. According to the Central Register of Occupational Diseases, 2,022 cases of occupational diseases were diagnosed in Poland in 2018, among which the following diseases dominated: infectious and parasitic diseases (32.9%), pneumoconiosis (19.4%) and

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Table 1. Institutions involved in diagnosing occupational diseases in Poland

Instance regulatory units	Organizational units
First (I)	Occupational disease in- and out-patient clinic departments of the provincial occupational medicine centres
	Occupational disease in- and out-patient clinics of medical universities
	Contagious disease out-patient clinics of provincial occupational medicine centres or provincial-level contagious disease in- and out-patient clinics – for contagious and parasitic occupational diseases
	Organizational units of health care complexes where the patient was hospitalised – for diagnosing of occupational diseases in patients hospitalised for acute symptoms of the disease
Second (II)	Occupational medicine scientific research unit

Source: Based on the Regulation by the Council of Minister of 30 June 2009

chronic voice disorders (14%). The work sectors with the highest risk included, respectively, agriculture, forestry, hunting and fishing; industrial processing, and education, as well as mining and quarrying [3].

The second group of diseases that can arise in connection with work includes the so-called para-occupational diseases or work-related diseases. Unlike occupational diseases, they have not been described in detail in the form of a regulation. Their existence can be inferred indirectly, through art. 227 § 1 of the Labour Code, which imposes the obligation on the employer to prevent occupational diseases and other work-related diseases, as well as art. 236 of the Labour Code, which requires a systematic analysis of the causes of accidents at work, occupational diseases and other diseases related to the work environment [4]. Even though the Labour Code distinguishes these two categories of diseases, in practice they are not equivalent and there are elementary legal differences between them, which are summarized in Table 2.

Table 2. Comparison of occupational and para-occupational disease

	Occupational diseases	Para-occupational diseases
Legal definition	Defined in art. 235^1 of the Labour Code	None
Authority responsible for diagnosis	Authorized regulatory unit	None
Types of benefits that can be obtained by the injured party	Social security benefits Benefits obtained by means of civil law proceedings	Benefits obtained by means of civil law proceedings
Entity responsible for determining the cause and effect relationship between exposure and disease	Authorized regulatory unit	Injured party
Employer's legal responsibility for the effects of the disease	Supplementary – when pursuant to the Civil Code it has been proven that the employer failed to provide employees with a safe workplace	Independent, full

Source: author's elaboration based on [2]

Polish law regulating the issue of para-occupational diseases seems to be incomplete, there is no legal definition and no designated authority responsible for diagnosis.

According to the World Health Organization (WHO), para-occupational diseases are multifactorial and not directly related to the work environment [5]. However, the work environment can facilitate their development and worsen or accelerate their course. The WHO also emphasizes the fact that the most common para-occupational diseases belong to the group of civilization diseases, and thus they occur more often than typical occupational diseases. Moreover, it is often difficult to clearly determine whether their development results from occupational exposure or from a poor lifestyle [6].

Therefore, it could be beneficial to define the bodies that will objectively and reliably engage in the diagnostic process of para-occupational diseases and will be able to unambiguously establish the cause and effect relationship between employees' health and working conditions. Failure to regulate this issue in the Polish Labour Code has unfavourable consequences for employees. First of all, the injured party cannot apply for social security benefits. Secondly, on the civil law path the worker is independently responsible for proving the cause and effect relationship between occupational exposure and the disease. Thus, in the current system, the proper diagnosis of a para-occupational disease is made by a court expert in the course of civil proceedings brought against the employer [7]. Considering the fact that para-occupational diseases are much more common than occupational diseases, it seems necessary to update the current list of occupational diseases or to introduce legal principles covering para-occupational diseases. Such actions could increase the awareness of employers and employees about the legal and financial consequences of health damage caused by working conditions and, as a consequence, could intensify activities aimed at providing employees with safe and health-friendly jobs.

Para-occupational diseases – types and epidemiology. According to the European Agency for Safety and Health at Work (EU-OSHA), the most common para-occupational diseases in Europe include: cancer (25%), skeletal system diseases (15%) and cardiovascular diseases (12%) [8]. The EU-OSHA also warns that these conditions, together with accidents at work, constitute a significant economic problem. It turns out that every year they are responsible for the loss of 3.3% of working days, which economically translates into the loss of about 476 billion euros. The impact of para-occupational diseases on the population demographic situation and mortality rates is also important. It is estimated that 2 million people worldwide die from work-related diseases every year, mostly (28%) due to cardiovascular diseases [9, 10]. The huge scale of the problem is also illustrated by Polish statistics; according to the Demographic Yearbook, among the total number of 402,852 deaths in 2017, as much as 42% resulted from cardiovascular disease and 25% from cancer [11].

It is worth noting that work is an integral part of life. In 2016, a statistical Pole worked 1,832 hours, which means that he/she spent about 20% of the whole year at work [12]. This leads to the conclusion that ignoring the work environment when analysing the risk factors for diseases such as cardiovascular diseases, cancer or skeletal system diseases, is a major oversight.

Cardiovascular diseases as para-occupational diseases – risk factors. Cardiovascular diseases are the leading cause

of death in Poland. In 2017, 167,075 people died because of them [11]. Statistical data with a detailed insight into the most common cardiovascular diseases causing death is provided in Table 3.

Table 3. Number of deaths caused by cardiovascular diseases in Poland in 2017

Cause of death	Number of deaths [in thousands]	% of total number of deaths due to cardiovascular and cerebrovascular diseases
Ischemic heart disease	44,716	26.76%
Heart failure	37,216	22.28%
Atherosclerosis	33,245	19.90%
Cerebrovascular disease	30,630	18.33%
Hypertension	7,278	4.36%

Source: author's elaboration based on [11]

The commonly used classification of risk factors for cardiovascular diseases includes:

- non-modifiable factors – male sex, advanced age, family history of heart diseases'
- modifiable factors – overweight, obesity and large waist circumference, hypertension, high blood cholesterol, type 2 diabetes, smoking, lack of regular exercise, alcohol abuse, stress.

A compilation of risk factors leads to damage to the heart and blood vessels. The predominance of the modifiable risk factors over the non-modifiable factors is widely emphasized in medical literature. The disproportion is significant, according to a report published in *The Lancet* journal, modifiable factors contribute to the development of 70% of cardiovascular diseases [13].

Unfortunately, modifiable factors are widespread in the Polish population. According to the WHO estimates for 2016, 69% of men and 57% of women in Poland have excessive body weight, and the percentage of obese people is 25% and 26%, respectively [14]. In the latest epidemiological study conducted by Małyszko et al. (May Measurement Month 2017) on a sample of nearly 6,000 people, hypertension was diagnosed in 35.2% of the surveyed population aged over 18 [15]. Although the percentage of smokers is gradually decreasing, 24% of Poles still smoke cigarettes [16]. Moreover, Poland has particularly unfavourable results in terms of physical activity of its citizens – as many as 55.2% of men and 61.9% of women declare no physical activity after work [17].

Considering the above, it can be concluded that Poles are burdened with modifiable CVD risk factors which may be the result of both an unhealthy lifestyle and adverse working conditions. Therefore, while making a diagnosis of work-related disease, it is very difficult to draw a line between these two elements. It is also worth noting that besides well-established risk factors for CVD, there are also factors specifically related to the work environment; namely, psychosocial, physical and chemical factors.

Psychosocial factors – Stress. Stress is a non-specific reaction to all the demands made on a body. It is a natural phenomenon that, if it lasts only for a short period of time and at low intensity, it has the beneficial effect of stimulating the autonomic and immune systems. The physiological basis of response to an acting stressor is the sympathetic nervous system controlling the secretion of adrenaline and noradrenaline, and the HPA axis (Hypothalamus-Pituitary Gland-Adrenal Cortex axis) regulating the secretion of stress hormone – cortisol. Unlike short-term exposure, long-term exposure has a negative impact on health, in particular by disturbing the function of the cardiovascular system, dysregulation of metabolic and psychosomatic processes, and also by weakening the body's immune system [18, 19].

The work environment is a source of many stressors, which in medical literature are described as 'psychosocial risks' and refer to these aspects of organization and management at work, together with their social and environmental context, that can potentially cause psychological, social or physical damage. Cox et al. divide them into two basic groups: factors that belong to the work *content* and factors that belong to the work *context*. The first group includes variables such as: environment and equipment, the nature of tasks performed, workload, work space and time-frame of work. The second group includes: culture and functions of the organization, role in the organization, scope of decision-making, interpersonal relations, and work-home relationship [20]. Interestingly, not all stressors equally affect the level of stress experienced by employees. According to the generally recognized JDCS model (job demand – control – support) there are three main variables that influence employees' mental health, namely: level of work demands, level of work-related decision latitude and social support. Work that involves high demands, low decision latitude and low levels of social support poses the greatest threat to the well-being and health of employees [21–23]. Medical literature provides broad evidence of the link between cardiovascular diseases and psychosocial risk at work; especially in terms of arterial hypertension. A meta-analysis performed by Liu et al. indicates that stress at work is associated with a significant increase in the risk of hypertension (OR=2.40, 95% CI=1.65–3.49), moreover, the study showed that hypertensive patients had a higher incidence of psychosocial stress compared to normotensive patients (OR=2.69, 95% CI=2.32–3.11) [24]. The likely mechanism of the increase in blood pressure includes excessive activation of the HPA axis and increased production of cortisol, which enhances the vasoconstrictive effect of catecholamines. In addition, it seems to be the effect of sympathetic-parasympathetic imbalance in favour of the sympathetic nervous system, which maintains the body at a high level of excitation and keeps arterial pressure within its upper limits [25]. Recent studies also demonstrate the increased levels of angiotensin II and IL-6 in the blood of people exposed to adverse psychosocial factors, probably also increasing the risk of hypertension [26, 27].

The pathogenesis of hypertension is multifactorial and not yet fully understood; however, the impact of stress on its development seems significant. In accordance to the afore-mentioned JDCS model, the main variables affecting employees' mental health are: level of work demands, decision latitude and social support. The preliminary report from the Polish BAEL survey, published in the second quarter of 2019, showed that more than 1/3 of working people (i.e. 6, 245,000 people) very often or often experience time pressure at work, and the scope of tasks can be determined by just over half of the employed (50.5%) [28]. Considering the above, it can be suggested that Poles are exposed to stress in their workplaces. This situation is also intensified by the fact that Poles work

statistically longer and are often disproportionately less paid than citizens of other EU countries [13].

Considering the definition of para-occupational diseases, which are caused or exacerbated by the conditions of the work environment or by the manner of performing work, hypertension may be considered one of them. Moreover, taking into account the above data and the epidemiology of hypertension in Poland (4.3 million men and 5.6 million women affected in 2018) – the need to reduce psychosocial risk factors in the workplaces and, consequently, to reduce stress levels among employees seems favourable [29].

Ischemic heart disease (IHD) is another cardiovascular disease considered to be work-related. Commonly recognized risk factors for IHD include – in addition to age – overweight, hypertension, sleep disorders and smoking, as well as stress at work and shift work. The correlation between job strain and IHD is confirmed by numerous clinical studies and meta-analyses, which show that the PAR (population attributable risk) indicator, describing the difference in risk for exposed versus non-exposed population, is about 3–4% [30]. According to Selander et al., job strain significantly increases the risk of acute coronary syndrome (OR 1.39) [31]. In addition to the typically listed stressors, according to the above-mentioned JDCS model, excessive levels of overtime are also a risk for IHD. Marianna Virtanen et al. found a 1.8-fold increase in the risk of IHD in employees exceeding the recommended working time [32]. Stress modulates the development of IHD through the same mechanisms as in the case of hypertension. Pathogenesis includes both excessive activation of the HPA axis and autonomic dysregulation. It is also worth noting that hypertension itself, through mechanical damage to the endothelium, stimulates the process of atherogenesis, which is a key element in the pathogenesis of ischemic heart disease. The impact of psychosocial stress on the atherosclerotic plaque formation has been documented in medical literature. It turns out that prolonged mental strain causes inflammation within the endothelium, and non-specific activation of macrophages, along with their transformation into foam cells [33]. Since IHD is a multifactorial disease, it is very difficult to determine to what extent work-related stress contributes to its development. However, there are prospective, cohort studies indicating that excessive workload, mental strain, low decision latitude, as well as job insecurity, translate into an increase in IHD risk, even after adjusting the results with lifestyle risk factors [34].

Physical factors – Noise. Environmental exposure to noise can cause damage to both the hearing organ and to organs not directly involved in auditory perception. Noise, as confirmed by numerous studies, is an underestimated risk factor for cardiovascular diseases, in particular hypertension, ischemic heart disease and stroke [35–37]. According to the WHO estimates, DALY (disability-adjusted life-years) due to ischemic heart disease associated with environmental noise exposure is as high as 60,000 [38]. Münzel et al. attempted to explain this relationship in their latest study on an animal model. They subjected mice to intermittent exposure to aircraft sounds with an average volume of 72 dB and a maximum volume of 85 dB. Interestingly, it was proved that a 4-day exposure had numerous adverse health effects; mice showed an increase in plasma levels of noradrenaline and angiotensin II, increased systolic pressure, as well as endothelial dysfunction caused by the induction of oxidative stress, and a decrease in endothelial nitric oxide (NO). Moreover, increased NK cells (Natural killer) and neutrophils migration to the endothelium was observed [39]. It is worth noting that these changes occurred when exposed to sounds of lower intensity than the maximum permissible noise level at work (85 dB) in Poland. According to the estimates of Statistics Poland, of all harmful factors in the work environment in 2018, noise constituted the greatest threat; the exposed population was as high as 193,600 people, i.e. 59.5% of all employees working in the hazardous work environment [40]. It should be emphasized that noise standards were established mainly in terms of acoustic damage. It seems that 85 dB is not a reliable limit in relation to cardiovascular diseases. It turns out that even much lower sound levels cause stress among employees. A study conducted by Golmohammadi et al. showed that among bank employees who work in open-space offices, irritation related to noise, understood as background noise, is reported by up to 95% of employees. The assessment was based on the NAS (Noise annoyance scale) standardized questionnaire, and the conversations conducted by colleagues, turned out to be the most annoying sound [41]. Raising awareness, both among employers and employees, about the impact of surrounding sounds on health seems to be essential to improve population well-being. At present, only a bilateral, permanent, cochlear or sensory-nervous hearing loss due to noise, expressed as an increase in the hearing threshold of at least 45 dB, is recognized as an occupational disease in the Polish legal system [2].

Microclimate. Working in a variable temperature environment or in an excessively warm or cold microclimate is a heavy burden for an employee. Analysing the latest publications on this issue, it can be seen that a lot of attention is paid to the issue of working in an excessively hot microclimate, especially in countries of equatorial, subtropical and tropical climate [42, 43]. This can be associated with the global temperature rise. This problem also applies to Poland – this year (2019) in summer the average area temperature was about 2.5 °C higher than the average temperature in 1981–2010, and the highest recorded temperature exceeded 38 °C [44]. Work, especially physical, performed in an excessively hot environment is associated with exacerbation of existing cardiovascular diseases, as well as increased mortality due to them. Physiological changes that occur under the influence of heat – vasodilatation, increased heart rate and progressive dehydration – can exacerbate heart failure, stroke, and acute coronary syndromes. Flouris et al. attempted to select the employees who are least resistant to high temperatures in the workplace. It turns out that heat has the worst effect on employees characterized by at least two of the following factors (women/men): age ≥ 53.0/55.8; BMI ≥ 29.5/25.7 kg/m2; percentage of body fat ≥ 28.8/34.9; body surface area ≤ 2.0/1.7 m2; peak oxygen consumption ≤ 48.3/41.4 mlO2/kg of lean mass/min [45]. However, it is worth noting that a warm microclimate is also harmful for younger employees. A study carried out by Pradhan et al. in Qatar, which aimed to assess mortality among workers aged 25–35 who often worked at >31 °C, showed that mortality was significantly increased in hot months compared to colder months, and the majority of deaths (200 out of 571 in 2009–2017) occurred due to cardiological reasons [46].

Considering the above, it should be concluded that the abnormal microclimate in the work environment has a significant impact on the condition of the circulatory system and it is worth taking actions to minimize it. In the Polish legal system, only heat stroke or its consequences, heat exhaustion or its consequences, and frostbite are recognized as occupational diseases [2].

Chemical factors – Polluted air and dust. There are many chemical factors that increase the risk of cardiovascular diseases, but the current article only discusses the most common, i.e. exposure to dust and tobacco smoke. Air in the work environment can be contaminated with harmful gases (including carbon monoxide, nitrogen oxides, ozone, sulfur dioxide), as well as particulate matters (PMs). Dust is the second, after noise, most harmful factor with which Polish employees encounters while working in a hazardous environment [40]. Due to the diameter of particles suspended in the air, PM10 (2.5–10μm) and PM 2.5 (<2.5μm) are distinguished, and among PM 2.5 additionally UFP dust (<0.1 μm, ultra-fine particles). Medical studies emphasize that fine particles (below 2.5μm) which when inhaled reach the alveoli, demonstrate the greatest toxicity. In this context, UFPs that can penetrate to the cardiovascular system and accumulate outside the respiratory system, are considered the most dangerous. In blood vessels, they are destructive, causing oxidative stress and intensifying the process of atherogenesis [47]. Interestingly, elevated UFP concentrations are found not only in places that are associated with increased air pollution – including welding shops, mechanical workshops, industrial halls – but also in places considered uncontaminated, e.g. in restaurants. This is due to the fact that the elevated UFP concentration is not only caused by industrial pollution, but also by thermal processes which are common in many workplaces, including the kitchen [48].

Tobacco smoke. The adverse effects of tobacco smoke on the cardiovascular system have been widely documented in medical literature. Potential consequences include:

1) accelerating the development of atherosclerosis – by intensifying oxidative stress, reducing the bioavailability of nitric oxide, increasing the production of pro-inflammatory cytokines and modifying the lipid profile in favour of atherogenic low density lipoproteins (LDL) [49];
2) increased risk of thrombosis – by increased platelet activation and increased fibrinogen concentration [47].

Exposure to tobacco smoke is an indisputable risk factor for cardiovascular diseases; workplaces should strive to maximally reduce tobacco consumption. The employer who is legally responsible for safe and hygienic working conditions is under the obligation to introduce preventive actions. Pursuant to the current anti-smoking act, the employer may prohibit smoking throughout the entire workplace; the employer may also prohibit smoking during breaks and enforce the ban by means of disciplinary sanctions [50].

CONCLUSIONS

Taken together, legal principles covering para-occupational diseases in Poland seem incomplete. It is suggested that providing detailed legal authorization and defining the bodies that will objectively and reliably engage in the diagnostic process of para-occupational diseases may be beneficial to employees. This study has described the latest research indicating that workplaces are full of risk factors for the development and deterioration of cardiovascular diseases. Considering the fact that CVDs shape the epidemiological situation, both in Poland and worldwide, it would be favorable to increase awareness of the risks associated with working in an adverse environment. It is also suggested that increased preventive care and modification of workplace exposure would have a positive effect on employees' cardiovascular health.

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