

THE EFFECT OF NIGHT SHIFT WORK ON HEALTH OF HEALTHCARE WORKERS

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Abstract. Objectives: Night shift work and long working hours are associated with increased health risk. The aim of the study was to follow the effects of night shift work on morbidity of hospital healthcare workers (HCWs), determinants of ill health and mediating factors. **Materials and methods:** A cross-sectional anonymous survey, comprising 2,690 HCWs and including information on individual and behavioral variables, working hours, shift system, and sleep quality was carried out. The health status questionnaire included a list of 13 groups of diseases. **Results:** Great proportion of the studied HCWs had night shifts, often 12-hour and long working hours weekly. Cardiovascular diseases (CVDs) were with the highest prevalence, followed by digestive and endocrine diseases. The proportion of chronic diseases was higher with ex-night and night shift workers, reaching statistical significance for CVDs. Odd ratios (OR) showed increased risk of CVDs (OR = 1.98; $p < 0.01$), endocrine, digestive, mental and malignant diseases with night work. Sleep quality index was statistically significantly associated with CVDs, endocrine and digestive diseases and mental illness, and higher BMI – with CVDs and endocrine diseases. **In conclusion,** our data confirmed the increased health risk in HCWs, working night shifts and long working hours, especially for CVDs, with a mediating effect of their sleep quality.

Key words: night shift work, long working hours, healthcare workers, chronic diseases, sleep, behavioral risks factors

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Received: 05 April 2024; **Revised:** 26 April 2024, **Accepted:** 12 August 2024

INTRODUCTION

The multifactorial etiology of chronic non-communicable diseases is well known, however, occupational risk factors, including night shift work and long working hours, may also contribute to their development [1-4], mainly increasing the cardiovascular, metabolic, endocrine and mental diseases, while night shift work is also discussed as a risk factor for the development of hormone-dependent cancer diseases [5, 6]. The effects of night shift work are as-

sociated with desynchronization of circadian rhythms and the related hormonal, metabolic and physiological changes, sleep disorder and social misalignment, as well as with changes in the prevalence of behavioral risks factors such as smoking, alcohol intake, unhealthy diet, lower physical activity, etc. [1, 7-9]. The long working hours, both on a daily and weekly basis, are considered a risk factor for health deterioration. Epidemiological studies have shown the adverse effect of long working hours on the risk of developing a cardiovascular disease, including arterial

hypertension, myocardial infarction, stroke, coronary heart disease, endocrine and metabolic diseases such as diabetes mellitus and metabolic syndrome, chronic fatigue, stress, anxiety, and sleep disorders [10]. Recently, a joint study of WHO and ILO showed 23% increase in risk of myocardial infarction and 35% – of stroke, for working 55 or more hours per week [11].

Night shift work is more prevalent in healthcare sector, especially in hospitals, and often includes extended shifts. The shortage of staff in healthcare is a problem in many countries and is compensated with overtime and/or multiple employment, contributing to long working hours on a weekly basis. The increase in night shifts and working hours leads to sleep disturbances and high levels of fatigue [12, 13], both of which are well-known health risk factors.

The aim of the study was to follow the effects of night shift work on the morbidity rate of hospital healthcare workers (HCWs), determinants of ill health and mediating factors.

MATERIALS AND METHODS

Study design

A cross-sectional survey was conducted in 19 large hospitals (each of them has >150 beds) in Sofia, Bulgaria, as a part of a study of risk factors for health in healthcare. The survey was anonymous; 4,000 self-administered questionnaires were submitted to the healthcare workers at their workplaces, and the return rate was 67.25%. The studied group includes 2,690 healthcare workers, presenting about 23% of the hospital HCWs in Sofia. The median age of the studied group is 49.0 (IQR, 40-58) years and the median length of service – 27.0 (IQR 15-35) years; 354 men aged 21 through 70 years and 2,336 women aged 21 through 70 years were surveyed. The studied group included 761 physicians, 1,426 nurses, 207 laboratory assistants, 176 midwives, 77 rehabilitators and physiotherapists, and 43 other HCWs. Ethical aspects were approved by Collegium of Public Health and Public Risk Directorate of National Center of Public Health and Analyses (No. 4 /November 3, 2017). The study was included in the National Program on Safety and Health at Work, approved by the Ministerial Council Resolution No. 801/December 22, 2017. All the participants signed informed consent forms.

Data collection

A questionnaire with information of the individual and workplace characteristics, as well as the previous and current work schedules of the healthcare work-

ers was filled in. Information on the current schedule was collected suggesting the options: only daily shifts, morning/afternoon shifts, rotating shifts or only night shifts. In the study, night shift is defined as hours worked between 24:00 and 08:00. To assess the history of night work, the respondents reported the number of years they worked night shifts (including rotating and non-rotating night shifts), and based on the reports, three groups were formed: day shift workers, ex-night shift workers and night shift workers. The participants also answered questions on overtime and having multiple jobs, contributing to long working hours, specified as follows: 21-40 hours, 41-50 hours, 51-60 hours and > 60 hours per week.

The information on health symptoms is based on workability index, developed by the Finnish Institute for Occupational Health [14], translated and adapted in Bulgaria by Mincheva and Vangelova [15]. It includes a list of 13 groups of diseases (56 diseases in total), diagnosed by a physician.

The sleep quality was studied with Karolinska Sleep Diary (KSD), and sleep quality index (SQI) earlier described in details [16] was calculated; fatigue was measured with a 9-question instrument [8]. A questionnaire on behavior characteristics, smoking, duration of smoking and the number of cigarettes smoked per day (up to 5; 6-10; 11-20; 21-30 and more than 31 cigarettes daily), consumption of alcohol (1-2 times per week, 4 times per week or every day and the amount of alcohol consumed in ml/week), sports and physical activity, consumption of fat-rich food, etc., the results of which were earlier published in details [17], was filled in. Body mass index (BMI) was calculated, and the first-degree relative history of arterial hypertension, ischemic heart disease and myocardial infarction/stroke, diabetes and breast cancer was taken.

Statistical analysis

The data was processed with IBM SPSS Statistics 15.0. Pearson chi-square, risk estimates, Pearson correlation coefficient and stepwise multiple regression analysis were applied for statistical analyses, and the statistical significance level was set at $p < 0.05$. Metrics were checked for normality of distribution with the Shapiro-Wilks test. Metric dimensions for age and length of service showed a lack of normal distribution ($p < 0.05$ for all values) and were presented with medians and interquartile range (IQR). Pearson chi-square test was used to test the relationship between categorical variables; risk estimates were used to determine the probability of occurrence of certain group of diseases. Correlation analysis was used to measure the strength of the linear relation-

ship between two variables and compute their association. Multiple regression analysis was used to analyze the relationship between a single dependent variable, a certain group of diseases and several independent variables, known to influence this group of diseases. The scores of KSD and a 9-question instrument of fatigue, as well as the data of behavioral and personal characteristics were included in the regression analyses.

RESULTS

The median age and length of service of ex-night shift workers were the highest (Table 1). In the three groups, the female health workers accounted for over 80%. The proportion of health workers with night shift work, working 12-hour shifts and long working hours on a weekly basis, was the greatest. The number of night shifts per month correlated statistically significantly with the number of hours worked per week ($r = 0.197$, $p < 0.001$).

The data showed high proportion of health workers with diagnosed chronic diseases in relation to history of night work. The proportion of health workers with > 3 diseases was the highest in ex-night shift workers (Table 2).

Cardiovascular diseases were with the highest prevalence rate (Fig. 1) among the studied health workers, followed by diseases of digestive system and endocrine diseases. In relation to history of night work, cardiovascular diseases were with the highest prevalence rate in the ex-night shift workers, followed by night shift workers. Similar grading was found for diseases of the digestive system and endocrine diseases, but only the data of cardiovascular diseases reached statistical significance ($\chi^2 = 40.261$; $p < 0.01$). Among cardiovascular diseases, statistically significant differences between the groups were reached by arterial hypertension ($\chi^2 = 33.747$, $p < 0.01$) and the category "other cardiovascular diseases" ($\chi^2 = 5.128$, $p < 0.05$). The highest percentage of people with arterial hypertension and other cardiovascular diseases was found in the group of ex-night shift workers (32.3% and 5%, respectively), followed by night shift workers. The differences in the rates of the diseases of digestive system, endocrine, mental and malignant diseases did not reach statistical significance; however, the rates were the highest with the ex-night shift workers (25.5% for diseases of the digestive system, 23.5% for endocrine diseases, 3.9% for mental illnesses and 3.3% for malignant diseases, respectively), followed by night shift workers.

Table 1. Individual characteristics and working hours of health workers in relation to night shift work among the group of workers without night shift work, the group of ex-night shift workers and the group of workers with night shift work

Individual characteristics	Workers without night shift work median IQR n = 146	Ex-night shift workers median IQR n = 673	Workers with night shift work median IQR n = 1422	p
Age	43.0 (IQR, 34-53)	52 (IQR, 44-59)	48 (IQR, 38-58)	< 0.001
Length of service	20 (IQR, 7-30)	30 (IQR, 21-36)	26 (IQR, 13-35)	< 0.001
Females n; %	119; 81.5%	592; 88.1%	1223; 86.1%	NS
People over 45 years old n; %	65; 45.5%	495; 75.1%	850; 61.4%	0.003
Working 12 hour shifts n; %	14; 9.6%	145; 21.8%	1071; 75.7%	< 0.001
Working week – up to 40 hours n; %	57; 42.5%	247; 41%	347; 26.5%	< 0.001
41-50 hours n; %	45; 33.6%	204; 33.8%	484; 37%	< 0.001
51-60 hours n; %	19; 14.2%	99; 16.4%	311; 23.8%	< 0.001
Over 61 hours n; %	13; 9.7%	53; 8.8%	166; 12.7%	< 0.001

Table 2. Proportion of health workers diagnosed with chronic diseases according to the history of night work (in %)

	0 diseases	1-2 diseases	> 3 diseases	χ^2/p
Day shift workers (%)	35.2	35.2	29.6	22.245/0.005
Ex-night shift workers (%)	30.3	26.4	43.3	
Night shift workers (%)	38.3	26.7	34.9	

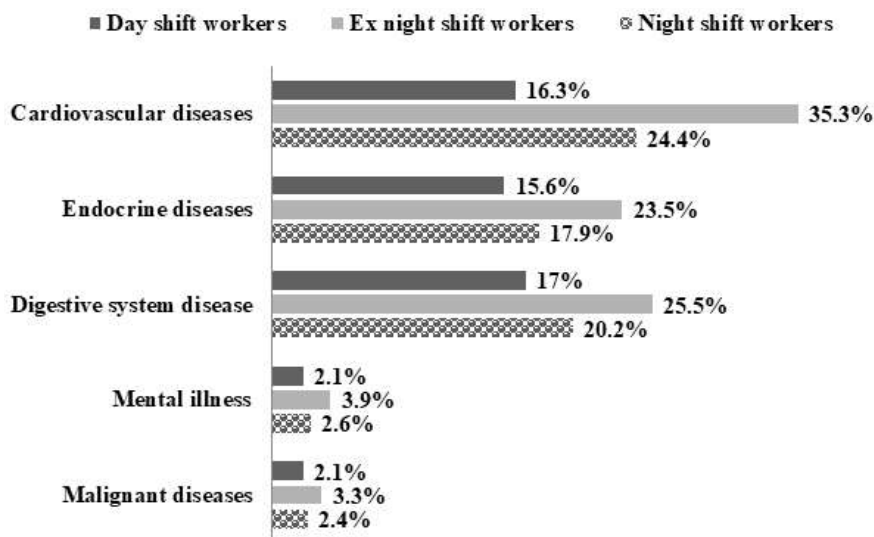


Fig. 1. Proportion of health workers with diagnosed chronic diseases in relation to night shift work

Table 3. Risk (OR) for cardiovascular, endocrine, digestive, mental and malignant diseases and history of night work

Night shift work	OR	95% Confidential interval	χ^2/p
Cardiovascular diseases	1.982	1.255-3.132	8,911/0.003
Endocrine diseases	1.327	0.831-2.119	NS
Digestive system diseases	1.365	0.869-2.145	NS
Mental illness	1.432	0.444-4.624	NS
Malignant diseases	1.263	0.390- 4.093	NS

Odd ratios (OR) showed an increased risk of cardiovascular, endocrine, digestive, mental and malignant diseases with night work (Table 3), but only the data for cardiovascular diseases reached statistical significance. The risk of arterial hypertension with working night shifts was statistically significant (OR = 2.20 (95% CI: 1.35-3.61; $p = 0.001$)), as well as the risk of diabetes (OR = 2.45 (95% CI: 0.77-7.81)).

Impairment of sleep followed by sleep quality index (SQI: 1 – low sleep quality, 5 – high sleep quality) was found with the health workers working on a rotating shift schedule and with the increase of night shifts monthly, earlier described in details [16].

The rate of smokers was very high with the studied health workers, especially with ex-night workers and night workers (46.8% and 43.5%, respectively), and the night shift workers smoked more ($\chi^2 = 17.067$, $p < 0.05$), earlier described in details [17]. The studied health workers were rarely engaged with sports, but more than half of the participants of the three groups walked daily. Most of the health workers tried to eat healthy food and were rarely drinking alcohol, as the differences between the groups did not reach statistical significance.

The model includes the following indicators: gender, age, length of service, position, workplace, work

schedule, number of night shifts per month, duration of night work in years, working hours per week, sleep quality index and fatigue, smoking, duration of smoking, number of cigarettes per day, doing sports, fast walking, fat food consumption, alcohol consumption, BMI, first-degree relatives history of arterial hypertension, ischemic heart disease and myocardial infarction/stroke, first-degree relatives history of diabetes and first-degree relatives history of breast cancer.

Determinants of cardiovascular diseases were the age, first degree relative's history of arterial hypertension, sleep quality index, BMI, number of cigarettes per day and first degree relative's history of ischemic heart disease, describing 20.3% of cardiovascular diseases ($p < 0.001$) (Table 4). BMI, length of service, alcohol consumption, sleep quality index, first degree relative's history of diabetes and work on a shift schedule were statistically significantly associated with endocrine diseases ($p < 0.001$). Age, sleep quality index, number of cigarettes per day and working hours per week were statistically significantly associated with diseases of the digestive system ($p < 0.001$). The mental illnesses were determined by sleep quality index and gender, and malignant diseases increased with age.

Table 4. Stepwise multiple regression analysis of cardiovascular, endocrine, digestive, malignant diseases and mental illness as dependent variables according to individual, behavioral and working time risk factors

		Variables	Standardized β	t	p
1.	Cardiovascular diseases	Age in years	0.298	7.541	< 0.001
		First-degree relatives with arterial hypertension	0.142	3.440	0.001
		Sleep quality index (1 – bad sleep; 5 – good sleep)	-0.132	-3.314	0.001
		BMI	0.128	3.189	0.002
		Number of cigarettes per day	0.117	2.983	0.003
		First-degree relatives with ischemic heart disease	0.112	2.786	0.006
$r^2 = 20.3\%$; $F = 23.563$; $p < 0.001$					
2.	Endocrine diseases	BMI	0.219	5.231	< 0.001
		Length of service in years	0.117	2.802	0.005
		Alcohol consumption	-0.109	-2.648	0.008
		Sleep quality index (1 – bad sleep; 5 – good sleep)	-0.105	-2.519	0.012
		First-degree relatives with diabetes	0.091	2.206	0.028
		Work schedule	-0.086	-2.073	0.039
$r^2 = 11.2\%$; $F = 12.254$; $p < 0.001$					
3.	Digestive diseases	Sleep quality index (1 – bad sleep; 5 – good sleep)	-0.117	-2.747	0.006
		Age in years	0.140	3.244	0.001
		Number of cigarettes per day	0.105	2.466	0.014
		Working hours per week	0.088	2.040	0.042
$r^2 = 4.7\%$; $F = 7.537$; $p < 0.001$					
4.	Mental illness	Sleep quality index (1 – bad sleep; 5 – good sleep)	-0.130	-3.044	0.002
		Gender	-0.126	-2.952	0.003
$r^2 = 2.7\%$; $F = 8.523$; $p < 0.001$					
5.	Malignant diseases	Age in years	0.135	3.274	0.001
$r^2 = 0.2\%$; $F = 10.719$; $p = 0.001$					

DISCUSSION

Our data showed a higher prevalence rate of comorbidities in HCWs in long term working rotating shifts with night work, mainly 12-hour shifts, and long working hours weekly. The shift schedules in healthcare sector are very complicated, especially when taking into account overtime and multiple employment and on-call periods, and the long-term effects difficult to investigate. We accepted the approach based on history of night work, acknowledging that along with shift work with night shifts, great proportion of investigated HCWs on long term worked extended shifts and long working hours weekly.

Our data showed a high prevalence rate of cardiovascular diseases and hypertension in HCWs working night shifts, as well as ex-night shift workers, which is statistically significantly higher in comparison to day working HCWs. The OR showed also a statistically significantly higher risk for HCWs working night shifts. The data are consistent with the previous studies, including several meta-analyses [1, 18, 19],

in which night shift workers had a higher risk of cardiovascular disease than day shift workers, as well as with other studies of HCWs in the country [20, 21], including higher rates of dyslipidemia with night shift HCWs [21]. Determinants of cardiovascular diseases that we found were the age, first degree relative's history of arterial hypertension, sleep quality index, BMI, number of cigarettes smoked per day and first degree relative's history of ischemic heart disease, most of which are well known risk factors for CVD. The duration of working night shifts increased with the age. Impairment of sleep, investigated by SQI, was higher with increase in the number of night shifts/month [8, 16] and they correlated with the long working hours weekly [16]. In addition, night and ex-night shift workers had higher BMI and smoked more in comparison to day shift working HCWs, earlier described in details [17].

Our data also showed a higher prevalence of endocrine diseases in night and ex-night shift HCWs, reaching statistical significance for diabetes, consistent with literature data for a higher prevalence rate of

endocrine diseases, especially diabetes and obesity in night shift workers [1, 22]. BMI, length of service, alcohol consumption, sleep quality index, first degree relative's history of diabetes and work shift schedule were statistically significantly associated with endocrine diseases. In addition, the OR showed statistically significantly higher risk of diabetes mellitus with HCWs working night shifts.

The data was consistent with previous data for a higher prevalence rate of diseases of the digestive system [1, 23]. Age, sleep quality index, number of cigarettes per day and working hours per week were statistically significantly associated with diseases of the digestive system.

Our data also showed a higher prevalence of malignant diseases in the night and ex-night shift HCWs, and the age was indicated as the main determinant in the regression analyses. The data are consistent with increasing evidence of a link between night work and malignancies, especially hormone dependent [5, 6, 24-26].

One of the limitations of the study is that a questionnaire was used to follow the health symptoms, but we believe the information was precisely filled by HCWs, and the used questionnaire has been proved as reliable internationally both in practice and research. Second limitation is that we failed to distinguish the effect of night work and extended shifts as mostly HCWs in this study with night shifts worked rapidly rotating 12-hour schedules. Another limitation is the lack of evaluation of the effect of quick returns and recovery periods because of the complexity and differences in schedule arrangements between the different hospitals and departments, as well as individual schedules of the nurses, overtime and multiple workplaces. Great challenge was the long working hours on weekly basis for all groups (day, night and ex-night shift workers), and we consider to evaluate their effect separately.

Taking in account the finding of a mediating effect of sleep deterioration we consider that one other limitation of the study is that it failed to quantify the number of night shifts worked by the former shift working HCWs, covering day shifts only during the study. A study of Bjorvatn et al. [27] showed that seventy percent of the nurses (136 women and 14 men) in an intensive care unit in Norway had poor-quality sleep according to the Pittsburgh Sleep Quality Index (PSQI) with shift work including night work. However, these sleep problems tended to decrease with the lack of exposure and recur with re-exposure. Another study showed that the effect of shift work experience was the greatest among people in their forties and

reduced as participants left shift work (i.e., when they transferred to day working or retired), suggesting that the effects of shift work did not persist once people quit shift work [28].

CONCLUSIONS

Our data confirmed the increased health risk and comorbidities in HCWs working night shifts, mostly extended 12-hour shifts and often with long working hours on a weekly basis. The CVDs showed the highest rates with the HCWs, which were statistically significantly higher with working night shifts. Important aspects are the behavior and personal characteristics and the mediating effect of sleep between night shift work and health. Part of the HCWs had to quit night shift work because of some health condition. Urgent actions are needed to reduce health risk of HCWs by improving shift schedules of HCWs, reducing night work, extended shifts and long working hours. Health promotion and surveillance could contribute to strengthening the health of HCWs working night shift schedules.

Disclosure summary: *The authors have nothing to disclose.*

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