

THE IMPACT OF SHIFT WORK ON SELECTED AREAS OF HUMAN FUNCTIONING AND HEALTH – OVERVIEW OF RESEARCH

WPLYW PRACY ZMIANOWEJ NA FUNKCJONOWANIE I ZDROWIE CZŁOWIEKA – PRZEGLĄD BADAŃ

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ABSTRACT

Professional work absorbs a big part of our lives. It is primarily a source of economic and social benefits. In some cases, however, work can have a negative and even harmful impact on health and well-being. The contemporary lifestyle, especially shift work, has changed a daily rhythm of life. Time schedule, different from the natural one, affects the human body, causing changes in hormones, body temperature, mood and brain functioning. The aim of the study was to review epidemiological studies on the relationship between night shifts and the presence of some pathologies.

KEYWORDS: shift work, health status, health consequences.

STRESZCZENIE

Dużą część naszego życia pochłania praca zawodowa. Praca człowieka to przede wszystkim źródło korzyści ekonomicznych i społecznych. W niektórych sytuacjach praca może mieć jednak niekorzystny, a wręcz szkodliwy wpływ na zdrowie i samopoczucie. Współczesny styl życia, a w szczególności praca zmianowa zmieniły w wielu wypadkach dzienny rytm życia. Inny od naturalnego rozkład czasu pracy wpływa na organizm ludzki, powodując zmiany w hormonach, temperaturze ciała, nastroju oraz funkcjonowaniu mózgu. Celem pracy był przegląd badań epidemiologicznych dotyczących związku między pracą w nocy a występowaniem wybranych patologii.

SŁOWA KLUCZOWE: praca zmianowa, stan zdrowia, konsekwencje zdrowotne.

Introduction

Shift work, without which it is impossible to imagine many types of industries, has been mentioned on the list of the most harmful or disruptive factors occurring in the workplace. In recent years, the attention has increasingly been directed towards the threats of night shifts. People with non-standard working hours often report their negative impact on health. The physiological problem of shift work results primarily from activities taken up at the time inconsistent with the normal circadian rhythm of most physiological functions. Biological rhythms, often called an internal biological clock, is an adaptive mechanism that allows to synchronize the internal environment of the man with the external environment. The main synchronizer of endogenous rhythms are light, temperature, cycles, phases of the moon, seasons and the availability of food. In the context of

shift work the most important factors are: a day-night cycle and food. Biorhythms are a regulated daily cycle of activity and sleep, the rhythm of core body temperature, hormone secretion, changes in blood pressure, heart rate and urine output. They are normalized body processes and their detuning leads to serious health consequences. Already in the 90s of the 20th century, the study of working conditions in European countries showed a higher incidence of lesions among shift workers compared with those working daily.

Shift work at night is less effective and causes increased fatigue [1]. Analyzing the reports from various centers on the impact of shift work on workers' health, it can be concluded that the shift contributes to a significant deterioration in the quality of life, but also performance. Some believe that only 10% of the economically active tolerate shift work well [2]. In many publications

it is emphasized that night work and shifts should not be regarded as a factor of absolute pathological importance. There is a disease that can be solely attributed to changing working hours. However, one can cite a lot of evidence that night work and shifts are a factor of accelerating or intensifying the occurrence and course of many diseases and pathological conditions. It may primarily refer to sleeping disorders, digestive system, changes in the circulatory system – including ischemic heart disease and hypertension, metabolic disorders, immune system disorders, and neurotic disorders [1]. The negative impact on the hormonal regulation of the body is considered by some authors as a potential factor that may favor the development of hormone-dependent tumors, e.g. breast cancer [3]. Working in unusual varying times of the day can cause reproductive changes in the menstrual cycle, during pregnancy (spontaneous abortion, premature birth, low weight newborns), accelerating the onset of the menopause and reduced fertility. In addition to these health effects, the attention should also be paid to disturbances in the sphere of family and social life of shift workers, whose time schedule is contrary to the natural rhythm of their families [1, 3, 4].

According to the definition of the International Labour Organisation 1990, shift work is a method of working time organization, in which employees work in succession in the workplace, so that the plant can work longer hours. In the directive 2003/88/EC of the European Parliament and the Council of 4 November 2003 shift work was defined as this form of work organization whereby workers change at the same work stations according to a certain pattern, including rotation, and which may be continuous or discontinuous, entailing the need for workers to work at different time over a given period of days or weeks [5, 6, 7].

According to the Labour Code (art. 128. section 2), the concept of shift work means doing the job according to the agreed work schedules. The shift system does not comply with the standard 8-hour working time during the day, and includes the night shift, rotating shift work and / or irregular working hours. In practice, this usually means working in two shifts – 12-hour mode (usually day and night shift) or a three-shift system – eight hours of work (night afternoon and night shift) [8]. The type of work which comprises the night shift in Europe and North America is performed by approximately 15–20% of the economically active people, including about 23% of men [6]. Among the EU countries Slovenia takes the first place in terms of the shift frequency (31%). Poland ranks second (29.5%), and Slovakia – third (29.0%). And the least number of people employed as shift workers is in Denmark (4.4%) [9]. Shift work is a common phenomenon in many industries – mining, communications,

hospitality, transportation and public services – police, fire and health services. The occurrence of shift work in the industry is subject to both: specific technological processes that often cannot be interrupted due to the nature of the product and the use of expensive equipment, whose effective application is associated with the continuous use.

Shift work and cardiovascular disease

The mechanism of the shift work influence on the formation of cardiovascular diseases is not completely understood. Shift work and night work – are forms of employment associated with the distortion of the physiological rhythm, stress and therefore, they harm the human body. Many authors emphasize that shift work may indirectly influence the formation of hypertension and coronary heart disease [10, 11]. Examples of data based on the observation of a group of 7095 people aged 39–62 suggest that those working 11 hours or more have a 67% higher risk of cardiovascular disease than those working 7–8 hours. The adverse effects of shift work apply to both men and women, as confirmed in the Nurses' Health Study, which was attended by 71 617 women aged 45–65. After the 10-year follow-up of women with no previously identified ischemic heart disease, 934 underwent myocardial infarction, and the risk was 45% higher in women who slept 5 hours per day compared to the ones sleeping 8 hours a day (12). Studies conducted in Finland, show that shift workers have a 30–50% higher risk of cardiovascular disease compared to personnel working on a day shift, but in this case there are certain differences between groups (Tenkanen, et al., 1997). The mechanism of cause and effect, presented in this study, is a disorder of the circadian rhythm (Tenkanen et al., 1997). The risk of the incidence of coronary heart disease increases along with longer experience of shift work (Knutsson, 1989). However, shift workers also have elevated levels of other risk factors for coronary artery disease, including the diversification of the diet (Knutsson, 1989). Other authors argue that '(...) the work shift is an absolute risk factor for coronary heart disease (...), shift work seems to involve a 40% increase in the risk of coronary heart disease' (Nurminen and Karjalainen, 2001). The Finnish study on a sample of 1,806 men showed that shift work significantly strengthened the other risk factors for coronary heart disease, including smoking, physical inactivity and obesity. Due to this, it is essential to take into account epidemiological studies of growing risk factors related to the lifestyle, smoking and others (Knutsson et al., 1988; Nurminen and Karjalainen, 2001). Boggild et al. (2001) on a random sample of the Danish population were checking whether shift work was associated with other factors influencing heart dis-

ease. They found that in at least one group of shift workers a higher prevalence of almost all unfavorable factors of working environment appeared, which were the subject of analysis (both physical and psychosocial conditions). The exception to this rule were only: exposure to dust and quantitative requirements [12].

Shift work and gastrointestinal dysfunction

A number of studies indicate that circadian rhythm disorders caused by shift work can affect a higher incidence of symptoms (heartburn, dyspepsia, lack of appetite, abdominal pain) [1]. It is not clear, however, whether shift work influences a more frequent occurrence of gastric and duodenal ulcer. Still, it is emphasized that the irregularity of life associated with shift work is a factor unfavorable in treatment of ulcers [13]. It is worth noting that the disruption of circadian cycles in the secretion of melatonin, associated with shift work (the origin of the pineal and intestinal melatonin) may also affect the functioning of the stomach and intestines. Melatonin preferably influences the metabolism of the mucous membrane and the muscular work, and increases the digestive tract in experimental treatment of gastric ulcers in laboratory animals [14]. Peptic ulcer is determined by many factors and shift work seems to be one of several risk factors for this disease.

Shift work and sleep

Shift work (at night) is not to be missed when searching for the causes of occupational stress. It has a detrimental effect on health, negatively influencing the natural physiological process of the body, i.e. a dream. The change of circadian rhythm disorders leads to stress. It reduces the amount of secretion of melatonin, which is released by the pineal gland and activates the mechanism of sleep and wakefulness. On average, about 30% of adult life is sleep. The number of hours of sleep needed for the body regeneration is genetically coded and varies for each person. Depriving the man of sleep for several days can lead to disturbances in the reception of impressions, logical thinking, confusion, hallucinations, fatigue, and mental disorders [15].

On the next day after work people working at night experience problems with sleep, the reaction time to stimuli is prolonged and the risk of making mistakes increases. These people are more irritable and sleepy. There has been a decrease in concentration, problems in analyzing and assimilating new information, as well as decision-making. Decreased efficiency, especially mental, serves to increase the number of accidents at work. We conducted the study which compared impaired psychomotor skills in people with deficient sleep and people under the influence of alcohol. More than

a dozen hours of the continuous standby corresponding reduction in the efficiency is observed at a concentration of 0.5 per mile of alcohol blood and more than 20 hours – at a concentration of 1 per mile of alcohol in the blood [16, 17, 18].

Knauth et al. showed that people working rotationally, on average sleep during the week 5–7 hours fewer, which in the long run gives chronic partial sleep deprivation. It can result in pathological sleepiness, anxiety, irritability, weakness at coping with difficult situations. There has also been a decline of concentration, difficulty in making decisions and analyzing the situation [19].

Shift work and cancer

Shift work and night work, disrupting circadian rhythms, can interfere with a number of physiological functions. This leads to the appearance of many pathologies. In the last few years a lot of attention was paid to these known but still studied pathologies. Analysis of work conditions suggested the influence of abnormalities in insulin secretion, and melatonin on the occurrence of certain malignancies [20]. Fluctuations of the melatonin level in the blood can influence the development of cancer, in particular breast and colon cancer, but ovarian, endometrial and prostate cancer are possible as well.

The impact of night work on the risk of breast cancer

The hypothesis of the relationship between breast cancer, night work and exposure to light at night was first formulated by Stevens in 1987 [21]. According to her, night work and exposure to light at night inhibit the synthesis of melatonin, and then increase the concentration of estrogen, which can lead to an increased risk of breast cancer. One of the first studies on the effects of shift work at night on the risk of breast cancer (Schernhammer et al.) have been conducted in the US in a large cohort of a population of 78 562 nurses – Nurses Health Study (NHS). In the course of a 10-year follow-up of this population (1988–1998), 2,441 cases of breast cancer were recorded. In the study, there was a statistically significant increased risk of breast cancer by 36% of nurses with at least 30 years of work experience including rotating night shifts [22]. During the follow-up cohort in Norway (the study of Lie et al.), numbering 44 835 nurses, there was 537 new cases of breast cancer. On the basis of this cohort, the case-control study comparing the performance characteristics in women with breast cancer and women with controls was conducted [23].

Colon cancer

The results of animal studies indicate that the antiproliferative activity of melatonin is not limited to breast

cancer cells but may also include other types of cancer, particularly colon cancer. Studies in rodents have shown that melatonin significantly inhibits the growth of cancer cell lines and colon cancer carcinogenesis induced by the chemical carcinogenic or mutagenic effects, i.e. 1,2-dimethylhydrazine) [24]. Furthermore, in the serum of patients with colorectal cancer lower levels of melatonin compared to healthy subjects were observed [25], which may suggest a link between low levels of melatonin and the development of colon cancer in humans. Schernhammer et al., in a cohort of 78 568 nurses (Nurses' Health Study I), showed a significant risk of developing colorectal cancer after 15 years of working in the night shift (increased by 35%). The analysis takes into account potential confounding factors, i.e. age, incidence of colorectal cancer in relatives, body mass index, alcohol consumption, smoking, physical activity and diet [26].

Endometrial cancer

Increased risk of developing endometrial cancer largely depends on the hormonal and metabolic factors that may be affected by reducing the secretion of melatonin associated with night shift work. Reduced levels of melatonin and its association with increased risk of endometrial cancer is not entirely clear. In 2007, Viswanathan et al. first published results of analysis of the incidence of endometrial cancer in a cohort study of 121 701 nurses (Nurses' Health Study I). During 16 years 515 cases of invasive endometrial cancer in a group of nurses who worked at night were diagnosed. Analysis showed a statistically significant increased risk of endometrial cancer in women working for 20 years and more in the system of night shift work. Risk was particularly high in obese women [27].

Impact of shift work on a woman's body

Disorders of the menstrual cycle are also mentioned as a result of shift work. Research by Gaworska-Krzeminska conducted in Poland in more than 2 thousand nurses showed that the menstrual cycle among nurses was significantly deregulated after shift work [30]. A similar statistical significance in the area of menstrual disorders as a result of shift work is confirmed by Chung et al. [28].

The results of the research by Burdelak et al. conducted in a population of nurses and midwives have shown an increased incidence of thyroid disease (21.2%) after working for 15 years in two shifts [29].

In research by Syrocka et al. thyroid diseases were the most frequently mentioned health problems by the respondents. Of the 37 women with various disabilities 18 (52.9%) suffered from hypothyroidism, 17.6% from

hyperthyroidism and 14.7% from Hashimoto's thyroiditis, which is a worrying phenomenon [30].

Another very important area of family life is sex life and satisfaction with sex life

Some of the nurses surveyed in the study conducted by Syrocka said that after starting shift work these parameters have deteriorated. In terms of intimate life of more than 44% it was specified that shift work made it difficult to have love life [31]. Poorer satisfaction with sex life after starting shift work is experienced by 33.6% of respondents. There is little research on satisfaction with sex life among shift workers. In the publications of several researchers, for example Zużewicz et al., the problem of reduced sexual performance and libido as a result of long work shifts is only mentioned. This conclusion, however, is not confirmed by any detailed analysis and can also be caused by the natural aging process of the body [32]. In the publication by Iskra-Golec et al., the study by Bosch and de Lange was quoted. The researchers, however, only mentioned the increased frequency of complaints about sexual life of people working in two shifts, compared with working regularly [33].

Stress in shift work

Stress is a common consequence of shift work, long hours spent at work, work consisting in performing tasks that require interference with sleep habits and resulting fatigue. Increased risk of stress is associated with disruption of natural biological circadian cycles, shorter time and poorer quality of sleep during the day, and the conflict of professional and private roles. Fatigue can interact in two ways: on the one hand, it may predispose an employee to experience stress, on the other hand, it can enhance the impact of any pre-existing stressor. Stress and fatigue in most affect people working at night, with up to 75% of shift workers feeling sleepy during each night shift (Akerstedt, 1995, 1988, 1985). Research by Bristol Accord (Bristol survey) indicates that participants who are at high levels of occupational stress work at night more often than workers with low levels of work-related stress (Smith et al., 2000) [34–37]. In recent studies of nurses working at night, Kobayashi et al., (1999) found that cortisol levels and cell activity were at night time low, which suggested that night work was highly stressful and could be harmful to the immune system [38].

In a recent study on differences between employees working during the day and at night in terms of exposure to physical and psychosocial occupational hazards in the care of the elderly in Denmark, Nabe – Nielsen et al. (2009) found that, compared with those working in

the day, people who are constantly working at night are more likely to have reduced control at work, low social support from superiors, as well as physical and mental violence, and high physical requirements. Working at night, however, they were less exposed to generally high demands of work. These differences persisted after adjustment for age, position and place of work. The authors suggested, therefore, that these results indicated the importance of the properly considered characteristics of work in examining health effects of shift work.

In previous studies [39], Shields (2002) explored the characteristics of shift workers and compared the stress factors and health behaviors of shift workers and people working on one day shift. The four-year analysis indicated that in men working at night, on a rotating basis, or as part of an irregular schedule, the rate of chronic diseases increased. Older workers usually experience more difficulty in a situation when they have to tolerate disruption of the circadian rhythm, so they may have delayed reactions, be more drowsy and unable to deal with tasks that require precision and attention [40]. For example, in the case of truck drivers over the age of 55, the risk of fatal road accidents exponentially increases (Mayhew, 1993) [41]. Another stressor is also the occurrence of conflicts as regards private and professional roles; for example, women working in the rhythm of shifts may be more likely to experience sleep disturbances (Bohle, 1999). The growing popularity of 12-hour shifts may contribute, therefore, to increasing the prevalence of fatigue and thus, to an increased prevalence of stress (especially among those working overtime). The negative health consequences of working 12-hour shifts to a much greater extent seem to involve shifts in the night than in the daytime [42]. However, research on the negative effects of work in the system of 12 - hour shifts has been carried out to a minimum (Leka and Jain, 2010). Research by Bristol Accord shows that 30% of employees with a high level of occupational stress were often forced to stay at work for a long time or at times conflicting with the rhythms of labor (Smith et al., 2000). However, it should be noted that the effect of a 'healthy worker' may interfere with the results of a large part of studies on the influence of work in the night [43].

Shift work cannot be eliminated from the life of modern societies, and thus, it is impossible to completely eliminate the negative effects of this kind of work. These effects, considered in physiological, sociological and health terms, do not meet one of the criteria used in a modern definition of health, which is the total physical, mental and social development. If the adaptation of a man to work 'in a non-physiological rhythm' is impossible, if there is a presumption that this activity has

a negative impact on the quality and length of life, particular attention should be focused on how to mitigate its negative effects and improve quality of life.

References

- Costa G, Gadbois Ch, Jansen B, Knauth P, Leonard R. Shiftwork and Health. *Best Eur Stud Time*. 2000; 1: 1–42.
- Golec I. Praca zmianowa a rytmiczność okołodobowa. W: Iskra-Golec I, Costa G, Folkard S i in. (red.). *Stres pracy zmianowej. Przyczyny, skutki, strategie przeciwdziałania*. Kraków: Universitas; 1998.
- Lowden A, Moreno C, Holmbäck U, Lennernäs M, Tucker P. Eating and shift work – effects on habits, metabolism and performance. *Scand J Work Environ Health*. 2010; 36: 150–162.
- Haus E, Smolensky M. Biological clocks and shift work: circadian dysregulation and potential long-term effects. *Cancer Causes Control*. 2006; 17: 489–500.
- Sobczyk A. Kilka uwag na tle nowelizacji czasu pracy. *Pr Zabezp Społ*. 2003; 12: 21–22.
- Sobczyk A. *Zasady prawnej regulacji czasu pracy. ABC*, Warszawa 2005. 157.
- Liszczy T. *Prawo pracy*. LexisNexis, Warszawa 2009. 340.
- Eberly R, Feldman H. Obesity and shift work in the general population. *Internet J Allied Health Sci Prac*. 2010; 8(5).
- Badania Eurostat: Europe in figures – Eurostat yearbook 2010. <http://www.eurostat.ec.europa.eu> (Access 15.09.2016).
- Morikawa Y i wsp. Relationship between shift work and onset of hypertension in cohort of manual workers. *Scand J Work Environ Health*. 1999.
- Ayas NT, White DP, Manson JE i wsp. A prospective study of sleep duration and coronary heart disease in women. *Arch Intern Med*. 2003; 163(2): 205–9.
- Kivimäki M, Batty GD, Hamer M i wsp. Using additional information on working hours to predict coronary heart disease: a cohort study. *Ann Intern Med*. 2011 Apr 5; 154: 457–63.
- Canada National Occupational Health & Safety Resource. <http://www.ccohs.ca> (Access 15.09.2016).
- Reiter RJ, Tan DX, Mayo JC, Sainz RM, Leon J, Bandyopadhyay D. Neurally-mediated and neurally-independent beneficial actions of melatonin in the gastrointestinal tract. *J Physiol Pharmacol*. 2003; 54 Suppl 4: 113–25.
- Konturek S. *Fizjologia człowieka. Neurofizjologia T. IV*. UJ, Kraków 2006. 39.
- Davis S, Mirick D, Stevens R. Night Shift Work, Light at Night, and Risk of Breast Cancer. *J Natl Cancer Inst*. 2001; 93: 1557.
- Jakuszkowiak K, Jakitowicz J. Wzorzec snu nocnego a choroba niedokrwienna serca. *Sen*. 2005; 5, 2: 69–73.
- Kęska K. Specyfika służby a zaburzenia snu u policjantów. *Sen*. 2008; 8: 22.
- Schwartzbaum J, Ahlborn A, Feychting M. Cohort study of cancer risk among male and female shift workers. *Scand J Work Environ Health*. 2007; 33: 336.
- Karasek M, Pawlikowski M. Pineal gland, melatonin and cancer. *Review Neuroendocrinol Lett*. 1999; 20(3–4): 139–144 (1).
- Stevens RG. Electric power use and breast cancer: a hypothesis. *Am J Epidemiol*. 1987; 125(4): 556–561.
- Schernhammer ES, Laden F, Speizer FE, Willett WC, Hunter DJ, Kawachi I i wsp. Rotating night shifts and risk of breast cancer in women participating in the nurses' health study. *J Natl Cancer Inst*. 2001; 93(20): 1563–1568.
- Lie JA, Roessink J, Kjaerheim K. Breast cancer and night work among Norwegian nurses. *Cancer Causes Control*. 2006; 17(1): 39–44.

24. Anisimov VN, Popovich IG, Zabezhinski MA. Melatonin and colon carcinogenesis: I. Inhibitory effect of melatonin on development of intestinal tumors induced by 1,2-dimethylhydrazine in rats. *Carcinogenesis*. 1997; 18(8): 1549–1553.
25. Kos-Kudła B, Ostrowska Z, Kozłowski A, Marek B, Ciesielska-Kopacz N, Kudła M i wsp. Circadian rhythm of melatonin in patients with colorectal carcinoma. *Neuroendocrinol Lett*. 2002; 23(3): 239–242.
26. Schernhammer ES, Laden F, Speizer FE, Willett WC, Hunter DJ, Kawachi I i wsp. Night-shift work and risk of colorectal cancer in the nurses' health study. *J Natl Cancer Inst*. 2003; 95(11): 825–828.
27. Viswanathan AN, Hankinson SE, Schernhammer ES. Night shift work and the risk of endometrial cancer. *Cancer Res*. 2007; 67(21): 10618–10622.
28. Gaworska-Krzemińska A. Skutki zdrowotne i społeczne pracy zmianowej wśród personelu pielęgniarskiego. Rozprawa habilitacyjna. Gdański Uniwersytet Medyczny. *Annales Academiae Medicae Gedanensis*. 2013; XLIII (supl.).
29. Chung FF, Yao CC, Wan GH. The associations between menstrual function and life style/working conditions among nurses. *Taiwan J Occup Health*. 2005; 47: 149–156.
30. Burdelak W, Bukowska A, Krysicka J, Peptońska B. Night work and health status of nurses and midwives. Cross-sectional study. *Medycyna Pracy*. 2012; 63: 517–529.
31. Syrocka J, Gaworska-Krzemińska A, Barton M. Wpływ pracy zmianowej na organizm kobiety. *Problemy Pielęgniarstwa*. 2014; 22(3).
32. Zużewicz K, Kwarecki K. Skutki fizjologiczne pracy zmianowej. Bezpieczeństwo i ochrona człowieka w środowisku pracy. Warszawa: Centralny Instytut Ochrony Pracy 1999. 23.
33. Iskra-Golec I, Costa G, Folkard S, Marek T, Pokorski J, Smith L. Stres pracy zmianowej, przyczyny, skutki, strategie przeciwdziałania. Kraków: Universitas. 1998.
34. Adjustment of the physiological circadian rhythms and the sleepwake cycle to shiftwork. In: S. Folkard & T. Monk (Eds.), *Hours of Work: Temporal Factors in Work Scheduling*. Oxford: John Wiley & Sons. Akerstedt, T. (1988). Sleepiness as a consequence of shift work. *Sleep*. 11(1): 17–34.
35. Akerstedt T. Work hours, sleepiness and the underlying mechanisms. *Journal of Sleep Research*. 1995; 4(2), 15–22. Akerstedt T i Landstrom U. Work place countermeasures of night shift fatigue. *International Journal of Industrial Ergonomics*. 1998; 21(3–4): 167–178.
36. Akerstedt T, Knutsson A, Westerholm P, Theorell T, Alfredsson L, Kecklund G. Sleep disturbances, work stress and work hours: A cross-sectional study. *Journal of Psychosomatic Research*. 2002; 53(3): 741–8.
37. Akerstedt T, Knutsson A, Westerholm P, Theorell T, Alfredsson L, Kecklund G. Work organisation and unintentional sleep: Results from the WOLF study. *Occupational & Environmental Medicine*. 2002; 59: 595–600.
38. Smith MJ, Hurrell JJ, Murphy RK. Stress and health effects in paced and unpaced work. In: G Salvendy & MJ Smith (Eds.), *Pacing and Occupational Stress*. London: Taylor and Francis. Smith A (1991). A review of the non auditory effects of noise on health. *Work & Stress*. 1981; 5: 49–62.
39. Smith MJ. Machine-paced work and stress. In: CL Cooper, MJ Smith (Eds.), *Job Stress and Blue Collar Work*. Chichester: Wiley & sons. Smith A, Johal S, Wadsworth E, Smith G, Peters T (2000). The scale of occupational stress: The Bristol stress and health at work study. Health & Safety Executive research report no. CRR 265. Sudbury: HSE Books 1985.
40. Nabe-Nielsen K, Tüchsen F, Christensen KB, Garde AH, Diderichsen F. Differences between day and non day workers in exposure to physical and psychosocial work factors in the Danish eldercare sector. *Scandinavian Journal of Work Environment & Health*. 2009; 35(1): 48–55.
41. Mayhew C, Quinlan M. The effects of outsourcing on occupational health and safety: A comparative study of factory-based workers and outworkers in the Australian clothing industry. *International Journal of Health Services*. 1999; 29 (1): 83–107.
42. Bohle P. Shiftwork in nursing: Relationships between work/non-work conflict, domestic responsibilities, gender and health – research report. Sydney: National Occupational Health and Safety Commission. 1999.
43. Leka S, Jain A, Orlak K (tłum.). Zagrożenia psychospołeczne i ich wpływ na zdrowie. Warszawa. Stowarzyszenie Zdrowa Praca 2013.

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