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ASSOCIATION BETWEEN SLEEP DURATION AND SLEEP QUALITY, AND METABOLIC SYNDROME IN TAIWANESE POLICE OFFICERS

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Abstract

Objectives: This study's objective was to examine association between sleep duration and sleep quality, and metabolic syndrome (MetS) and its components in Taiwanese male police officers. **Material and Methods:** Male police officers who underwent annual health examinations were invited to join the study and eventually a total of 796 subjects was included in it. The study subjects were divided into 5 groups according to the length (duration) of sleep: < 5, 5–5.9, 6–6.9, 7–7.9 and ≥ 8 h per day, and the global Pittsburgh Sleep Quality Index was used to categorize their sleep quality as good or poor. To analyze the association between sleep problems and MetS, adjusted odds ratio and respective 95% confidence intervals (CI) were computed. **Results:** The prevalence of MetS in Taiwanese male police officers was 24.5%. Abdominal obesity had the highest proportion (36.2%) among 5 components of MetS. More than 1/2 of the police officers (52.3%) had poor sleep quality. Police officers with higher scores of sleep disturbances had a higher prevalence of MetS (p = 0.029) and abdominal obesity (p = 0.009). After adjusting for age, low-density lipoprotein cholesterol, smoking status, alcohol drinking habit, physical habitual exercise, snoring and type of shift work, the police officers who slept less than 5 h were 88% more likely to suffer from abdominal obesity than those who slept 7–7.9 h (95% CI: 1.01–3.5). Sleep quality was not associated with MetS and its components. **Conclusions:** The police officers who slept less than 5 h were more likely to experience abdominal obesity in Taiwan, and those with higher scores of sleep disturbances had a higher prevalence of MetS and abdominal obesity. It is recommended that police officers with short sleep duration or sleep disturbances be screened for MetS and waist circumference in order to prevent cardiovascular diseases.

Key words:
Metabolic syndrome, Sleep duration, Sleep quality, Police officer

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INTRODUCTION

Being a police officer is recognized as a dangerous occupation [1–3]. An American study has found a much higher occupational fatality rate in police officers when compared with the national average [4]. Actually, police officers constitute a population at an increased risk of cardiovascular diseases [3,5], also presenting a higher prevalence of their main risk factors, such as metabolic syndrome (MetS) [6–8] and occupational factors, notably: sudden physical stress [9], occupational stress [10], shift work [11,12], obstructive sleep apnea [13] and sleep problems [14].

Metabolic syndrome is characterized by the coronary heart disease risk factors clustering, including: abdominal obesity, elevated blood pressure, elevated fasting plasma glucose and triglyceride concentration, and low serum high-density lipoprotein cholesterol (HDL) [15]. This clustering increases the risk for cardiovascular diseases and all-cause mortality [16]. Epidemiological studies have shown that police officers have a higher prevalence of MetS compared with the general population [17,18]. Thus, it is important to investigate the association between sleep problems, a major complaint among police officers [14], and MetS so that preventive strategies can be implemented.

Short sleep duration has been positively associated with MetS in U.S. midlife adults and in Taiwanese male adults [19,20], and self-reported global sleep quality has been related to MetS and its components in U.S. adults [21]. In U.S. police officers, sleep duration and sleep quality have been associated with the mean number of MetS components [22], and sleep duration has been also strongly associated with MetS [23]. To measure sleep quality the above studies have used the global Pittsburgh Sleep Quality Index (PSQI). However, in those studies individual component scores of the global PSQI have not been analyzed. Besides, in the case of police officers, shorter sleep duration and more overtime work combined with midnight shift work may be important contributors to MetS [11]. The mentioned above studies in police officers have not adjusted for shift work in the analysis of association between sleep problems and MetS.

To our best knowledge, no previous non-American research has discussed the association between sleep problems and MetS in police officers. Therefore, the objective of the present study was to examine the association between sleep duration, individual component scores of global PSQI and sleep quality, and MetS and its features in Taiwanese police officers.

MATERIAL AND METHODS

Study population

The police officers of Taipei City Police Department who underwent the annual health examination for the fiscal year 2013–2014 were invited to participate in the study. A total of 890 police officers agreed to participate and there were no refusals. Because of a limited females sample size (N = 66), only 824 male police officers were included. All of the subjects completed a structured questionnaire by means of face-to-face interviews including demography, medical history, current medication and sleep assessment.

Exclusion criteria were as follows: history of depression or psychiatric disorders, chronic renal diseases or dialysis, malignant tumors, thyroid diseases and cerebrovascular diseases. After excluding 28 police officers, 796 subjects were included in the final analysis.

Measurements

Anthropometrics were obtained from the subjects dressed in light clothing and barefoot. Body height was measured to the nearest 0.1 cm and body weight to the nearest 0.1 kg. Body mass index (BMI) was obtained by dividing body weight in kg by a squared body height in m. Abnormal BMI was defined by being ≥ 25 kg/m^2 according to the MetS criteria, adopted by the American Association of Clinical Endocrinologists [24]. Waist circumference was measured to the nearest 0.1 cm at the end of normal expiration on bare skin, midway between the lower rib margin and iliac crest.

For blood pressure measurement, the subjects rested for 10 min in a supine position in a quiet place and 2 readings were taken with 10-minute intervals, using an appropriately sized cuff wrapped around the right upper arm and a vital sign monitor (ELK UDEX-Twin Type II, Japan). All the subjects had 12-h overnight fasting before blood testing, which included creatinine, alanine aminotransferase (ALT), total cholesterol, triglyceride, high-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL) and fasting plasma glucose. Serum biochemistry was measured by the use of the hexokinase method with an autoanalyzer (Beckman Coulter DxC800, USA).

Smoking habit was categorized as follows: a current smoker: the subjects who smoked at least 100 cigarettes in their lifetime and who smoke, a former smoker: the subjects who smoked at least 100 cigarettes in their lifetime but who do not smoke, a never smoker: the subjects who had never smoked at all or smoked < 100 cigarettes in their lifetime [25]. Alcohol drinking habit was classified into a drinker – defined as at least 1 drink per week within the previous 6 months, and a non-drinker. Physical habitual exercise was classified as follows, exercise: have aerobic exercise sufficient to cause sweating during leisure time, and no exercise.

Definition of MetS

Metabolic syndrome was defined according to the statement of the American Heart Association / National Heart, Lung, and Blood Institute for Asian populations [15]. A subject has MetS when at least 3 of the following 5 risk factors are present: abdominal obesity: waist circumference ≥ 90 cm; hypertension: systolic blood pressure ≥ 130 mm Hg or diastolic pressure ≥ 85 mm Hg or current use of antihypertensive medication; low HDL: HDL < 40 mg/dl (1.03 mmol/l) or current use of medication treatment for reduced HDL; hyperglycemia: fasting plasma glucose ≥ 100 mg/dl (5.6 mmol/l) or current use of antidiabetic medication; and hypertriglyceridemia: triglyceride ≥ 150 mg/dl (1.7 mmol/l) or current use of medication treatment for elevated triglyceride.

Sleep quality and sleep duration

Sleep quality was assessed over a 1-month interval by using a Chinese version of the global PSQI, which is a validated 19-item, self-reported questionnaire and generates scores of 7 components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, sleeping medication use and daytime dysfunction [26]. The sum of scores for these 7 components produces a global sleep quality score ranging from 0 to 21 points. The Chinese version of the global PSQI has an overall Cronbach's α coefficient of 0.82–0.83, and an acceptable test-retest reliability with a coefficient of 0.77–0.85 [27]. The subjects were also categorized by the global PSQI scores: 5 or < 5 points as "good sleep quality," > 5 points as "poor sleep quality." Data of sleep duration were retrieved from the sleep duration item of the global PSQI and were further divided into 5 groups as follows: < 5 h, 5–5.9 h, 6–6.9 h, 7–7.9 h, and ≥ 8 h [28] per day. The group with sleeping 7–7.9 h was used as a reference group.

Shift work and snoring

We investigated shift work schedules of all the subjects and categorized 2 types of shift work, as follows: mainly day shift: work from 9 a.m. to 9 p.m. on service within the previous 1 month, non-day shift: shift work at night from 9 p.m. to 9 a.m. or roster work within the previous 1 month. Roster work is similar to shift work but less regular and more flexible [29]. Snoring was defined as cough or snoring loudly 3 or more times per week, and the data were taken from the sleep disturbances item of the global PSQI.

ETHICS

An informed consent was obtained from all the subjects before joining the study. The study protocol was approved by the Joint Institutional Review Board of Taipei Medical University, Taiwan.

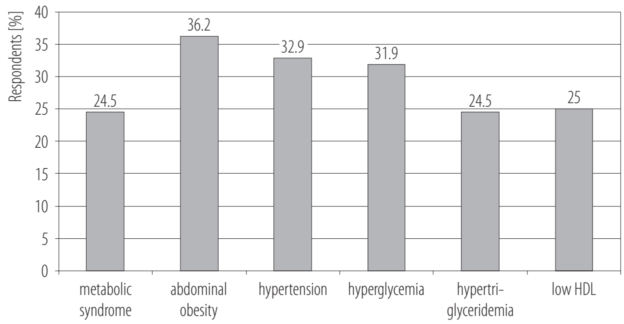
STATISTICS

Statistical Package for Social Sciences software (version 19.0; SPSS, Chicago, IL) was used for statistical analysis. Continuous variables were expressed as mean ± standard deviation and the differences between the groups were analyzed using the independent t-test. The one-way analysis of variance was performed to determine the differences in demography across the 5 groups of sleep duration. The Chi-square (Chi^2) test was used to determine the differences in categorical variables across the subgroups. Univariate and multivariate logistic regression analyses were conducted to assess the association between sleep duration and sleep quality, and MetS and its components. Bonferroni adjustment was used as *post hoc* comparisons to adjust for family-wise type I error. P value below 0.05 ($p < 0.05$) was considered as statistically significant.

RESULTS

Age of the police officers ranged from 20 to 60 years with an average of 37.36±7.73 years. The prevalence of MetS in all the police officers was 24.5%. Forty-four percent had 1 or 2 components of MetS, while 30% had none. Among the 5 components of MetS, abdominal obesity had the highest proportion (36.2%), while hypertriglyceridemia had the lowest one (24.5%) (Figure 1). The average sleep duration was 6.08±1.08 h per day in all the police officers. The police officers sleeping ≥ 8 h had the highest prevalence of MetS (30.9%). The mean global PSQI score in all the police officers was 6.09±3.09, and more than 1/2 of them (52.3%) had poor sleep quality.

Proportion of the police officers with non-day shift work was 52.5%. The group of police officers with non-day shift work included 348 (43.7%) police officers with shift work at night and 70 (8.8%) police officers with roster work. The prevalence of MetS in the non-day shift police officers was 25.4%, while that in the mainly day shift police officers was 23.5%. The police officers with non-day shift had a shorter sleep duration (5.89±1.12 h vs. 6.29±0.98 h, $p < 0.001$) and higher global PSQI scores (6.68±3.12 vs. 5.54±2.93, $p < 0.001$) when compared with those with mainly day shift work. The police officers with non-day shift work had also poorer sleep quality when compared to those with mainly day shift work ($p < 0.001$).



HDL – high density lipoproteins.

Fig. 1. Proportions of all the police officers in metabolic syndrome and its components

Table 1 shows descriptive characteristics of the police officers. There were significant differences in BMI and alanine aminotransferase (ALT) levels among the 5 groups of sleep duration. The police officers who slept less than 5 h and sleeping ≥ 8 h had a higher BMI level than those sleeping 7–7.9 h ($p = 0.025$). A similar difference was noted in the ALT level ($p = 0.020$). The police officers who drank alcohol had poorer sleep quality than those who did not drink ($p = 0.011$).

Table 2 shows the differences regarding the prevalence of MetS and its components according to sleep characteristics. The police officers with higher scores of sleep disturbances had a higher prevalence of MetS ($p = 0.029$) and abdominal obesity ($p = 0.009$). There was no other

Table 1. Descriptive characteristics of the police officers

Variable	Sleep duration							Sleep quality		
	total (N = 796)	< 5 h (N = 60)	5–5.9 h (N = 175)	6–6.9 h (N = 334)	7–7.9 h (N = 172)	≥ 8 h (N = 55)	p	good (N = 380)	poor (N = 416)	p
Age [years] (M±SD)	37.36±7.73	37.67±7.30	37.33±7.36	37.16±7.59	37.20±8.14	38.84±8.90	0.664†	37.85±7.96	36.91±7.50	0.080#
Smoking habit [n (%)]										
never smoker	453 (56.9)	29 (6.4)	100 (22.1)	197 (43.5)	105 (23.2)	22 (4.9)	0.165‡	224 (49.4)	229 (50.6)	0.103‡
former smoker	106 (13.3)	9 (8.5)	19 (17.9)	44 (41.5)	23 (21.7)	11 (10.4)		56 (52.8)	50 (47.2)	
current smoker	237 (29.8)	22 (9.3)	56 (23.6)	93 (39.2)	44 (18.6)	22 (9.3)		100 (42.2)	137 (57.8)	
Alcohol drinking habit [n (%)]										
non-drinker	782 (98.2)	60 (7.7)	172 (22.0)	327 (41.8)	168 (21.5)	55 (7.0)	0.627‡	378 (48.3)	404 (51.7)	0.011‡
drinker	14 (1.8)	0 (0.0)	3 (21.4)	7 (50.0)	4 (28.6)	0 (0.0)		2 (14.3)	12 (85.7)	
Physical habitual exercise [n (%)]										
no exercise	297 (37.3)	28 (9.4)	70 (23.6)	118 (39.7)	64 (21.5)	17 (5.7)	0.365‡	134 (45.1)	163 (54.9)	0.253‡
exercise	499 (62.7)	32 (6.4)	105 (21.0)	216 (43.3)	108 (21.6)	38 (7.6)		246 (49.3)	253 (50.7)	
BMI [kg/m^2] (M±SD)	25.16±3.61	26.18±3.66	24.29±3.49	25.13±3.62	24.56±3.29	25.71±4.50	0.025†	24.98±3.57	25.32±3.64	0.184#
Waist circumference [cm] (M±SD)	86.74±9.60	88.61±9.30	86.57±9.25	86.97±10.03	85.56±8.66	87.58±10.98	0.235†	86.53±9.54	86.94±9.75	0.547#
Systolic blood pressure [mm Hg] (M±SD)	118.76±15.17	119.73±14.42	117.63±15.17	118.70±15.15	119.31±14.99	119.89±16.95	0.782†	119.18±15.47	118.37±14.90	0.451#
Diastolic blood pressure [mm Hg] (M±SD)	77.17±11.25	78.27±12.17	76.14±11.53	77.21±10.84	77.14±10.95	79.15±12.68	0.442†	77.32±10.91	77.04±11.56	0.721#
Fasting glucose level [mg/dl] (M±SD)	99.91±26.34	100.55±27.38	102.33±33.44	100.06±26.37	98.30±20.84	95.67±9.07	0.465†	99.51±23.38	100.28±28.80	0.682#
Triglyceride level [mg/dl] (M±SD)	122.90±100.47	105.65±47.02	129.67±116.10	116.36±84.58	126.59±118.34	148.38±113.30	0.101†	123.59±104.27	122.27±96.98	0.854#
Total cholesterol level [mg/dl] (M±SD)	190.84±34.21	187.07±32.75	191.43±37.33	189.70±34.70	192.97±32.29	193.25±28.18	0.720†	191.63±33.20	190.11±35.13	0.529#

Table 1. Descriptive characteristics of the police officers – cont.

Variable	Sleep duration							Sleep quality		
	total (N = 796)	< 5 h (N = 60)	5–5.9 h (N = 175)	6–6.9 h (N = 334)	7–7.9 h (N = 172)	≥ 8 h (N = 55)	p	good (N = 380)	poor (N = 416)	p
HDL level [mg/dl] (M±SD)	47.13±10.40	46.70±10.70	47.33±11.28	47.23±10.15	47.53±10.14	45.13±9.61	0.648†	47.05±10.53	47.20±10.30	0.840#
LDL level [mg/dl] (M±SD)	119.40±30.37	119.25±30.66	118.62±32.61	119.30±30.81	120.72±29.28	118.62±23.38	0.976†	120.25±30.13	118.63±30.61	0.455#
ALT level [mg/dl] (M±SD)	32.04±21.50	39.67±25.42	31.23±19.44	32.48±23.87	28.95±16.97	33.33±18.81	0.020†	30.83±19.51	33.15±23.13	0.129#
Creatinine level [mg/dl] (M±SD)	0.94±0.14	0.94±0.12	0.93±0.16	0.95±0.14	0.95±0.15	0.93±0.14	0.548†	0.94±0.14	0.95±0.14	0.432#

M – mean; SD – standard deviation; BMI – body mass index; HDL – high-density lipoprotein cholesterol; LDL – low-density lipoprotein cholesterol; ATL – alanine aminotransferase.
† One-way analysis of variance was used to compare age, BMI, waist circumference, systolic blood pressure, diastolic blood pressure, fasting glucose level, triglyceride level, total cholesterol level, HDL level, LDL level, ALT level and creatinine level across 5 groups of sleep duration.
‡ Chi^2 test was used to compare the proportion of smoking habit, alcohol drinking habit and physical habitual exercise across 5 groups of sleep duration and between good and poor sleep quality.
# Independent t-test was used to compare age, BMI, waist circumference, systolic blood pressure, diastolic blood pressure, fasting glucose level, triglyceride level, total cholesterol level, HDL level, LDL level, ALT level and creatinine level between good and poor sleep quality.

Table 2. Association between metabolic syndrome and its features and 7 component scores of the global Pittsburgh Sleep Quality Index

Metabolic syndrome and its components	Subjective sleep quality	Sleep latency	Sleep duration	Sleep efficiency	Sleep disturbances	Sleeping medication use	Daytime dysfunction
Metabolic syndrome (N = 195)							
yes (M±SD)	1.27±0.79	1.02±0.84	1.11±0.92	0.61±1.02	1.26±0.62	0.07±0.40	0.96±0.89
no (M±SD)	1.18±0.70	0.97±0.80	1.08±0.89	0.57±0.93	1.11±0.54	0.03±0.27	1.08±0.87
p	1.000	1.000	1.000	1.000	0.029*	1.000	0.694
Abdominal obesity (N = 288)							
yes (M±SD)	1.26±0.78	1.01±0.83	1.11±0.93	0.62±1.02	1.24±0.61	0.07±0.41	1.03±0.90
no (M±SD)	1.17±0.69	0.97±0.80	1.07±0.87	0.56±0.91	1.10±0.53	0.03±0.23	1.07±0.86
p	0.517	1.000	1.000	1.000	0.009*	0.790	1.000
Hypertension (N = 262)							
yes (M±SD)	1.21±0.75	1.00±0.81	1.10±0.94	0.58±0.99	1.21±0.60	0.06±0.36	0.97±0.84
no (M±SD)	1.20±0.71	0.98±0.82	1.08±0.87	0.58±0.93	1.12±0.54	0.04±0.28	1.10±0.89
p	1.000	1.000	1.000	1.000	0.262	1.000	0.291
Hyperglycemia (N = 254)							
yes (M±SD)	1.24±0.80	0.97±0.84	1.10±0.89	0.59±0.99	1.19±0.59	0.06±0.37	0.97±0.91
no (M±SD)	1.18±0.68	0.99±0.80	1.08±0.90	0.58±0.93	1.13±0.55	0.04±0.28	1.09±0.86
p	1.000	1.000	1.000	1.000	0.963	1.000	0.452
Hypertriglyceridemia (N = 195)							
yes (M±SD)	1.29±0.77	1.05±0.85	0.99±0.85	0.62±0.98	1.23±0.61	0.06±0.39	1.08±0.89
no (M±SD)	1.17±0.70	0.96±0.80	1.11±0.91	0.57±0.94	1.12±0.55	0.04±0.28	1.04±0.87
p	0.476	1.000	0.726	1.000	0.260	1.000	1.000
Low HDL (N = 199)							
yes (M±SD)	1.20±0.73	0.93±0.81	1.09±0.92	0.59±0.97	1.21±0.62	0.06±0.35	1.02±0.92
no (M±SD)	1.20±0.72	1.00±0.82	1.09±0.89	0.58±0.94	1.13±0.54	0.04±0.30	1.07±0.86
p	1.000	1.000	1.000	1.000	0.836	1.000	1.000

Abbreviations as in Table 1.
* $p < 0.05$. All p values derived from the independent t-test.

significant association between the 7 component scores of the global PSQI and MetS and its features.

Table 3 shows the association between sleep duration and sleep quality, and MetS components. The univariate logistic regression analysis revealed that the police officers who slept less than 5 h were 97% more likely to experience abdominal obesity when compared with those sleeping 7–7.9 h (95% confidence interval (CI): 1.08–3.57), and that the police officers sleeping ≥ 8 h were more likely to suffer from hypertriglyceridemia when compared with those sleeping 7–7.9 h (95% CI: 1–3.65). After adjusting for age, LDL, smoking status, alcohol drinking habit, physical habitual exercise, snoring and type of shift work, the multivariate logistic regression analysis revealed that the police officers who slept less than 5 h were 88% more likely to experience abdominal obesity when compared

Table 3. Associations between sleep duration and sleep quality, and metabolic syndrome and its components

Metabolic syndrome and its components	Sleep duration					Sleep quality	
	< 5 h	5–5.9 h	6–6.9 h	7–7.9 h	≥ 8 h	good	poor
Metabolic syndrome							
OR (95% CI)†	1.24 (0.63–2.43)	1.18 (0.72–1.93)	1.04 (0.67–1.61)	reference	1.53 (0.78–2.99)	reference	0.90 (0.65–1.24)
AOR (95% CI)‡	1.04 (0.51–2.13)	1.01 (0.60–1.72)	1.01 (0.63–1.61)	reference	1.44 (0.69–2.98)	reference	0.78 (0.55–1.11)
Abdominal obesity							
OR (95% CI)†	1.97 (1.08–3.57)*	0.85 (0.54–1.34)	1.16 (0.79–1.71)	reference	1.41 (0.76–2.63)	reference	1.13 (0.84–1.51)
AOR (95% CI)‡	1.88 (1.01–3.50)*	0.78 (0.48–1.25)	1.16 (0.77–1.73)	reference	1.39 (0.73–2.66)	reference	1.04 (0.76–1.41)
Hypertension							
OR (95% CI)†	1.36 (0.75–2.47)	0.75 (0.48–1.18)	0.81 (0.55–1.20)	reference	0.79 (0.41–1.52)	reference	0.94 (0.70–1.26)
AOR (95% CI)‡	1.21 (0.65–2.25)	0.66 (0.41–1.05)	0.78 (0.52–1.16)	reference	0.75 (0.38–1.47)	reference	0.89 (0.65–1.21)
Hyperglycemia							
OR (95% CI)†	0.96 (0.51–1.80)	0.97 (0.62–1.53)	1.02 (0.69–1.51)	reference	0.64 (0.32–1.29)	reference	0.96 (0.71–1.29)
AOR (95% CI)‡	0.87 (0.45–1.70)	0.90 (0.56–1.46)	1.00 (0.66–1.52)	reference	0.55 (0.26–1.14)	reference	0.92 (0.67–1.27)
Hypertriglyceridemia							
OR (95% CI)†	0.48 (0.21–1.08)	1.10 (0.68–1.76)	0.94 (0.61–1.45)	reference	1.91 (1.00–3.65)*	reference	1.00 (0.73–1.39)
AOR (95% CI)‡	0.38 (0.16–0.89)	1.00 (0.60–1.69)	0.92 (0.59–1.46)	reference	1.73 (0.86–3.48)	reference	0.96 (0.67–1.36)
Low HDL							
OR (95% CI)†	1.20 (0.61–2.35)	1.14 (0.70–1.86)	1.01 (0.65–1.55)	reference	1.89 (0.98–3.62)	reference	0.79 (0.57–1.08)
AOR (95% CI)‡	1.06 (0.53–2.13)	1.04 (0.62–1.72)	0.97 (0.62–1.52)	reference	1.80 (0.92–3.55)	reference	0.74 (0.52–1.03)
Abnormal BMI							
OR (95% CI)†	1.61 (0.89–2.92)	1.01 (0.67–1.55)	1.06 (0.73–1.53)	reference	1.49 (0.81–2.74)	reference	1.09 (0.82–1.44)
AOR (95% CI)‡	1.54 (0.83–2.88)	0.97 (0.62–1.51)	1.05 (0.72–1.55)	reference	1.41 (0.74–2.67)	reference	1.07 (0.79–1.44)

OR – odds ratio; AOR – adjusted odds ratio; CI – confidence interval.
Other abbreviations as in Table 1.
† Univariate logistic regression model.
‡ Adjusting for age, LDL, smoking status, alcohol drinking habit, physical habitual exercise, snoring (yes vs. no) and type of shift work (non-day shift vs. mainly day shift).
* $p < 0.05$.

with those sleeping 7–7.9 h (95% CI: 1.01–3.5). There was no significant association between sleep quality and MetS and its components.

DISCUSSION

The current study is the 1st to demonstrate the association between sleep duration, sleep quality and components of MetS among Asian police officers, which is congruent with the previous findings in the U.S. police officers [22,23]. The results showed that more than 1/2 of the police officers had poor sleep quality. Sleep disturbances were found to be associated with MetS and abdominal obesity. Police officers sleeping less than 5 h were more likely to suffer from abdominal obesity when compared with those sleeping 7–7.9 h.

There were several studies with a different prevalence of MetS in U.S. police officers. Yoo et al. have found 23.1% prevalence of MetS in Iowa white male police officers with the mean age of 39.1±8.7 years [8], Violanti et al. have found 16.3% prevalence in Buffalo male and female police officers with the mean age of 39.5±7.6 years [11], and Yoo and Franke have found 33% in Iowa male and female police officers with the mean age of 42.3±8.4 years [23]. The differences between the MetS prevalence among the 3 studies might be due to geographic regions or the subjects' gender. The prevalence of MetS in the current study (24.5%) was closer to the one from the study of Yoo et al. [8], and this similarity was found by the inclusion of only male police officers and similar age distribution.

The prevalence of MetS was different between Violanti et al. [11] and the current study. The possible reason was that the police officers in their study [11] included both males and females, and the mean age in their study was older than that in the current study. Besides, Yoo and Franke have found that police officers sleeping ≥ 8 h had the highest prevalence of MetS [23]. Similarly, the police officers sleeping ≥ 8 h had the highest prevalence of MetS in the current study.

Several studies have demonstrated an association between short sleep duration and MetS components. Hall et al. have reported that midlife adults sleeping less than 6 h were associated with MetS and abdominal obesity when compared with those sleeping 7–8 h [19]. McCanlies et al. have found that female police officers sleeping less than 6 h were associated with lower HDL when compared with those sleeping ≥ 6 h [22]. The current study found that the police officers who slept less than 5 h were more likely to suffer from abdominal obesity, which was similar to Hall's findings on abdominal obesity.

Longer sleep duration is an interesting issue with respect to MetS and its components. Choi et al. have shown that general population sleeping ≥ 9 h was associated with MetS [30]. Yoo et al. have shown that the police officers sleeping ≥ 8 h were associated with MetS and glucose intolerance when compared with those sleeping 6–8 h [23]. Our study did not find any significant association between long sleep duration and MetS in the multivariate logistic regression analysis. The difference between Yoo et al. and our results might have been caused by race, diagnostic criteria of MetS or statistical method. It is noteworthy that using the American cut-off point of male waist circumference of 102 cm [15] leads to a different result, i.e., the police officers sleeping less than 5 h and those sleeping ≥ 8 h were both significantly associated with abdominal obesity when compared with those sleeping 7–7.9 h after adjusting for the same previous covariates. Although this result is different from our finding, the International Diabetes Foundation [31] recommends 90 cm as the cut-off point for male Asians. Therefore, we thought it was appropriate to adopt the 90 cm as the cut-off point for the Taiwanese male police officers.

Poor sleep quality was associated with BMI, waist circumference and fasting glucose in the general population [21]. Jennings et al. have found that for every increase of 2.6 points on the global PSQI, a subject was 1.44 times more likely to meet the diagnostic criteria of MetS in Caucasian adults [21]. Yoo et al. have found no significant association between sleep quality and MetS and its components [23]. They have suggested that sleep duration was a more potent factor than sleep quality for MetS or glucose intolerance, and sleep quality did not mediate an association between sleep duration and MetS [23]. Our study did not show any association between sleep quality and MetS and its components either.

Concerning sleep disturbances and MetS and its components, 2 studies have found that sleep disturbances were a risk factor for obesity [32,33]. In addition, Narang et al. have shown that a higher sleep disturbance score was associated with higher waist percentiles, higher total cholesterol, and higher non-HDL cholesterol in adolescents [34]. The current study showed that police officers with higher sleep disturbance scores had abdominal obesity, partially consistent with the results of Narang et al. [34].

The mechanism underlying the association between sleep duration, sleep quality and MetS remains unclear. Short sleep duration or sleep restriction may lead to an increase in inflammatory markers of cardiovascular risk, such as high-sensitivity C-reactive protein [35]. Insufficient sleep can trigger a set of neuroendocrine, metabolic, and behavioral adaptations aiming at increasing food intake and conserving energy [36]. These adaptations allow people to overeat while maintaining sedentary lifestyle and efficient gain of fat [36].Weight gain and changes in appetite may relate to alterations in leptin and ghrelin that result from sleep deprivation induced by shift work [37,38]. Luenda et al. have revealed that the police officers sleeping less than 5 h, ≥ 8 h had higher levels of leptin compared to those sleeping 5–7 h, and that this biochemical change may have implications for obesity-related conditions [39].

Moreover, sleep-wake cycles can be disrupted by shift work schedules between biological rhythms and external demands of police officers' work [40–42]. Rotating shift work seems particularly susceptible to sleep disorders and MetS [11,12]. Another impact of sleep deprivation on human immune system is that it dysregulates monocyte production of pro-inflammatory cytokines, such as interleukin-6 and tumor necrosis factor-α [43,44]. Conversely, obesity involves a low-grade inflammatory state [45] which can induce sleep disturbances [46].

The current study had a unique feature, in that it is the 1st to demonstrate the association between sleep duration divided into 5 groups and individual components scores of the global PSQI, and MetS among Asian police officers. There are several limitations in this study. First, this cross-sectional study cannot elucidate the causality between sleep duration and MetS and its components. Second, police officers suffer from considerable psychological stress as one of the occupational-specific risk factors, but it was not addressed in the current study. Yoo et al. have found that perceived stress was not associated with the MetS in police officers [8]. They believe that this was likely to result from marked variability in the perceived stress among police officers. We adhered to Yoo's argument and did not control for stress in the current study.

Third, sleep duration and sleep quality were assessed by the use of the self-reported questionnaires instead of objective measurements such as actigraphy or polysomnography. However, the global PSQI scores can reflect usual, overall sleeping condition, whereas equipment measurements concentrate only on particular nights. Furthermore, we did not adjust for obstructive sleep apnea, which was one of the causes of poor sleep quality and also a risk factor for MetS [47]. However, we adjusted for snoring in the multivariate regression analysis as an important characteristic of obstructive sleep apnea, and there was still an association between the police officers who slept less than 5 h and abdominal obesity.

CONCLUSIONS

This study showed that the police officers who slept less than 5 h were more likely to experience abdominal obesity. No other association was found between sleep quality and MetS and its components. The police officers with higher scores of sleep disturbances had a higher prevalence of MetS and abdominal obesity. It is recommended that the police officers sleeping less than 5 h or with higher scores of sleep disturbances be screened for waist circumference and MetS. The aim of medical screening is to facilitate early detection and to prevent cardiovascular diseases. Further research is needed to explore the pathophysiology underlying the association of sleep duration or sleep disturbances and MetS in police officers.

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