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Metabolic syndrome and sleep duration in police officers

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Abstract. *Objectives*: To examine associations for sleep quality and quantity with metabolic syndrome (MS) and its five components in police officers.

Patients or Participants: The study population consisted of 98 randomly selected officers (39 women and 59 men) for whom MS and sleep data were available.

Methods: Sleep duration (categorized as short < 6 hours, long $\geqslant 6$ hours) for the past week and quality of sleep were collected by interviewer-administered questionnaires. MS was assessed using standard criteria. Generalized linear models were used to assess associations between sleep duration or sleep quality and MS, and the mean number of MS components.

Results: Metabolic syndrome was present in 22.0% and 2.6% of the male and female officers, respectively. Women with short sleep had a significantly higher mean number of MS components (mean $= 1.43$) than those with longer sleep (mean $= 0.81$, $p = 0.0316$). Officers who stopped breathing during the night had more MS components (mean $= 2.43$) compared to those who did not (mean $= 1.13$, $p = 0.0206$).

Conclusions: Sleep duration and quality were associated with the mean number of MS components, particularly in women. Future research should examine these associations prospectively, in a larger cohort, exploring possible gender differences.

Keywords: Short sleep, occupation, sleep quality

1. Introduction

Sleep problems that include too little sleep, too much sleep, and sleep disturbances, such as sleep apnea and snoring, have been found to be associated with a disruption in the circadian rhythm leading to both psychological and physiological disturbances [1–4]. Specifically, the association between sleep problems and metabolic regulation indicate that sleep problems may lead to the development of metabolic abnormalities and, in turn, metabolic syndrome (MS) which confers an increased risk of cardiovascular disease (CVD) [5–8].

MS is characterized by the clustering of five metabolic abnormalities: abdominal obesity, elevated triglycerides, decreased high-density lipoprotein cholesterol (HDL), high blood pressure, and increased fasting glucose [9,10]. To be diagnosed with MS an individual must have three of the five abnormalities [11]. Several studies have reported associations between sleep problems and MS [12–15] as well as the individual MS components such as endocrine function, abdominal obesity, fasting glucose level, and triglyceride level [3, 16]. Karlsson et al. [17] found that MS components were more common in both men and women who per-

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formed shift work; such shift work may lead to some MS components such as changes in cholesterol, blood glucose, and increased triglyceride levels. The individual components that comprise MS are also associated with CVD; the combination of three or more of the MS components is associated not only with increased rates of CVD, but also stroke, myocardial infarction, and all cause mortality [7–9,18,19]. Therefore, individuals who report sleep problems or who have work schedules that result in abnormal sleep, such as shiftwork, or overtime, may be at an increased risk for these conditions.

Sleep problems leading to MS may be particularly problematic for police officers. Officers report that overtime and shift work are two of the most difficult aspects of their jobs [20]. The aim of our study was to determine if either short sleep duration or the quality of sleep in officers was associated with MS or the mean number of MS components.

2. Methods

2.1. Population

In 1999, 115 police officers were randomly selected with some over sampling of women officers from a possible 934 to participate in a cross-sectional study. All officers agreed to participate in the study. Sleep data and information about MS was available on 98 officers (39 women and 59 men). The Center for Preventive Medicine, State University of New York at Buffalo, School of Public Health and Health Professions, Buffalo, N.Y., served as the data collection site. The methods used in this study have been previously described [21]. This study was approved by the State University of New York at Buffalo's Internal Review Board and the National Institute for Occupational Safety and Health Human Subjects Review Board. All participants signed an informed consent.

2.2. Assessment of metabolic syndrome

Presence of MS and MS components was derived from health information collected during a physical exam. MS components included elevated waist circumference ($\geqslant$ 102 cm for men, $\geqslant$ 88 cm for women), elevated triglycerides ($\geqslant$ 150 mg/dL), low HDL cholesterol ($<$ 40 mg/dL for men, $<$ 50 mg/dL for women), elevated glucose ($\geqslant$ 100 mg/dL for men and women) or treatment for diabetes, and elevated blood pressure ($\geqslant$ 130/85 mmHg) or treatment for hypertension. MS was considered present if a participant had three or more of the components.

2.3. Assessment of sleep

Sleep quantity and quality were obtained by self-report. Several of the sleep questions have been previously validated in the Pittsburgh Sleep Quality Index questionnaire developed by Buysse et al. [22] and the sleep apnea survey used by Maislin et al. [23]. Participants reported the average number of hours slept for the last five weekday nights (Sunday through Thursday), and weekend nights (Friday and Saturday). Overall duration of sleep hours was calculated by taking the weighted average. The following shows the formula used to calculate hours of sleep:

$$([(\text{average sleep per week })*5\ ) + (\text{average sleep per weekend } * 2)]\ /\ 7).$$

Sleep duration was then categorized as either short ($<$ 6 hours of sleep) or long ($\geqslant$ 6 hours of sleep) for analysis.

The sleep survey used to elicit information about the officers' quality of sleep, consisted of seven questions that focused on sleep characteristics, sleep behavior, and daytime functioning and were used in the analysis. Responses were based on occurrences per week and ranged from strongly agree (occurrence 5–7 times per week) to strongly disagree (never/0 times per week), including a "not applicable" response. All sleep problems were analyzed as "ever" versus "never," where ever consisted of "less than once a week," "1–2 times a week," "3–4 times per week," "5–7 times a week," and never for the response "never".

2.4. Assessment of covariates

Basic demographic information for each participant was collected by an interviewer-administered questionnaire and included information on age, sex, education and smoking. Officers reported their highest level of education which ranged from "less than 12 years of school" to "graduate degree". Smoking status was recorded as "current," "former," or "never".

2.5. Analysis

Statistical methods included univariate analyses, Poisson regression, t-tests, ANOVA, and ANCOVA models. Prevalence ratios and 95% confidence intervals were calculated using Poisson regression methods to determine if either MS or the mean number of MS components was more prevalent in officers who had short sleep duration ($<$ 6 hours) compared to those with longer sleep duration ($\geqslant$ 6 hours).

Table 1
Demographic characeristics by hours of sleep fort women and men

Characteristic	Sleep duration < 6 hours ($n = 28$)	Sleep duration $\geqslant$ 6 hours ($n = 70$)	p-value
Age	39.61 (6.96)*	39.61 (7.82)	0.9967
Sex			0.6536
Male	18 (64)	41 (59)	
Female	10 (36)	29 (41)	
Rank			0.3098
Police officer	21 (75)	40 (57)	
Sgt/Lt	2 (7)	13 (19)	
Capt/detective	4 (14)	15 (21)	
Other	1 (4)	2 (3)	
Education			0.2674
$\leqslant$ High school	7 (25)	11 (16)	
College < 4 yrs	17 (61)	39 (56)	
College 4+ yrs	4 (14)	20 (28)	
Marital status			0.1798
Single	5 (18)	15 (21)	
Married	16 (57)	48 (69)	
Divorced	7 (25)	7 (10)	
Race			0.3089
African American	5 (18)	13 (19)	
Caucasian	20 (71)	55 (78)	
Hispanic	3 (11)	2 (3)	
Smoking			0.1995
Current	8 (29)	9 (13)	
Former	9 (32)	25 (36)	
Never	11 (39)	35 (51)	
Physical activity	9.25 (13.40)	12.21 (18.48)	0.4440
Sleep (avg hours/wk)	4.92 (0.55)	6.95 (0.83)	

*Values are mean (Standard Deviation) for continuous variables and number (%) for categorical variables.

The association between sleep quality and the mean number of MS components was also examined using generalized linear models. P-values were generated for overall main effect tests along with the corresponding 95% confidence intervals. All analyses were conducted using SAS 9.1.3 (SAS Institute, Cary, NC).

3. Results

Table 1 shows the basic demographic information of the officers stratified by < 6 hours of sleep and $\geqslant$ 6 hours of sleep. Officers with fewer than six hours of sleep (mean age = 39.61, standard deviation = 6.96) reported on average 4.92 $\pm$ 0.6 hours of sleep, while officers with six or more hours of sleep (mean age = 39.61, standard deviation = 7.82) reported on average 6.95 $\pm$ 0.8 hours of sleep. MS was present in 14% of the overall population (22% of male officers surveyed and 3% of the females). Seven percent, four percent, and three percent of the officers had 3, 4, or 5 MS

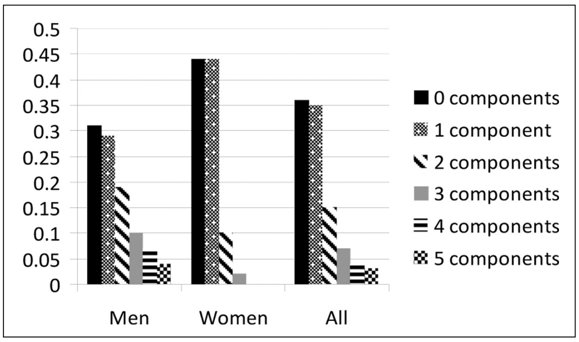

Fig. 1. Proportions of participants with none, one, two, three, four, or five metabolic syndrome components.

components respectively (Fig. 1). Among officers who reported 6 hours of sleep per 24 hour period, the prevalence of MS was 150% higher than among those who reported $\geqslant$ 6 hours of sleep (Table 2). Officers who reported less than six hours of sleep were 70% more likely to have low HDL cholesterol; although this association was attenuated after adjusting for age, sex, education, and smoking (PR = 1.46; 95% CI = 0.91, 2.35) (Table 2). Upon stratification by sex, this association remained statistically significant for female officers even after adjustments for age, smoking, and education (PR = 3.24; 95% CI = 1.53, 6.90) (data not shown).

Sleep duration was only associated with the mean number of MS components in female officers not male officers (Table 3). Those with fewer than six hours of sleep had significantly more mean MS components compared to those with six or more hours (1.30 $\pm$ 0.82 vs. 0.52 $\pm$ 0.63; $p = 0.004$). This difference remained significant after adjusting for age, education, and smoking (1.43 $\pm$ 0.24 vs. 0.81 $\pm$ 0.17; $p = 0.004$).

When sleep quality questions and mean number of MS components were evaluated, the mean number of MS components was significantly elevated for those officers who reported that they "stop breathing during sleep" (2.43 $\pm$ 0.52 vs. 1.13 $\pm$ 0.17; $p = 0.02$), although this association was attenuated slightly after adjustment for age, sex, smoking, and education (2.25 $\pm$ 0.53 vs. 1.15 $\pm$ 0.16, $p = 0.05$). After stratification by sex, this relationship remained significant in female officers even after adjusting for age, education, and smoking (1.96 $\pm$ 0.53 vs. 0.58 $\pm$ 0.15; $p = 0.04$) (Figs 2a and 2b).

4. Discussion

The aim of our research was twofold; first to determine if MS or MS components were associated with

Table 2

Prevalence ratios and 95% confidence intervals of the metabolic syndrome components by sleep duration

	Waist circumference		Elevated triglycerides		Low HDL cholesterol		Elevated glucose levels		Hypertension		Metabolic syndrome	
	< 6 hours	$\geqslant 6$ hours	< 6 hours	$\geqslant 6$ hours	< 6 hours	$\geqslant 6$ hours	< 6 hours	$\geqslant 6$ hours	< 6 hours	$\geqslant 6$ hours	< 6 hours	$\geqslant 6$ hours
N (%)	11 (39)	21 (30)	5 (18)	9 (13)	15 (54)	22 (31)	6 (21)	14 (20)	5 (18)	8 (11)	7 (25)	7 (10)
Model												
Unadjusted	1.31 (0.73, 2.35)		1.39 (0.51, 3.78)		1.70* (1.05, 2.78)		1.07 (0.46, 2.51)		1.56 (0.56, 4.37)		2.50 (0.97, 6.47)	
Adjusted for age	1.31 (0.73, 2.35)		1.39 (0.51, 3.78)		1.70* (1.05, 2.78)		1.10 (0.48, 2.53)		1.59 (0.57, 4.41)		2.52 (0.98, 6.49)	
Adjusted for age and sex	1.28 (0.73, 2.26)		1.29 (0.48, 3.50)		1.71* (1.05, 2.79)		1.07 (0.44, 2.61)		1.54 (0.58, 4.07)		2.42 (0.95, 6.12)	
Multivariate adjustment**	1.33 (0.74, 2.39)		n/a***		1.46 (0.91, 2.35)		1.13 (0.44, 2.86)		1.26 (0.44, 3.54)		2.29 (0.81, 6.49)	

N = simple prevalence ratios, where original sample size of < 6 is 28 and $\geqslant 6$ is 70.
*Indicates a significant Poisson regression prevalence ratio at $p = 0.05$ level.
**Prevalence rates are adjusted for age, sex, education, and smoking.
***Insufficient sample size for the model to run.

Table 3
Mean number of metabolic syndrome components by duration of sleep for women and men

Sex	Model	Sleep duration		p value
		< 6 hours	$\geqslant 6$ hours	
Women		$N = 10$	$N = 29$	
	Unadjusted	1.30 ± 0.82	0.52 ± 0.63	0.0035*
	Adjusted for age	1.29 ± 0.22	0.52 ± 0.13	0.0050*
	Adjusted for age, education, and smoking	1.43 ± 0.24	0.81 ± 0.17	0.0316*
Men		$N = 18$	$N = 41$	
	Unadjusted	1.61 ± 1.42	1.44 ± 1.48	0.6794
	Adjusted for age	1.63 ± 0.35	1.43 ± 0.23	0.6284
	Adjusted for age, education, and smoking	1.74 ± 0.40	1.69 ± 0.37	0.9233

Values are means $\pm$ standard deviation for the unadjusted model, and means $\pm$ S.E. for the adjusted models.
*Indicates significant ANOVA results at an alpha level of 0.05 confidence level.

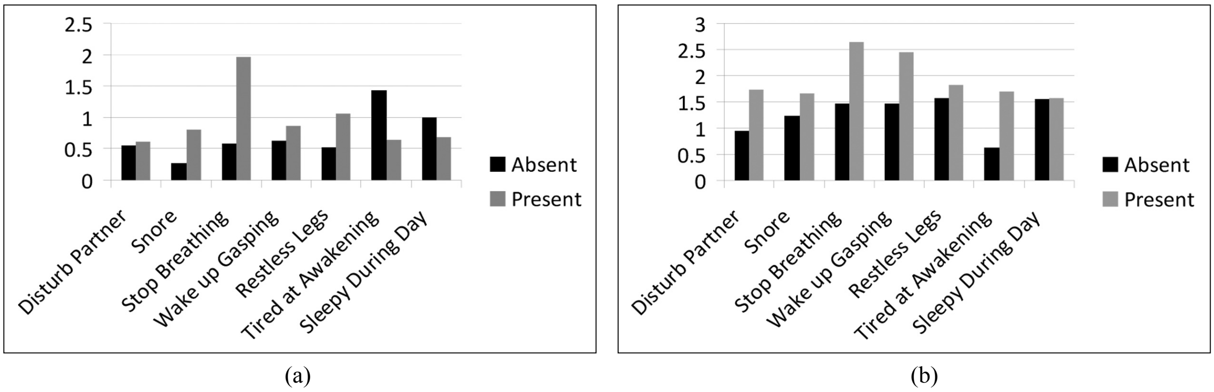

Fig. 2. (a) Mean number of metabolic syndrome components by indicators of sleep quality for female officers; (b) Mean number of metabolic syndrome components by indicators of sleep quality for male officers.

duration of sleep, and second to determine if MS or its components were associated with quality of sleep. We found that MS was not significantly associated with duration of sleep, neither long nor short. This was true whether the group was evaluated as a whole or if male officers and female officers were evaluated separately. However, among female officers who reported short sleep duration (< 6 hours), the prevalence of low HDL cholesterol was elevated compared to female officers who reported long sleep duration ($\geqslant 6$). Similarly, in female officers we also observed an association between the mean number of MS components and short sleep. This association in women stands in contrast to the lack of association found in men. The relative magnitude of the mean MS components between men and women across the two sleep categories suggests a protective effect of longer sleep for number of MS components only in women. However based on the results it appeared that the prevalence of MS in women between the two sleep groups was driven by low HDL (data not shown). To test this we examined the association between sleep duration and number of MS components adjusted for low HDL. The results confirmed our suspicion and indicated that the association between the number of MS and duration of sleep is mainly due to an association between sleep duration and low HDL.

A number of studies have found that sleep problems such as total number of sleep hours and quality of sleep are associated with indices of cardiovascular disease [24–28]. In contrast to our findings, a few studies have found that short sleep duration ($\leqslant 6$) was associated with MS [29,30]. Unlike our study, neither of these studies stratified by sex nor did they report a relationship between HDL cholesterol and short sleep. Hall [30] reported finding an association between short sleep, defined as < 6.99 hours, and increased levels of abdominal obesity, glucose, and triglycerides [30]. Choi et al. [29] found that abdominal obesity and hypertension were associated with short sleep ($\leqslant 5$ hours). Other studies, though not specifically examining MS or MS components, have found associations between short sleep duration and cardiovascular disease risk factors including elevated glucose, triglycerides, abdominal obesity, and blood pressure [24–28,31,32], none of which were significant in our population. However, in comparison to our study, many of these studies had fairly large sample sizes.

Besides the duration of sleep per night, there are a number of indicators of sleep quality that have also been shown to be associated with cardiovascular disease and MS. We evaluated seven that included, sleep disturbs partner, snoring, stops breathing, wake up gasping for breath, restless legs, tired upon waking, and sleepy during the day. Of these, stops breathing was found to be associated with the mean number of MS components in female officers. Sleep apnea, the condition in which an individual stops breathing during sleep, has also been shown to be associated with indicators of MS such as glucose intolerance, obesity, and high blood pressure as well as MS itself [5,12–15,26,33,34]. For example, Jennings et al. [14] found a link between overall sleep quality and obesity, as well as sleep quality and glucose intolerance. Coughlin et al. [12] reported that those individuals who stopped breathing during sleep were nearly six times more likely to have MS compared to those who did not. Contrary to our findings, Sasanabe et al. [33] reported that in Japanese participants, "cessation of breathing during sleep" was associated with MS in men but not women. Differences in our results compared to what has been reported in the literature may be due to differences in sample size, study design, as well as our unique population.

Although the results of this study are intriguing, this study is limited by the small sample size. Furthermore, because the study is cross-sectional, the findings cannot indicate the direction of causality. Longitudinal analyses may clarify the relationships we reported between sleep duration and the mean number of MS components as well as the relationship between women who stop breathing during sleep and the mean number of MS components.

There are few studies that have evaluated the association of MS with the duration of sleep quantity and quality of sleep in police officers. It is well known that policing is a highly stressful occupation and that due to this stress, officers may be at an increased risk of negative health outcomes such as CVD and MS [35]. Shift work, long work hours, and lack of sleep may all place officers at further increased risk for poor psychological and physical outcomes such as MS [20]. Further research examining these associations prospectively, in a larger cohort, and exploring possible gender differences may be worthwhile.

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Conflict of interest

There are no financial conflicts of interest.

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