RELATIONSHIP BETWEEN SHIFT WORK AND METABOLIC SYNDROME DIAGNOSTIC COMPONENTS: A PILOT STUDY IN NURSES WORKING SHIFTS IN TURKEY

Semra NAVRUZ VARLI[1], Saniye BİLİCİ[1]

[1] *Gazi Üniversitesi Sağlık Bilimleri Fakültesi Beslenme ve Diyetetik Bölümü, Ankara*

ABSTRACT

It is often emphasized that working shifts impairs sleep and natural biological body rhythms, tends to increase psychosocial stress, and thus paving the way for Metabolic Syndrome (MetS) related physiological problems. This study was carried out to determine the prevalence of Mets and the relationship between shift work and Mets diagnostic components among nurses working shifts. This cross-sectional study was performed on totally 110 volunteer female nurses, aged between 25 and 50 (mean age 33.0±6.3 years), who work day (56) and shifts (54) at a hospital in Ankara. Research data were obtained through a questionnaire. Also, the participants' anthropometric measurements, biochemical measurements and blood pressure measurements were taken. According to the criteria of International Diabetes Federation (IDF), 7.3% of all the individuals, 9.3% of the day workers, and 5.4% of the shift workers were diagnosed with MetS. The most common components of MetS in the participants were found to be abdominal obesity and low HDL-cholesterol levels. Individuals working in shifts should be informed about the health risks that may arise due to their working arrangements.

Key Words: Metabolic syndrome, shift working, night shift, nurses

VARDİYALI ÇALIŞMA VE METABOLİK SENDROM TANI KRİTERLERİ ARASINDAKİ İLİŞKİ: TÜRKİYE'DE VARDİYALI ÇALIŞAN HEMŞİRELERDE YAPILAN BİR PİLOT ÇALIŞMA

ÖZET

Vardiyalı çalışmanın uyku ve doğal biyolojik vücut ritimlerini bozduğu, psikososyal stresi arttırabildiği, bunun sonucu olarak Metabolik Sendrom (MetS) ile ilişkili fizyolojik rahatsızlıklara zemin hazırladığı üzerinde durulmaktadır. Bu çalışma, vardiyalı çalışan sağlık personelinde MetS sıklığının belirlenmesi ve vardiyalı çalışma ve MetS tanı kriterleri arasındaki ilişkinin araştırılması amacıyla planlanıp yürütülmüştür. Bu kesitsel çalışma Ankara ilinde bir hastanede 25-50 yaş grubunda (yaş ortalaması 33.0±6.3 yıl) olan, gündüz çalışan (56 kişi) ve vardiyalı çalışan (54 kişi) bireylerden oluşan, toplam 110 gönüllü kadın hemşire ile yapılmıştır. Araştırma verileri bir anket formu ile elde edilmiştir. Ayrıca bireylerin antropometrik ölçümleri, biyokimyasal ölçümleri ve kan basıncı ölçümleri alınmıştır. Uluslararası Diyabet Federasyonu (IDF) kriterlerine göre, çalışmaya katılan tüm bireylerin %7,3'ünde, gündüz çalışanların %9,3'ünde, vardiyalı çalışanların ise %5,4'ünde MetS bulunduğu belirlenmiştir (p>0,05). Araştırma grubunda MetS bileşenlerinden en yaygın olanların abdominal obezite ve düşük HDL-kolesterol düzeyleri olduğu gösterilmiştir. Vardiyalı çalışan bireylerin çalışma koşulları nedeniyle ortaya çıkabilecek sağlık riskleri hakkında bilgilendirilmesi faydalı olacaktır.

Anahtar Kelimeler: Metabolik sendrom, vardiyalı çalışma, gece vardiyası, hemşire

İletişim/Correspondence:
Araş.Gör. Semra NAVRUZ VARLI
Gazi Üniversitesi Sağlık Bilimleri Fakültesi
Beslenme ve Diyetetik Bölümü, Ankara
E- posta: semra_nvrz@hotmail.com

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INTRODUCTION

In the daily life of a healthy individual, daytime is allocated for work while night time is for relaxation and entertainment. However, some factors such as shift working might negatively affect an individual's daily rhythm leading to several health problems (1) and there are studies carried out on the physical, mental, and social effects of shift working on human health (2). Nursing is one of the professions that require shift working (3). Studies concerning health problems of nurses report negative effects of their working conditions on their general state of health (4-6). While there are plenty of studies reflecting nurses' problems in their musculoskeletal system that result from working shifts (7, 8), only a few reports in relation to cardiovascular system and metabolic syndrome (MetS) are available (8, 9). Nevertheless, it is stated in these studies that nurses working shifts experience health problems related to the cardiovascular system and MetS more often than other professionals working shifts (10), and that working shifts could be an occupational factor in terms of Mets development (11).

It was reported that there is a positive relationship between shift working and MetS, obesity, cardiovascular diseases, sleep disorders, weakened immune system, and increase in cancer incidences (12, 13). Furthermore, it is emphasized that shift working adversely affects sleep and natural biological body rhythms, tends to increase psychosocial stress, and thus setting the stage for MetS-related physiological problems (14). In addition, these observed effects usually arise as a result of working shifts for more than 10 years. Recent studies suggested that there is a relationship between shift working and MetS (12, 15-17). Metabolic syndrome prevalence among adults in the world is reported to be 22% on average. In Turkey, MetS prevalence is reported to be 28% among males whereas it is 40% among females (18). In a systematic research it was concluded that there was insufficient evidence regarding the association between shift work and prevalent MetS when the confounders are taken into account (12). In another study which aimed to determine the MetS prevalence in 152 hospital workers, of which 70% were composed of shift workers, MetS prevalence was reported to be 37.1% among shift workers while it was 20.8% among the day workers according to International Diabetes Federation (IDF) criteria (19). In these studies, it is stated that, in a four-five-year period, the possibility of MetS development was higher among nurses who work in rotating shifts including night shift compared to the control group who work only day shift (3, 5, 20).

The purpose of this study was to determine the MetS prevalence and the relationship between shift work and MetS diagnostic components among nurses working shifts. To our knowledge, this study is the first one comparing individuals who worked night shifts in the past (those who work in the day now) to those who still work shifts.

MATERIAL AND METHODS

This cross-sectional study was performed in a hospital between March 2014 and September 2014. In the study, the day work group comprised nurses working from 8 a.m. to 4.pm, and the shift work group included nurses working at least four times a month from 4 p.m. to 8 a.m. The monthly working hours of the nurses who took part in the study were 40 in total. A total of 110 nurses, 56 of whom working shifts and 54 performing day work for >1 year, all aged 25-50 were included in the study. Pregnant nurses and those who were placed in day work were excluded from the study.

Data collection process

Research data were collected with a questionnaire that was implemented face-to-face with the volunteer nurses. The questionnaire included general information about the individuals, their medical information, general dietary habits, physical activity assessment, and shift working information. In addition, the participants' anthropometric, biochemical, and blood pressure measurements were taken.

Anthropometric measurements

Measurements of body weight and height were taken by following standard techniques. A portable type of Tanita BC 601 body analyzer was used to measure body weight to the nearest half-kilogram. Height was measured to the nearest 0.1 cm with a wall-mounted stadiometer. Body mass index (BMI, kg/m^2) was calculated by dividing the weight of each subject by the square of height. The subjects were classified according to their BMI into three groups: normal weight (BMI: 18.5-24.9 kg/m^2), overweight (BMI: 25.0-29.9 kg/m^2), and obese (BMI $\geq$ 30 kg/m^2) (21). Waist circumference (WC) was measured above the iliac crest and below the lowest rib margin at minimum respiration. Hip circumference (HC) was measured at the widest part of the hip at the level of the greater trochanter to the nearest half-centimeter. The waist and hip circumferences were measured with a non-flexible tape. Skin fold thickness were measured according to Lohman et al. protocol (22).

Biochemical measurements

Of the biochemical tests used as criteria to diagnose MetS, triglyceride, HDL-cholesterol, and fasting glucose were taken into evaluation. Venous blood samples were taken by nurses from the participants early in the morning following a 12-hour fasting period at night. Fasting glucose (mg/dL), HDL-cholesterol (mg/dL), and triglyceride (mg/dL) tests were examined in Roche Cobas c501 (Roche Diagnostics GmbH D-68298 Mannheim) auto analyzer through the enzymatic/spectrophotometric method.

Blood pressure measurements

The participants' blood pressure measurements were taken using a sphygmomanometer. Blood pressure measurements (systolic blood pressure: SBP, diastolic blood pressure: DBP) were carried out in the sitting position after a 10-minute rest. Average values were calculated by taking three successive measurements from each arm.

Metabolic syndrome diagnosis

In diagnosing MetS, IDF (19) and National Cholesterol Education Program Adult Treatment Panel (NCEP-ATP III) (23) criteria were used for evaluation. The volunteer participants who were diagnosed with MetS or any other illness were informed that they should seek medical treatment in a general hospital.

Statistical analysis

All statistical data was analyzed using SPSS (The Statistical Package for Social Sciences) Version 22.0 (SPSS Inc., Chicago, IL, USA). Counts, percentage (%), mean ($\bar{x}$), and standard deviation (SD) values were taken for the evaluation of the data. Continuous variables were presented as mean and SD, whereas categorical variables were presented as frequencies and percentages. Differences between categorical variables were evaluated with Chi-square test. Correlations were evaluated using Pearson coefficient correlation. Continuous variables compared with Student's t-test for two independent groups. One-way ANOVAs were conducted to compare the three groups. To determine the significantly different group through multiple comparisons, SNK, a post hoc method, was utilized. The results were considered statistically significant when $p<0.05$.

RESULTS

The mean age of the individuals in the day shift group was 33.0±6.3 years (min: 25 years, max: 50 years) and their average work experience was found to be 11.2±7.2 years. The 28.6% of the day workers were found to have 10-14 years of experience as health personnel while 35.7% of them have 15-19 years. For the shift workers, 33.9% had 1-4 years of experience, whereas 48.3% had 5-9 years of experience. The participants' mean metabolic syndrome components and standard deviations (±SD) according to their shift positions are presented in Table 1. It was determined that the day workers' mean fasting blood glucose and triglyceride values (84.77±9.18 mg/dL and 83.79±33.93mg/dL, respectively) were higher than those of the shift workers (81.53±12.41 mg/dL and 79.96±30.36 mg/dL, respectively). The mean HDL-cholesterol level of the shift workers (60.23±14.30 mg/dL) was higher than that of the day workers (59.03±10.97 mg/dL) ($p>0.05$). No statistically significant difference was found between the day workers and the shift workers in terms of their mean MetS component levels ($p>0.05$).

Table 1. Means ($\bar{x}$) and standard deviations (SD) of metabolic syndrome components by the participants' shift types

Parameters	**Day workers (n: 54)**	**Shift workers (n: 56)**	**Total (n: 110)**	**z**	**p**
	$\bar{x}$**±SD**	$\bar{x}$**±SD**	$\bar{x}$**±SD**		
PBG (mg/dL)	84.77±9.18	81.53±12.41	83.12±11.01	-1.55	0.12
TG (mg/dL)	83.79±33.93	79.96±30.36	81.84±32.07	-0.07	0.94
HDL-cholesterol (mg/dL)	59.03±10.97	60.23±14.30	59.64±12.73	-0.11	0.91
Waist/hip	0.85±0.06	0.85±0.05	0.85±0.06	-1.41	0.68
BMI (kg/m^2)	24.63±3.52	23.80±3.42	24.21±3.48	-0.41	0.13
SBP (mmHg)	104.80±9.51	104.00±9.04	104.39±9.24	-0.48	0.62
DBP (mmHg)	70.67±8.10	71.57±7.16	71.13±7.61	-0.71	0.47

Legend: PBG: Preprandial blood glucose, TG: Triglyceride, HDL: High density lipoprotein, BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

The participants' shift information, the prevalence of their MetS components according to NCEP-ATP III and IDF criteria, and their total component distributions are shown in Table 2. In accordance with NCEP-ATP III and IDF criteria, the most common MetS components were abdominal obesity (37.27%) and low HDL-cholesterol level (23.63%). It was found that MetS components were negative in 44.5% of the individuals while one of the MetS components were positive in 32.7%. It was also discovered that 17.3% of the participants had any two of the MetS components positive whereas 5.5% had three or more components of MetS positive. MetS was diagnosed in 9.3% of the day workers and 1.8% of the shift workers. Similarly, for the IDF criteria, the most common MetS components in the research group were abdominal obesity (79.1%) and low HDL-cholesterol level (23.63%). It was determined that 49.1% of the participants had any one of the MetS components positive while 24.5% of them had any two of the components positive. It was observed that 7.3% of the individuals had MetS (waist circumference ≥80 cm + minimum two components), and 9.3 % of the day workers and 5.4% of the shift workers were diagnosed with MetS.

Table 2. Prevalence of metabolic syndrome components among participants by their shift types and their total component distribution

MetS components	NCEP-ATP III Day workers (n:54)		Shift workers (n: 56)		Total (n: 110)		IDF Day workers (n:54)		Shift workers (n: 56)		Total (n: 110)	
	n	%	n	%	n	%	n	%	n	%	n	%
Prevalence of MetS components												
NCEP-ATP III												
PBG ≥110 mg/dL	-	-	2	3.6	2	1.8						
IDF												
PBG ≥100 mg/dL							4	7.4	4	7.1	8	7.3
NCEP-ATP III												
BP ≥130/85 mmHg	5	9.3	1	1.8	6	5.5						
IDF												
BP ≥130/85 mmHg/hypertension							5	9.3	2	3.6	7	6.4
NCEP-ATP III												
WC >88 cm	23	42.6	18	32.1	41	37.3						
IDF												
WC ≥80 cm							45	83.3	42	75.0	87	79.1
TG ≥150 mg/dL	4	7.4	1	1.8	5	4.5	4	7.4	1	1.8	5	4.5
HDL-cholesterol <50 mg/dL	13	24.1	13	23.2	26	23.6	13	24.1	13	23.2	26	23.6
Total number of MetS components												
MetS components negative	24	44.4	25	44.6	49	44.5	9	16.7	12	21.4	21	19.1
One component positive	16	29.6	20	35.7	36	32.7	27	50.0	27	48.2	54	49.1
Two components positive	9	16.7	10	17.9	19	17.3	13	24.1	14	25.0	27	24.5
NCEP-ATP III												
MetS[a]	5	9.3	1	1.8	6	5.5						
IDF												
MetS[b]							5	9.3	3	5.4	8	7.3

Legend: NCEP-ATP III: National Cholesterol Education Program Adult Treatment Panel, IDF: International Diabetes Federation, MetS: Metabolic syndrome, PBG: Preprandial blood glucose, BP: Blood pressure, WC: Waist circumference, TG: Triglyceride, HDL: High density lipoprotein

[a]Three or more components positive, [b]WC ≥80 cm+minimum two components

Table 3 shows the results of the variance analysis for the measurements concerning MetS components (fasting blood glucose, SBP, DBP, triglyceride, HDL-cholesterol, and waist circumference) and independent variables. A statistically significant relationship was determined between the mean age and their triglyceride values ($p<0.05$) while no significant difference in terms of triglyceride was observed between 25-34 age group and 35-44 age group. It was seen that the mean values of triglyceride was higher

Table 3. Arithmetic means, standard deviations and significance test results of MetS components measurements by independent variables

Variables	SBP	DBP	PBG	HDL	TG	WC
Age (year)	0.512^{A}	0.403^{A}	0.350^{A}	0.943^{A}	**0.013^{A}*****	0.172^{A}
25-34	103.66±9.04	70.41±7.43	81.92±12.08	59.88±13.29	79.88±28.78	84.76±8.59
35-44	105.97±10.24	72.63±8.54	85.12±8.54	59.0±12.64	77.28±27.98	82.20±7.94
45-50	104.30±7.18	71.20±5.24	84.90±10.11	60.10±9.79	109.80±51.24	89.90±6.52
Educational background	0.864^{A}	0.996^{A}	0.613^{A}	0.716^{A}	0.573^{A}	0.610^{A}
High school	103.75±4.99	70.25±3.20	78.0±14.09	57.50±8.88	63.75±29.89	82.50±4.20
Associate degree	106.45±9.15	71.0±5.58	83.54±9.20	60.90±11.15	83.81±28.53	84.27±4.36
Undergraduate/graduate	104.08±9.15	71.17±8.10	83.60±11.16	59.19±12.11	83.14±33.45	86.16±8.90
Marital status	0.400^{B}	0.246^{B}	0.220^{B}	0.305^{B}	0.352^{B}	0.448^{B}
Married	105.0±9.49	71.82±8.20	84.18±12.11	60.66±12.49	84.18±33.69	86.14±7.89
Single	103.48±8.88	70.09±6.58	81.54±9.02	58.11±13.07	78.34±29.50	84.91±8.94
Work experience (year)	0.911^{A}	0.946^{A}	0.290^{A}	0.228^{A}	0.313^{A}	0.346^{A}
1-4	104.0±8.29	70.55±5.77	78.36±12.04	60.18±16.54	72.90±28.81	84.36±10.06
5-9	104.37±9.61	71.37±8.16	84.05±12.57	58.60±11.58	84.0±29.20	84.83±8.41
10-14	103.19±11.60	70.0±9.28	84.81±9.46	54.25±10.28	86.87±35.86	88.69±8.21
15-19	106.05±9.55	71.95±7.774	84.15±9.30	63.05±12.20	77.0±21.05	83.63±7.26
>20	103.0±7.84	70.20±10.94	85.80±6.76	66.40±15.58	63.80±14.09	88.60±3.36
Working hours	0.654^{B}	0.536^{B}	0.123^{B}	0.625^{B}	0.534^{B}	0.474^{B}
08:00-16:00	104.80±9.51	70.67±8.10	84.77±9.18	53.03±10.97	83.79±33.93	86.23±8.33
08:00-16:00 and 16:00-08:00	104.0±9.04	71.57±7.16	81.53±12.41	60.23±14.30	79.96±30.36	85.09±8.33

Data were presented as means ± standard deviations. In independent groups, one-way ANOVA (F values) and independent-samples t tests (t values): *p<0.001; **p<0.01; ***p<0.05(p^{A}: F test, p^{B}: T test).

Legend: SBP: Systolic blood pressure (mmHg), DBP: Diastolic blood pressure (mmHg), PBG: Preprandial blood glucose(mg/dl), HDL: High Density Lipoprotein (mg/dl), TG: Triglyceride (mg/dl), WC: Waist circumference (cm).

in the 45-50 age group. In addition, the relation between the participants' smoking conditions and the mean values of HDL-cholesterol was found statistically significant ($p<0.01$) as well as between the mean alcohol intake and systolic blood pressure ($p<0.05$). It was determined that in terms of the mean values of fasting blood glucose, triglyceride, systolic blood pressure, diastolic blood pressure, and waist circumference, the levels of participants who slept less than 6 hours a day on average were higher than those of others who slept more than 6 hours. Furthermore, HDL-cholesterol levels of those who slept more than 6 hours were lower. There was also a statistically significant relationship between the participants' sleep duration and the average waist circumference component of MetS ($p<0.05$).

The mean of waist circumference increased in parallel with their ages ($r=0.205$, $p<0.05$), and there was a positive relationship between their waist circumference and systolic blood pressure ($r=0.249$, $p<0.01$), diastolic blood pressure ($r=0.297$, $p<0.01$), fasting blood glucose ($r=0.239$, $p<0.05$) and triglyceride ($r=0.389$, $p<0.01$) levels while there was a negative relationship between their waist circumference and HDL-cholesterol level ($r=-0.291$, $p<0.0019$ (not shown in the table).

DISCUSSION

According to a meta-analysis study that quantitatively evaluates the relationship between night shift working and risk of MetS, MetS prevalence or incidence varies between 6.2% and 20.3% in studies using NCEP-ATP III criteria while between 3.9% and 28.5% in those utilizing IDF criteria (16). In this study, 1.8% of shift workers were diagnosed with MetS according to NCEP-ATP III criteria while this rate was 5.4% in accordance with IDF criteria.

In another study (3) investigating Mets incidence among health personnel working night shifts, male and female nurses were observed for four years, and it was determined that the nurses who worked night shifts had a higher risk of MetS compared to those who worked in the day. In this study, *night shift* was defined as working for >4 nights a month while *day shift* was defined as working from 7 a.m. to 9 p.m. for at least one year (3). In a similar study that compared the day shift between 4 a.m. and 23:59 p.m. with the night shift between 8 p.m. and 03:59 a.m., a statistically significant relationship was discovered between the shift type and MetS (24). Different from the aforementioned studies, an increased Mets prevalence among night shift workers was not determined in this study performed on nurses. The study revealed that the mean age was higher in individuals working day shift at present and that they were exposed to an average of 9.4±4.1-year shift work in the past. Even if a long time has passed after the night shift ended, only a few of the individuals can readapt the circadian systems to nocturnal activity. In addition, it can be concluded that the higher MetS prevalence observed among day shift workers compared to those who work night shifts could possibly result from their night shift history in the past when MetS could have developed.

To our knowledge, there is no study in the literature investigating the relationship between shift working in the past and today and MetS. In a study carried out in 1811 workers serving a big airline company, it was found that, when compared to male workers who worked in the day (those who did not work shifts before), MetS prevalence defined according to the IDF and NCEP ATP-III criteria was higher among male workers who worked shifts before (those who work in the day now) while no statistically significant difference was observed among women in terms of MetS prevalence (25). In a similar way, this study revealed that MetS prevalence defined in accordance with IDF and NCEP ATP-III criteria was higher among individuals who worked shifts in the past (those who work in the day now). Almost all the day work participants in the present study (92.6%) worked shifts before. It is known that shift working system increases the risk of MetS development in nurses in a four to five years' period. When the duration of the exposure to shift wok in the past (9.4±4.1 years) is taken into consideration, the increased MetS prevalence among daytime working nurses today can be explained.

Decrease in the amount of sleep in shift workers may result in important metabolic effects. In a recent systematic compilation in which cross-sectional and longitudinal studies examined together, it was stated that short sleep duration was related to weight gain as an independent variable especially for individuals in younger age groups (26). In a study that investigated the relationship between sleep duration and MetS, it was found that short sleep duration, independent from all other lifestyle-related habits, was positively related to impaired glucose tolerance, dyslipidemia, and risk of high blood pressure (27). In these studies, it was reported that the lack of sleep increases blood pressure (28), activates the systemic inflammatory processes (29), and poses an independent risk factor for diabetes (30). Furthermore, it is believed that reduced sleep duration could be related to glucose intolerance and insulin resistance (31). In this study, it was determined that the average sleep duration of the day workers (6.6±1.3 hours) was higher than that of the shift workers (5.0±2.1 hours). It was also discovered that pre-prandial blood glucose, triglyceride, systolic blood pressure, diastolic blood pressure, and waist circumference averages of the participants who slept less than 6 hours a day on average were higher than those of others who slept more than 6 hours, and also their HDL-cholesterol levels were lower. In addition, it was observed that the waist circumference averages of the individuals who slept less than 6 hours were approximately 4 cm higher than those of others who slept more than 6 hours, and that when the average sleep duration decreased, waist circumference average increased.

CONCLUSION

The present study is important because it is the first study in the literature investigating the relationship between shift working in today and the past (today day working) with MetS. However, it is quite difficult to determine to what extent the increase in MetS risk observed among former shift workers might result from night shift working in the past or working conditions in the present or possible effects of other factors. Individuals working in shifts should be informed about the health risks that may arise due to their working arrangements. It is important to establish national legal regulations in line with international legislation in order to reduce risks and to work effectively for shift work systems.

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