



NATIONAL CENTER OF PUBLIC HEALTH AND ANALISES

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## **CHARACTERISTICS OF THE SHIFT WORK SCHEDULES AND HEALTH RISK IN HOSPITAL CARE**

### **DISSERTATION SUMMARY**

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## LIST OF ABBREVIATIONS

<b>aMT6s</b>	<b>6-sulfatoxymelatonin</b>
<b>IARC</b>	<b>International Agency for Research on Cancer</b>
<b>KSS</b>	<b>Karolinska Sleepiness Scale</b>
<b>SQI</b>	<b>Sleep quality index</b>
<b>BMI</b>	<b>Body mass index</b>
<b>CVD</b>	<b>Cardio-vascular diseases</b>
<b>ED</b>	<b>Endocrine diseases</b>
<b>DSD</b>	<b>Digestive system diseases</b>
<b>MHD</b>	<b>Mental health disorders</b>
<b>MD</b>	<b>Malignant diseases</b>

## I. INTRODUCTION

Over the last decade, the share of night shift workers in both manufacturing and services has increased. About 15-20% of the population in European countries work in shifts, which include night work. Data from the National Survey on Working Conditions conducted in 2011 show that in Bulgaria about 17% of workers have shift schedules with night work, as the share of workers in the health sector is 34%.

Shift schedules in hospital settings are extremely complex, they include different numbers of night shifts, different durations of the shift, including extended 12-hour shifts, speed and direction of rotation, individual schedules, which poses a number of challenges in assessing the risk of workers' health. It is known that health professionals work overtime and with multiple workplaces, but there is no data on the share of the different groups of professionals who work overtime and at multiple work places and to what extent this increases the amount of night work.

One of the main problems with night shifts is the disruption of circadian rhythms. In shift workers there are more complaints of problems with the gastrointestinal tract, sleep and reproductive health, higher incidence of cardiovascular and metabolic diseases and more. In recent years, interest in the possible effect of night shifts on the endocrine system and the risk of hormone-dependent cancers such as breast, endometrial, prostate and other cancers, has increased. In October 2007, the International Agency for Research on Cancer (IARC) classified shift work with circadian rhythm disruptions, as a human carcinogen (Group 2A) based on sufficient evidence in animals and limited in humans, and in 2020 the formulation was updated to night shift work.

## **II. AIM AND TASKS**

### **AIM**

The aim of the Dissertation presented is to assess the characteristics of the shift schedules, physiological changes and health risks of healthcare professionals working in hospital care in Sofia.

### **TASKS**

For the fulfillment of the aim, the following tasks were defined:

1. Development of a questionnaire on the exposure of shift work (night work, overtime and multiple workplaces, duration of work shifts, etc.) and assessment of shift work schedules, of physicians and nursing professionals in hospitals in Sofia .
2. Monitoring of the changes in the excretion of melatonin and cortisol in saliva in female nursing professionals in hospitals in Sofia.
3. Study of the quality of sleep and fatigue in different characteristics of the shift work schedules.
4. Study of individual and behavioral characteristics of the studied subjects depending on the shift work schedules.
5. Self-rated health status and diagnosed diseases of physicians and nursing professionals in hospital systems in Sofia.
6. Assessment of the risk arising from the shift work for deterioration of the employees' health in hospital care in the city of Sofia.

### III. SUBJECTS AND METHODS

#### 3.1 Study group

The study covers 2690 healthcare workers, from 19 hospitals in Sofia with the mean age of  $48.0 \pm 12.0$  years, of which 761 physicians and 1929 nursing professionals. 354 men aged 21 to 70 years and 2336 women aged 21 to 70 years are studied. The mean age of physicians is  $44.3 \pm 14.1$  years and the mean age of nursing professionals is  $49.4 \pm 10.7$  years. The total average length of service of all respondents is  $24.8 \pm 12.7$  years. The average length of service of physicians is  $19.2 \pm 14.0$  years. In the group of nursing professionals the average length of service is  $27.0 \pm 11.4$  years.

#### 3.2 Methods

- **Development of a questionnaire regarding the exposure to shift work and assessment of the shift work schedules for physicians and nursing professionals in hospitals in Sofia**

The questionnaire includes information on the previous and current work schedules of the specialists, whether the current work schedule includes only day shifts, night shifts only, morning/afternoon shifts or rotating shifts. The night shift is defined as the hours worked, which fall between 22:00 - 06:00. Information is also collected on how many night shifts were made in 1 month, the duration of shifts, etc. To assess the history of night work, respondents report the number of years working night shifts. Questions related to overtime and multiple work places (second job) and whether doing extra work increases night work are included. The average hours worked per week are summarized in the following categories - 21-40 hours, 41-50 hours, 51-60 hours and >60 hours/week and include main work, overtime and multiple workplaces, if there are any.

- **Monitoring of the changes in the excretion of melatonin and cortisol in saliva in female nursing professionals in hospitals in Sofia**

32 hospital nurses are covered, women aged  $49.4 \pm 11.4$  years and length of service of  $26.6 \pm 10.7$  years, working fast-rotating 12-

hour shifts in two hospitals in Sofia. 16 of the nurses are examined during the day shifts, and 16 during the night shifts, and the two groups did not have a significant difference in age, length of service and duration of night work.

Changes in the excretion of 6-sulfatoxy-melatonin, the main metabolite of melatonin in the urine, before and at the end of the day and before and at the end of the night shift are followed, respectively: morning between 05:00 - 07:00 and evening between 17: 00 - 19:00. urine AMT6s is determined by ELISA melatonin sulphate from IBL International, Germany with an intra-assay coefficient of variation (CV) of 5.2 - 12.2% for the range 5.8-204 ng/ml and inter-assay CV of 5.1 - 14.9% for the range 12.4-220 ng/ml. The data are compared with reference values of Mahlberg et al. (1) listed as reference in the kit.

The concentration of cortisol in saliva in the dynamics of the work shifts is monitored: day shift: 07:00, 11:00, 15:00 and 19:00 and night shift: 19:00, 23:00, 03:00 and 07:00 hours. Cortisol concentration is determined by ELISA kits of Euroimmun, Germany with an intra-assay CV of 4.8% and inter-assay CV of 7.2%. The data are compared with reference values provided by Euroimmun. Questionnaires on sleepiness, stress and fatigue are filled in at the same time, and on stress symptoms at the end of the shifts.

Questionnaires on sleepiness, stress and fatigue are fill in at the same time, and also stress symptoms at the end of the shifts.

The exclusion criteria from the study are as follows: 1) nurses who had taken sedatives, hypnotics, anti-inflammatory drugs or hormonal drugs (eg corticosteroids, melatonin or oral contraceptives) for 4 weeks before the study; and 2) nurses with metabolic, neurological, or renal disease, mental disorder, or pregnancy.

#### ▪ **Questionnaire**

A study of sleep quality and fatigue in different characteristics of shift modes includes a questionnaire of Karolinska Sleepiness Scale (KSS), calculated sleep quality index (SQI) and a survey on the presence and levels of fatigue (9 questions regarding the physical and mental condition of workers).

The health questionnaire includes a question of self-rated health condition with the possibility of answer - very good, good, fair and



poor and a list of 13 groups of diseases (56 diseases in total) diagnosed by a physician based on the performance index developed from the Finnish Institute of Occupational Health.

Study of individual and behavioral characteristics of the studied subjects, which included the distribution and overlap of some conventional risk factors: smoking, duration of smoking and number of cigarettes per day, alcohol consumption, sports and physical activity, consumption of fat and greasy foods, body mass index (BMI). In women, data have been observed on the menstrual cycle, its frequency, age of first menstruation, age of menopause, age of first childbirth, number of live births, breastfeeding and duration of breastfeeding, as well as data on the use of oral contraceptives and undergoing hormone therapy. A family history of cardiovascular disease, diabetes, breast cancer, genital cancer in women, and prostate cancer in men is observed.

- **Statistical analysis**

The data is entered and processed by IBM SPSS Statistics 15.0. ANOVA,  $\chi^2$ , stepwise multiple regression analysis, correlation analysis are applied. An analysis of repeated measurements with a significance level of  $p < 0.05$  is used to assess circadian changes.

## IV. RESULTS

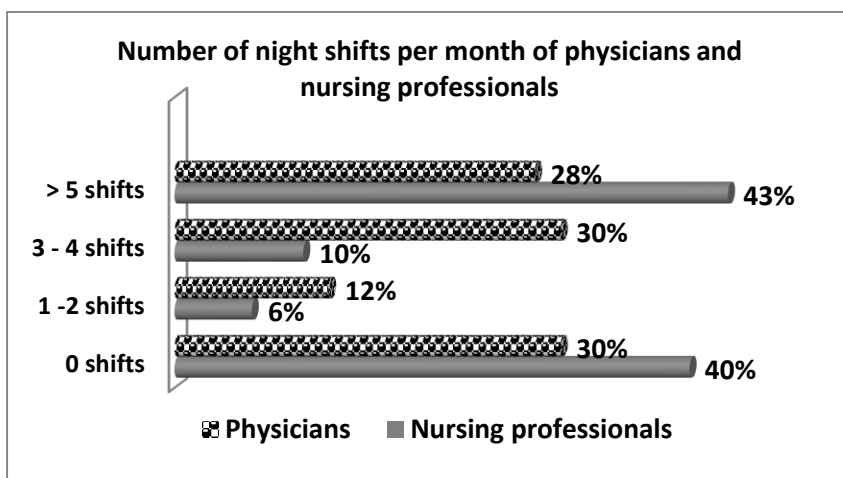
### 4.1 Evaluation of the shift work schedules for physicians and nursing professionals in hospitals in Sofia

The results show that the highest share among the respondents is occupied by workers in rotating shifts with 54% of the group of nursing professionals and 64% of the group of physicians. In second place with 33% of nursing professionals and 26% of physicians are working only in day shifts. In third place are those working in the morning/afternoon shifts.

The results show that most of the physicians with 51% and nursing professionals again with 51% work 12-hour shifts. 28% of nursing professionals and 22% of physicians work 8-hour shifts. The rest of the respondents work shifts with different and/or changing duration.

43% of nursing professionals and 28% of physicians work more than 5 night shifts per month (Fig. 1).

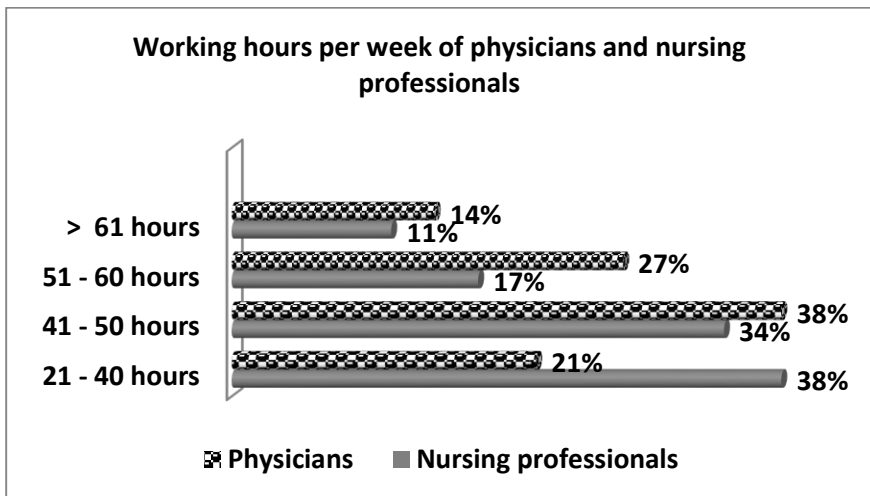
**Figure 1.** *Number of night shifts per month of physicians and nursing professionals in hospitals in Sofia (%)*



There is a high percentage of physicians and nursing professionals who work >41 hours per week. It should be noted that a part of the physicians covered in the study - (14%) and nursing professionals - (11%) have an extremely long working week, with over 61 hours per week (Fig. 2).

Although some of the specialists (physicians and nursing professionals) in hospital care during the study work only day work, 15% of them report that they take 1 to 3 night shifts per month. 80% of the day workers in previous years worked night shifts, almost half with a duration of up to 10 years, and the rest with different durations. Day workers, work mainly 8-hour shifts (51.4%). 16.5% of them work 12-hour shifts, while those working on rotating shifts have work organization mainly with 12-hour shifts (74.9%) and in more than 70% employed with more than 5 night shifts per month).

**Figure 2. Working hours per week of physicians and nursing professionals in hospitals in Sofia (%)**



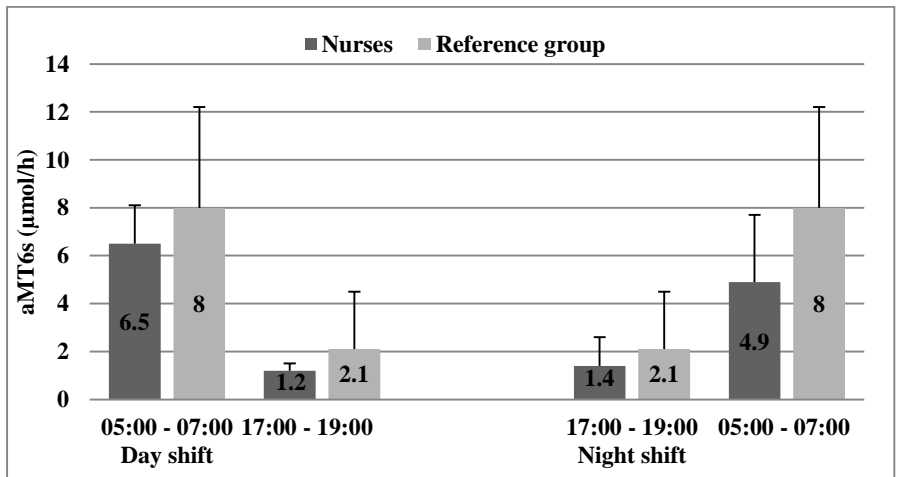
An important aspect of the working hours of health professionals (physicians and nursing professionals) are the long working hours resulting from overtime and multiple workplaces. The last one often includes night shifts (from 2 to 5 per month), respectively, when summing up the number of night shifts in the first workplace and on a

second job, it can reach 12. The greater number of working hours per week is associated with significantly more night shifts per month ( $p=0.011$ ).

#### 4.2 Changes in the excretion of melatonin and cortisol in saliva in female nursing professionals in hospitals in Sofia.

Melatonin maintains its typical circadian rhythm ( $F=7.949$ ,  $p=0.008$ ), with high early morning values and low evening values, both during the day and night shifts (Fig. 3). The mean values of aMT6s in all hours studied are lower than the reference values. Early morning levels of hormone excretion during the night shift are significantly lower than morning values before the day shift ( $F=6.181$ ,  $p=0.018$ ). Differences in evening levels of hormone excretion in nurses working day and night shifts are not significant.

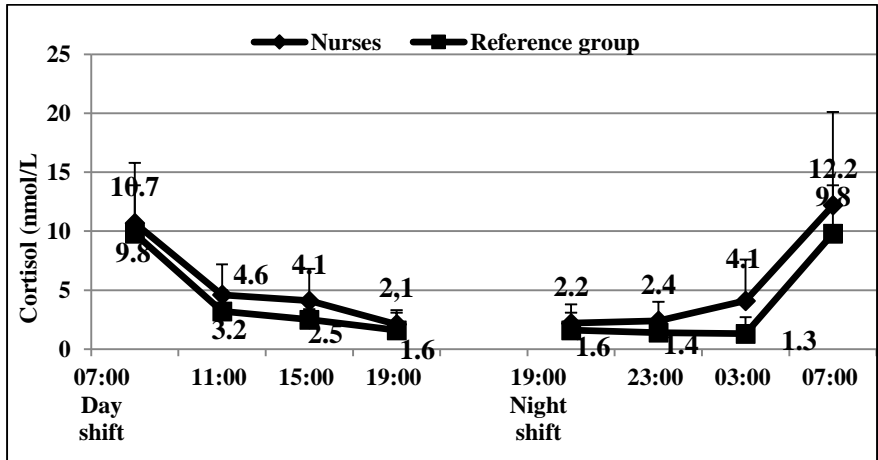
**Figure 3.** *Urinary excretion levels of aMT6s during day and night shifts in nurses*



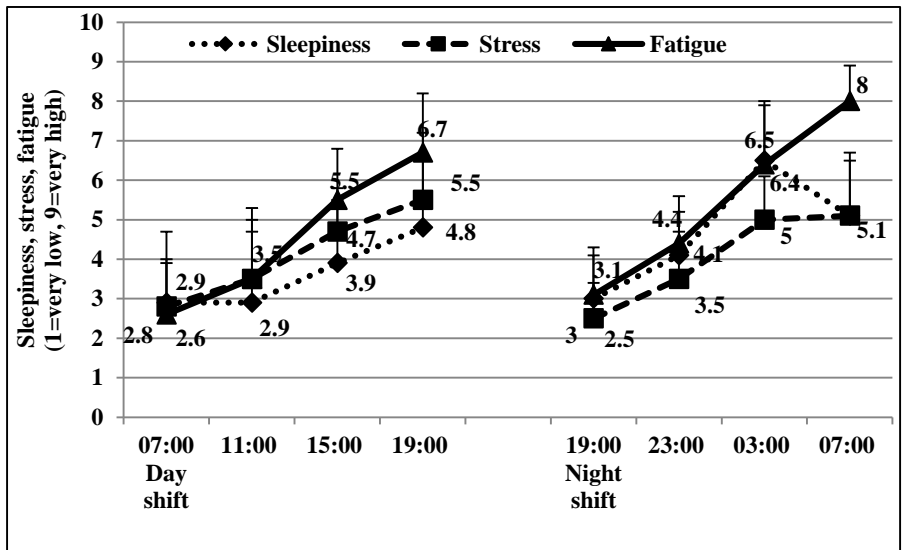
When monitoring salivary cortisol levels, it is found that cortisol also maintains its 24-hour rhythm ( $F=12.731$ ,  $p=0.001$ ), with high morning values at the beginning of the day shift, close to the reference values, but with higher values for part of the day shift. The increase in cortisol levels during the night shift starts earlier than the reference values and higher morning values are also found (Fig. 4). The variation

in cortisol values during both shifts is greater than in the reference group.

**Figure 4.** Salivary cortisol levels during day and night shifts in nurses



**Figure 5.** Self-rated sleepiness, stress and fatigue during day and night shifts in nurses



Sleepiness increases with progression of both shifts, especially during the night shift around 3 a.m. The self-rated stress also shows an increase as the shifts progress and is slightly higher during the night shift. Fatigue increases with advancing of the shifts ( $F=4.331$ ,  $p=0.007$ ), with higher values during night shifts compared to day shifts (Fig. 5).

Our data do not show significant differences between day and night shifts regarding reported symptoms of stress. The nurses feel tense, irritable and very exhausted at the end of the shifts. They also believe that the workload is high and that taking breaks during work is not enough.

#### **4.3. Quality of sleep and fatigue with different characteristics of the shift work schedules**

In the case of nurses, the results show that for all characteristics of sleep, except for sleep duration, with the most impaired sleep are health workers with >5 night shifts per month (Table 1). Differences related to fatigue are not significant, but fatigue levels are higher in nurses working night shifts.

In the group of physicians the characteristic sleep duration does not show significant differences according to the number of night shifts per month, but most quality characteristics of sleep are significantly affected by the number of night shifts per month, most significant for ease of falling asleep, insufficiency of sleep, fatigue in the morning after awakening, sleep quality index, and sleep throughout the night. Fatigue is higher among physicians with night work (Table 2).

**Table 1. Quality and quantity of sleep (1 = poor sleep, 5 = no sleep problems) and fatigue (1 = low level of fatigue, 9 = high level of fatigue) according to the number of night shifts per month for the group of nurses**

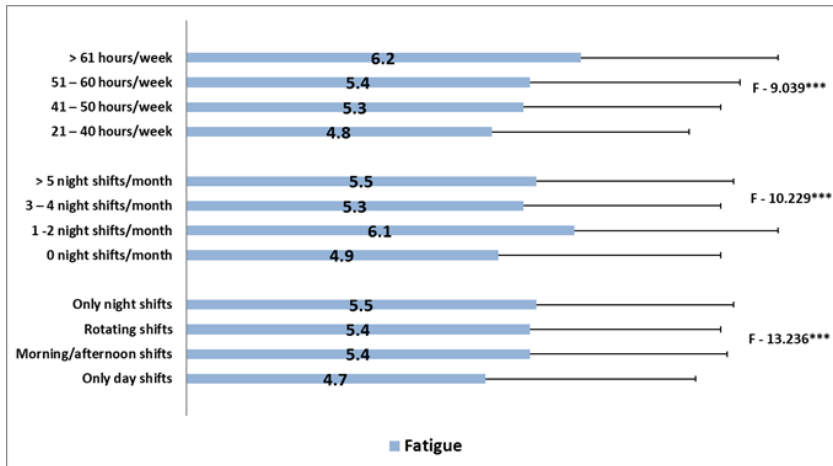
Sleep characteristics	$\bar{x} \pm SD$				F
	0 shifts (n = 454)	1 - 2 shifts (n = 87)	3 - 4 shifts (n = 162)	> 5 shifts (n = 617)	
Sleep duration	7.8 ± 1.2	7.6 ± 1.1	7.7 ± 1.2	7.6 ± 1.4	NS
Quality of sleep	3.3 ± 0.8	3.3 ± 0.7	3.4 ± 0.9	3.2 ± 0.9	4.317**
Insufficiency of sleep	2.6 ± 1.3	2.8 ± 1.1	2.7 ± 1.2	2.3 ± 1.2	6.332***
Fatigue in the morning after awakening	2.8 ± 0.9	3.0 ± 0.7	3.0 ± 0.9	2.7 ± 0.9	6.273***
Ease of falling asleep	3.2 ± 1.0	3.2 ± 0.8	3.2 ± 1.0	3.0 ± 1.0	4.498**
Waking up during sleep	2.9 ± 0.9	3.2 ± 1.0	3.2 ± 0.9	2.8 ± 1.0	5.845**
Early awakening	2.9 ± 1.1	3.1 ± 0.9	3.0 ± 1.1	2.8 ± 1.1	NS
Sleep throughout the night	3.4 ± 1.1	3.6 ± 1.0	3.4 ± 1.1	3.1 ± 1.1	8.741***
Sleep quality index	3.1 ± 0.7	3.3 ± 0.6	3.2 ± 0.8	3.0 ± 0.7	6.877***
Fatigue	5.1 ± 3.1	5.6 ± 4.0	5.5 ± 3.6	5.4 ± 3.1	NS

**Table 2. Quality and quantity of sleep (1 = poor sleep, 5 = no sleep problems) and fatigue (1 = low level of fatigue, 9 = high level of fatigue) according to the number of night shifts per month for the group of physicians**

Sleep characteristics	$\bar{x} \pm SD$				F
	0 shifts (n = 226)	1 – 2 shifts (n = 85)	3 – 4 shifts (n = 224)	> 5 shifts (n = 198)	
Sleep duration	7.4 ± 0.9	7.5 ± 1.2	7.4 ± 1.1	7.4 ± 1.4	NS
Quality of sleep	3.5 ± 0.9	3.5 ± 1.0	3.5 ± 0.9	3.3 ± 0.9	NS
Insufficiency of sleep	2.7 ± 1.3	2.5 ± 1.2	2.4 ± 1.1	2.3 ± 1.1	4.451**
Fatigue in the morning after awakening	2.9 ± 1.0	2.6 ± 0.9	2.6 ± 0.9	2.6 ± 0.9	5.649**
Ease of falling asleep	3.6 ± 1.0	3.4 ± 1.0	3.5 ± 1.0	3.2 ± 1.0	6.196***
Waking up during sleep	3.1 ± 1.1	3.2 ± 1.0	3.4 ± 1.0	3.1 ± 1.0	NS
Early awakening	3.1 ± 1.1	3.4 ± 1.2	3.2 ± 1.1	3.1 ± 1.2	NS
Sleep throughout the night	3.5 ± 1.1	3.7 ± 0.9	3.6 ± 1.0	3.3 ± 1.1	3.509*
Sleep quality index	3.4 ± 0.7	3.3 ± 0.7	3.3 ± 0.7	3.1 ± 0.7	4.260**
Fatigue	5.0 ± 3.2	6.5 ± 3.2	5.4 ± 2.9	5.5 ± 2.8	5.078**



**Figure 6. Self-rated fatigue according to the work schedule, the number of night shifts per month and the duration of working hours per week (1 = low level of fatigue, 9 = high level of fatigue)**



Fatigue, duration of night work, length of service and the number of night shifts per month are predictors of sleep impairment ( $r^2=11.3\%$ ;  $F = 50.371$ ;  $p=0.000$ ), as sleep impairs with the increase of the levels of fatigue, duration of night work, length of service and the number of night shifts per month.

The sleep quality index is significantly associated with overall fatigue levels ( $r^2=14.3\%$ ;  $F=131.061$ ;  $p=0.000$ ). Overall fatigue increases with sleep impairment.

Higher levels of overall fatigue (Fig. 6) are found in specialists working shifts with night work compared to working only day shifts. Overall fatigue also increases with the number of working hours per week, with the highest values in workers >61 hours per week.

#### **4.4 Individual and behavioral characteristics of the studied subjects according to the night shift work**

In the studied group, night shift workers and ex night shift workers have a higher average age and longer length of service. The share of subjects with normal body weight is the highest in all three groups, but the share of obese people is not negligible, the highest in people working night shifts (Table 3).

**Table 3. Individual characteristics among the respondents in relation to the history of night work**

<b>Individual characteristics</b>	<b>Without night shift workers <math>\bar{x} \pm SD</math> n=132</b>	<b>Ex night shift health workers <math>\bar{x} \pm SD</math> n=577</b>	<b>Night shift health workers <math>\bar{x} \pm SD</math> n=1255</b>
Age	43.0 ± 12.4	51.1 ± 10.3	47.1 ± 12.4
Length of service	20.1 ± 13.1	28.1 ± 11.0	23.7 ± 13.2
Females (%)	81.5	88.1	86.1
Individuals over 45y.(%)	45.5	75.1	61.4
BMI	24.4 ± 4.9	25.8 ± 10	25.3 ± 4.8
BMI ≤ 24.9 (%)	63.6	49.6	51.5
BMI 25 – 29.9 (%)	22	35.5	32.3
BMI ≥ 30 (%)	14.4	14.9	16.2

The share of smokers is very high 43.6%, without significant differences between the groups, without and with night work. In terms of the number of cigarettes per day, night shift workers smoke significantly more cigarettes per day. The average duration of smoking in years is 20.6 ± 10, higher for night workers who are slightly older.

The share of people who do sports rarely is high (51.7%), but 50% of the studied group have brisk walking every day. 45.3% of the respondents believe that they eat healthy, 45.8% that they eat healthy sometimes, 70% rarely eat fatty foods, without significant differences between those who work with and without night shifts. 65.7% do not consume concentrated alcohol compared to 29.1% who consume alcohol 1-2 times a week, 5.1% consume alcohol 3-4 times a week, and only 0.04% consume alcohol every day, with no significant differences

depending on the presence of night work. The mean amount of alcohol consumed in milliliters is  $78.8 \pm 63.8$  and did not differ significantly between the two groups, but the individual differences within the groups are significant.

The individual characteristics of the studied women show a high share of menopausal women in both groups, which corresponds to the age structure of the subjects. Regarding the data for menstrual cycle and the frequency of the cycle, the answers for a regular cycle with a frequency of 26 - 31 days prevail (average value 54.4%). The majority of women breastfed 83.2%. The share of studied women who did not use contraceptives is 69.7% and who did not have hormone replacement therapy is 87.7%.

A number of other individual characteristics such as age of first menstruation, age of menopause, age of first child birth, number of children do not show differences depending on night work, except for age of hormone - replacement therapy and duration of hormone - replacement therapy in years slightly higher in women who work night than in women who have never worked night shifts. The duration of breastfeeding and contraceptive use in years are slightly higher in women without night work.

#### **4.5 Self-rated health status and diagnosed diseases of physicians and nursing professionals in hospital care in Sofia**

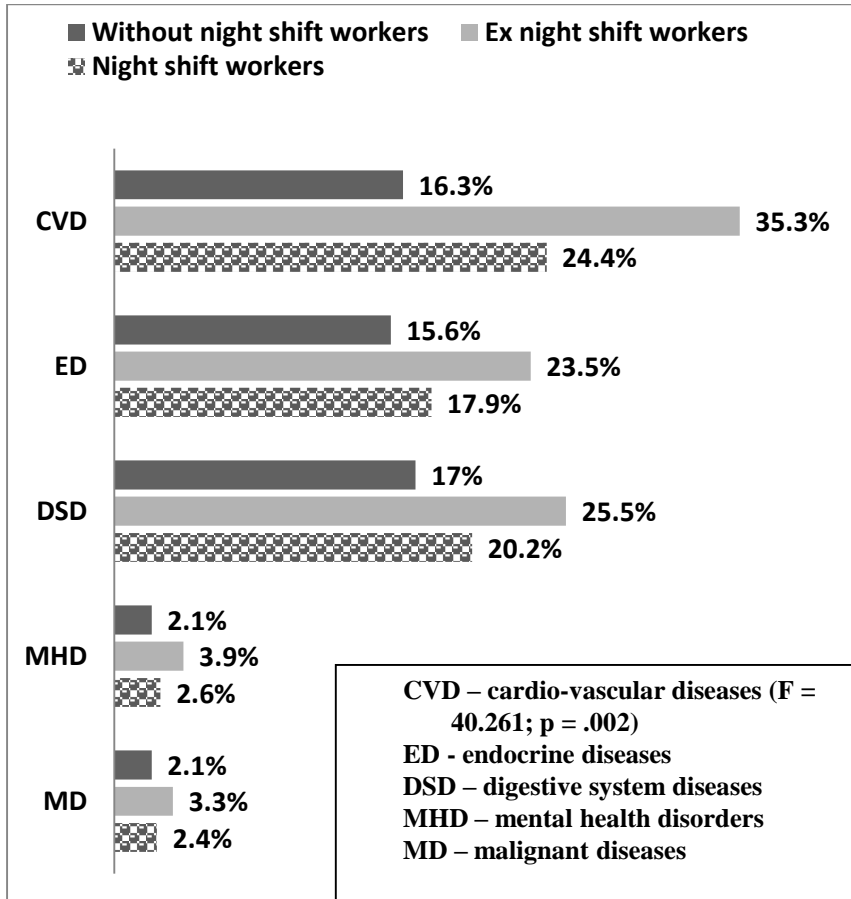
The highest share is of those who find their health to be good (57.6%). The percentage of physicians who find their health to be very good is higher (17.9%) compared to nursing professionals with 9.5%. The share of the latter who believe that their health condition is satisfactory (31.8%) is higher compared to physicians (22.4%).

The results related to the history of night work (Fig. 7) show that the highest percentage of people with cardiovascular ( $F=40.261$ ;  $p<0.01$ ), digestive, endocrine, mental and malignant diseases are in the group of ex night shift workers, followed by night shift workers and the lowest among health workers, who never worked night shift.

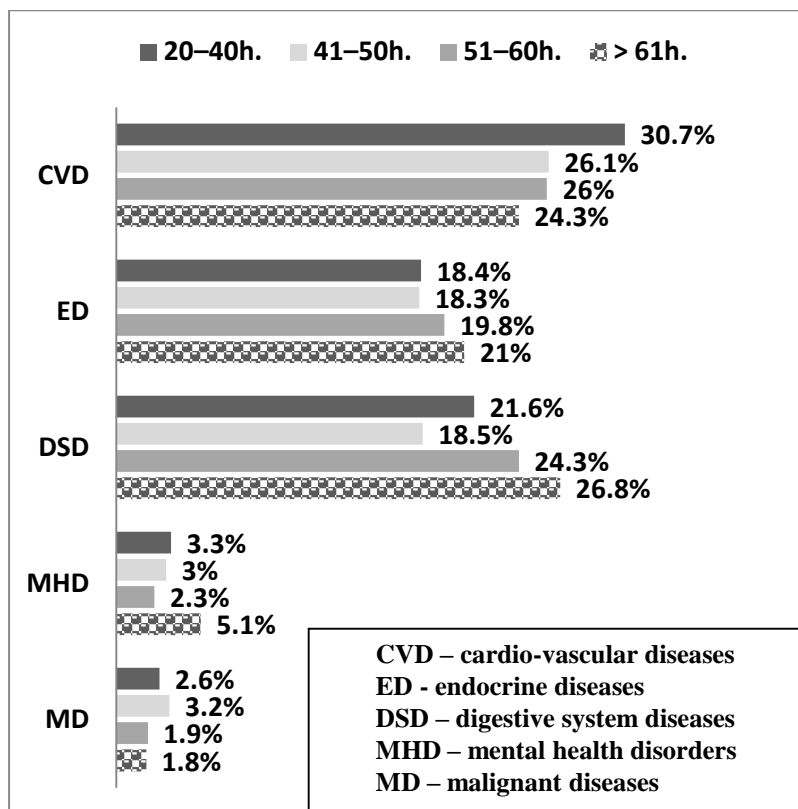
From the healthcare workers diagnosed with cardiovascular disease, with the highest percent are those who work 20 - 40 hours. With the highest share of diagnosed persons with digestive, endocrine

and mental diseases are those working >61 hours per week, and with the highest percentage of malignancies are those working 41-50 hours per week (Fig. 8).

**Figure 7. Diseases in health professionals according to the history of night work in hospital care in Sofia**



**Figure 8. Diseases of health professionals according to working hours per week in hospital care in Sofia**



**Table 4. Risk (OR) for cardiovascular, endocrine, digestive diseases, mental health disorders and malignant diseases and history of night work among all respondents**

Night work	OR	95% Confidence interval	F/p
CVD	1.982	1.255 - 3.132	8.911/.003
ED	1.327	0.831 - 2.119	NS
DSD	1.365	0.869 - 2.145	NS
MHD	1.432	0.444 - 4.624	NS
MD	1.263	0.390 - 4.093	NS

The data show an increased risk for all groups of diseases in the presence of night work, compared to the lack of night work, as only

the results for cardiovascular disease reach statistical significance ( $p=0.003$ ) (Table 4).

**Table 5.** *Stepwise multiple regression analysis of cardiovascular diseases as a dependent variable according to individual, behavioral and working time risk factors*

<b>Dependent: Cardiovascular diseases Predictors</b>	<b>Standardized <math>\beta</math></b>	<b>T</b>	<b>p</b>
Age in years	.298	7.541	.000
First-degree relatives with arterial hypertension	.142	3.440	.001
Sleep quality index (1-bad sleep; 5-good sleep)	-.132	-3.314	.001
BMI	.128	3.189	.002
Number of cigarettes per day	.117	2.983	.003
First-degree relatives with ischemic heart disease	.112	2.786	.006
$r^2=20.3\%$ ; $F=23.563$ ; $p=0.000$			

Age, the presence of first-degree relatives with arterial hypertension, sleep quality index, BMI, number of cigarettes per day and the presence of first-degree relatives with ischemic heart disease are predictors of cardiovascular disease ( $p=0.000$ ) (Table 5).

BMI, length of service, alcohol consumption, sleep quality index, first-degree relatives with diabetes and work schedule are predictors of endocrine diseases ( $p=0.000$ ) (Table 6).

Age, sleep quality index, number of cigarettes per day and working hours per week are predictors of digestive diseases ( $r^2=4.7\%$ ;  $F=7.537$ ;  $p=0.000$ ), with the number of digestive diseases increasing

with sleep impairment, with increase in age, number of cigarettes per day and working hours per week.

**Table 6. Stepwise multiple regression analysis of endocrine diseases as a dependent variable according to individual, behavioral and working time risk factors**

Dependent: Endocrine diseases Predictors	Standardized $\beta$	T	p
BMI	.219	5.231	.000
Length of service in years	.117	2.802	.005
Alcohol consumption	-.109	-2.648	.008
Sleep quality index (1-bad sleep; 5-good sleep)	-.105	-2.519	.012
First-degree relatives with diabetes	.091	2.206	.028
Work schedule	-.086	-2.073	.039
$r^2=11.2\%$ ; $F=12.254$ ; $p=0.000$			

The sleep quality index and gender are predictors of mental health disorders ( $r^2=2.7\%$ ;  $F=8.523$ ;  $p=0.000$ ), with the number of mental disorders increasing with impairment of sleep and being higher in men.

Age in years and overall fatigue are significantly associated with malignancies ( $r^2=0.2\%$ ;  $F=12.452$ ;  $p=0.000$ ) as the number of malignancies increases with the increase of age and levels of fatigue. Breast cancer is determined by age and overall fatigue ( $r^2=0.1\%$ ;  $F=6.889$ ;  $p=0.001$ ). Including behavioral risk factors, predictors of breast cancer are age, the presence of first-degree relatives with breast cancer, and the age of first child birth ( $r^2=0.1\%$ ;  $F=6.894$ ;  $p=0.000$ ).

## V. DISCUSSION

Our data show that the healthcare professionals in the hospitals in Sofia work mainly on rotating shifts, and that more than half of them work night shifts. Part of the respondents, working day or morning/afternoon shifts, are on duty with 1 - 4 night shifts per month and/or have a history of night work, since a very small percentage of both physicians and nursing professionals have never worked a night shift work.

The high share of physicians and nursing professionals who work overtime and with multiple workplaces, contribute to significantly increased working hours per week among them, which is a prerequisite for both sleep disorders and fatigue. The quality of sleep and fatigue, in turn, are strongly influenced by both long working hours and night work. The results show a statistically significant impairment in the quality of sleep during shift work, most pronounced in those working on a rotating shift with night work, and with an increase in the number of night shifts per month, most pronounced in those working more than 5 night shifts per month in which is observed impairment of most sleep characteristics. These data are in line with earlier findings (2, 3). The data from our study also show that those who work night shifts and those who work more than 41 hours a week have higher levels of fatigue than those who work up to 40 hours a week, which is again in line with previous studies in literature that find increased levels of fatigue in the presence of night work and working excessively long hours on weekly bases (4-6).

Stress is known to activate the hypothalamic-pituitary-adrenal axis, increasing circulating levels of cortisol in the blood, a hormone that affects metabolism and regulates the immune system (7). This suggests that biological monitoring of cortisol in saliva may be useful in characterizing the pathophysiological effects of stress and shift work (8). Our data show a diurnally oriented circadian cortisol rhythm with significant variations during the shifts and higher cortisol values compared to the reference group at some hours during the day shifts and especially during the second half of the night shifts, which is in consistency with the established by Anjum et al. and Baba et al. (9, 10).



Studies find a link between night shifts and levels of aMT6s excretion. Bracci et al. (11) shows that the group of nurses working night shifts have significantly lower levels of aMT6s in the urine than the group working day shifts. Davis et al. (12) find that the levels of aMT6s during night shifts are approximately 62% lower than those during day shifts. Our data is consistent with the cited studies and show significantly lower morning values at the end of night shifts compared to the values at the beginning of day shifts, as well as lower average values of aMT6s in all studied hours during both shifts compared to the reference values.

The multifactorial etiology of chronic non-communicable diseases is well known, but occupational risk factors, including shift work and night work, contribute to their development, both directly through desynchronizing circadian rhythms and related hormonal, metabolic and physiological changes, and through changes of behavioral risk factors, such as smoking, alcohol intake, diet, physical activity and others. Although most of the behavioral characteristics of the monitored health professionals did not show significant differences in night work, such as the pursuit of healthy eating, alcohol use, and physical activity, the incidence of smoking was slightly higher among night workers, and they definitely smoke more cigarettes per day. The share of overweight and obese respondents is also slightly higher among night workers. Along with behavioral factors, most of the individual risk factors associated with the development of hormone-dependent malignancies do not show differences depending on night work.

Despite the higher share of physicians and nursing professionals who find their health to be good, our data from monitoring the number of diagnosed chronic diseases show a high proportion of people with cardiovascular, endocrine and digestive system diseases among health professionals working night work, as well as those who switched from night shift work to day work, compared to specialists without data on night work.

There are number of evidence that the presence of certain individual and behavioral factors increases the risk of cardiovascular, endocrine, and digestive diseases. Our data support these evidence, and show that the presence of factors such as poor sleep, age, family

history, BMI, smoking lead to an increased risk of cardiovascular, endocrine and digestive diseases.

The results of monitoring the risk (OR) of cardiovascular, digestive, endocrine, mental and malignant diseases, compared to the presence of night work, show an increased risk of all groups of diseases in the presence of night work, which is consistent with other data from the literature (13-15).

Given the relationship between the organization of the work time and shift work schedules with the impairment of sleep and fatigue - predictors of deteriorating health, increased incidence of cardiovascular, endocrine, digestive and mental diseases, further research is needed to fully investigate the effect of certain work schedules and recovery periods, as well as regular application of standardized questionnaires and interviews to allow monitoring and comparison of the health status of workers over time

## VI. CONCLUSIONS

- ✓ The health professionals in the hospital care in Sofia, work mainly on rotating shifts with night work. The share of individuals working long hours on a daily and weekly basis is high, including >51 working hours per week.
- ✓ Melatonin maintains its typical circadian rhythm ( $F=7.949$ ,  $p=0.008$ ) with mean values of aMT6s lower than reference values. Significantly lower early morning levels of hormone excretion were found during night work, compared to morning values before the day shift.
- ✓ In dynamics during the work day, cortisol maintains its 24-hour rhythm ( $F=12.731$ ,  $p=0.001$ ), with high morning values at the beginning of the day shift, close to the reference values, but with higher values for part of the day shift and second half of the night shift and greater variation in values during both shifts. Data on salivary cortisol levels confirm the self-rated high levels of stress and increased health risk.
- ✓ The results show a statistically significant impairment of sleep quality in health workers with 5 or more night shifts per month in all sleep characteristics, except for the sleep duration. With an increase of working hours per week, a significant impairment of sleep is found, especially in workers with more than 51 working hours per week.
- ✓ Shift work with 5 or more night shifts per month, as well as overtime and multiple workplaces, with a working week of

41 hours and more, respectively, contribute to increased levels of fatigue among hospital medical staff.

- ✓ Healthcare workers with a history of night work have a higher incidence of cardiovascular disease, hypertension, digestive diseases and endocrine diseases, as part of the individuals with chronic illnesses switching to day work and limiting overtime and multiple workplaces.
- ✓ The results show an increased risk (OR) of cardiovascular, digestive, endocrine, mental and malignant diseases in the presence of night work, as well as an increased risk of digestive, endocrine and malignant diseases in the presence of 41 working hours per week.
- ✓ The sleep quality index is a predictor of cardiovascular, endocrine, digestive and mental diseases along with age/work experience, family history of the relevant diseases, intensity of smoking for CVD and digestive diseases, alcohol consumption for endocrine diseases, work schedule and working hours per week for endocrine and digestive diseases, gender for mental disorders.
- ✓ Age and fatigue are predictors of malignant diseases and breast cancer, and for the breast cancer the presence of first-degree relatives with breast cancer and the age of birth of first child.

## **VII. CONTRIBUTIONS**

### **SCIENTIFIC CONTRIBUTIONS**

- ✓ For the first time in our country the excretion of aMT6s, the main metabolite of melatonin, was monitored in healthcare professionals, and the data show a decrease in the excretion of the hormone in nurses working night work.
- ✓ For the first time in Bulgaria, stress assessment was performed in hospital nurses with a set of indicators, including changes in cortisol levels in saliva and self-rated stress, fatigue, sleepiness and stress symptoms, as the data on hormone levels confirm the self-rated high levels of stress and increased health risk.

### **SCIENTIFIC-APPLIED CONTRIBUTIONS**

- ✓ A questionnaire has been developed for assessment of the shift work schedules and the presence of overtime and multiple workplaces, aimed at the healthcare sector and in accordance with the regulatory tools and the state of the problem.
- ✓ The share of the employees in the hospital care of Sofia with night work, overtime and multiple workplaces, long working hours on a daily and weekly basis has been established.
- ✓ A survey including a representative group of 2690 health workers from 19 hospitals in Sofia is conducted, which ensures the reliability of the results.
- ✓ Characteristics of the organization of the work hours for impairment of the quality of sleep and increase of fatigue in physicians and nursing professionals in hospital care have been established.
- ✓ Data of higher morbidity in physicians and nursing professionals depending on the shift schedules, overtime and multiple workplaces, individual and behavioral risk factors have been established.
- ✓ Recommendations to limit the health risk during shift work in hospital care have been prepared.

## VIII. LIST OF PUBLICATIONS on the topic of the dissertation

- Cekova I, Vangelova K. Risk of hormone-dependent cancers during shift work. *Health and safety at work* 2016; 2 (1): 21-31; (ISSN 2367-7171).
- Cekova I, Stoyanova R, Dimitrova I, Vangelova K. Sleep and fatigue in nurses in relation to shift work. *Advances in Intelligent Systems and Computing Proceedings of 20th Congress of International Ergonomics Association* 2018; 2(819): pp. 186-193. DOI: 10.1007/978-3-319-96089-0\_21.
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- Cekova I. Occupational risk factors for the development of hormone-dependent cancers. *Health and safety at work* 2019; 5: 35-47; (ISSN 2367-7171).
- Vangelova K, Dimitrova I, Cekova I, Stoyanova R. The effect of work-related risk factors on health symptoms of hospital nurses. *Acta Medica Bulgarica* 2021; 58 (1): 81-87. DOI: 10.2478/AMB-2021-0013
- Cekova I, Vangelova K. P-44 The association between night shift work and cardiovascular and endocrine diseases in healthcare workers in Bulgaria. *Occupational and Environmental Medicine* 2021;78:A65. DOI: 10.1136/OEM-2021-EPI.173

## **IX. PARTICIPATION IN SCIENTIFIC EVENTS in relation with the dissertation**

- Cekova I, Vangelova K, Stoyanova R. Excretion of melatonin and cortisol in saliva in hospital nurses. First Congress of Occupational Medicine and Expertise of Working Capacity with an international conference on the Epsilon project, November 7 - 8, 2018, Sofia, Bulgaria
- Cekova I, Stoyanova R, Dimitrova-Toneva I, Vangelova K. Sleep and fatigue in nurses in relation to shift work. 20th Congress of International Ergonomics Association, 26 - 30.08.2018, Florence, Italy\*
- Cekova I, Stoyanova R, Dimitrova-Toneva I, Vangelova K. The effect of night shift work on cardiovascular and endocrine diseases in hospital physicians. International Summer School IMRB, 3 – 5.07.2019, Paris, France\*
- Cekova I, Vangelova K, Stoyanova R. The effect of night shift work on melatonin and cortisol in hospital nurses. 11th International Joint Conference on Occupational Health for Healthcare Workers, 22 – 24.10.2019, Hamburg, Germany\*
- Vangelova K, Dimitrova I, Cekova I, Stoyanova R. Work-related risk factors in hospital physicians and nurses in Sofia. 11th International Joint Conference on Occupational Health for Healthcare Workers, 22 - 24.10.2019, Hamburg, Germany
- Cekova I, Vangelova K. The association between night shift work and cardiovascular and endocrine diseases in healthcare workers in Bulgaria. 28th International Symposium on Epidemiology in Occupational Health EPICOH, 25-28.10.2021, Montreal, Canada-online\*

\* - Participation after winning a grant

Getting involved in grant application and winning a research grant

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