Original Article

Influence of Work Characteristics on the Association Between Police Stress and Sleep Quality

Claudia C. Ma [1,*], Tara A. Hartley [1], Khachatur Sarkisian [1], Desta Fekedulegn [1],
Anna Mnatsakanova [1], Sherry Owens [1], Ja Kook Gu [1], Cathy Tinney-Zara [1], John M. Violanti [2],
Michael E. Andrew [1]

[1] Biostatistics and Epidemiology Branch, Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Morgantown, WV, USA
[2] Department of Epidemiology and Environmental Health, School of Public Health and Health Professions, University at Buffalo, Buffalo, NY, USA

A B S T R A C T

Background: Police officers' stress perception, frequency of stressful events (stressors), and police work characteristics may contribute to poor sleep quality through different mechanisms.
Methods: We investigated associations of stress severity (measured by stress rating score) and frequency of stressors with sleep quality and examined the influence of police work characteristics including workload, police rank, prior military experience, and shift work on the associations. Participants were 356 police officers (256 men and 100 women) enrolled in the Buffalo Cardio-Metabolic Occupational Police Stress Study from 2004 to 2009. A mean stress rating score and mean frequency of stressors occurring in the past month were computed for each participant from the Spielberger Police Stress Survey data. Sleep quality was assessed using the global score derived from the Pittsburgh Sleep Quality Index survey. Linear associations of the stress rating score and frequency of stressors with sleep quality (Pittsburgh Sleep Quality Index global score) were tested. Age, sex, race/ethnicity, and smoking status were selected as potential confounders.
Results: The stress rating score was positively and independently associated with poor sleep quality ($\beta = 0.17$, $p = 0.002$). Only workload significantly modified this association ($\beta = 0.23$, $p = 0.001$ for high workload group; p-interaction = 0.109). The frequency of stressors was positively and independently associated with poor sleep quality ($\beta = 0.13$, $p = 0.025$). Only police rank significantly modified the association ($\beta = 0.007$, $p = 0.004$ for detectives/other executives; p-interaction = 0.076).
Conclusion: Both police officers' perception of stress severity and the frequency of stressors are associated with poor sleep quality. Stress coping or sleep promotion regimens may be more beneficial among police officers reporting high workloads.
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1. Introduction

Poor sleep is common in North American police officers [1]. Sleep problems have been linked with a variety of physical and mental health outcomes [2–4]. Specifically, the magnitude of association between sleep problems and cardiovascular disease (CVD) has been found to be similar to traditional CVD risk factors [5]. Traumatic event exposure is inherent in policing and has been associated with the development of sleep problems lasting for long periods of time [6]. Mohr et al (2003) [7] found that inadequate

sleep mediated the inverse association between traumatic stress and health functioning in police officers. In addition to traumatic event exposure, officers report experiencing a high number of organizational and administrative stressors, including excessive workloads, work/life imbalance, lack of control over workload, lack of communication, and inadequate support from supervisors and colleagues [8].

Several prior studies have found associations between workplace stress and sleep problems in diverse occupational groups [2], yet few studies have examined these associations in police officers.

* Corresponding author. National Institute for Occupational Safety and Health, 1095 Willowdale Road, MS 4050, Morgantown, WV 26505, USA.
E-mail address: iia4@cdc.gov (C.C. Ma).

We previously reported a significant inverse association between perceived stress and sleep quality [9] and between traumatic police stress and self-reported sleep quality and sleep disturbances [10]. Other work characteristics may modify the association between workplace stress and sleep quality. Akerstedt et al [11] found that hectic work was a significant predictor of both disturbed sleep and fatigue in a large nationally representative sample of Swedish workers; night shift work was a predictor for disturbed sleep. Nurses who work night shift had poorer sleep quality than those working day shift [12].

We have previously reported that more than half of the police officers indicated having poor sleep quality as measured by the Pittsburgh Sleep Quality Index (PSQI) and that 28.7% had scores high enough to suggest a need for clinical sleep treatment [13]. In that same study, we found a significant and inverse association between the Spielberger Police Stress Survey indices and poor sleep quality particularly sleep disturbances. The stress indices are the product of stress rating and the frequency of stressful events (stressors) which were developed by Spielberger et al [14]. Stress severity and the frequency of stressors may influence sleep differently. In the present study, we examined the association of stress severity and frequency of stressors (that are specific to police work) separately with sleep quality. In addition, we tested the influence of work characteristics on the associations of the stress severity and frequency of police work–related stressors with overall sleep quality, furthering the understanding of the association between the Spielberger Police Stress Survey indices and sleep quality and identifying more factors contributing to the sleep disorders in the study population. We previously reported that workload, police rank, prior military experience, and shift work did not significantly modify the association between the level of perceived stress and sleep quality [9], in which stress was not police work specific and was assessed using the Perceived Stress Scale [15]. However, the effect modification by these police work characteristics in the association between police work–related stress and sleep quality is not known to our knowledge.

We tested the following three hypotheses: 1) whether a significant and positive association exists between stress severity and poor sleep quality in police officers; 2) whether a significant and positive association exists between the frequency of police work–related stressful events and poor sleep quality in police officers; and 3) whether these associations are modified by the work characteristics such as workload, police rank, prior military experience, and shift work.

2. Methods

2.1. Study participants

Participants were police officers enrolled in the Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) Study for investigating the associations between workplace stress and subclinical CVD. The data used for the present analysis were from the BCOPS cross-sectional design conducted between June 4, 2004 and October 2, 2009, and were collected at the Center for Health Research, School of Public Health and Health Professions, University at Buffalo, Buffalo, NY. All participants provided informed consent, and the study was approved by the University at Buffalo Institutional Review Board. Inclusion criteria were being a sworn police officer and willingness to participate in the study. Of 710 police officers who worked in the Buffalo, New York Police Department, 65.4% (N = 464) agreed to participate. Retired officers (n = 33) and participants with missing values for police stress and sleep quality data (n = 75) were excluded from the

analysis, resulting in a final sample of 356 officers (256 men and 100 women).

2.2. Assessment of perceived stress severity and frequency of occurrence of stressors

Police stress severity and the frequency of occurrence of stressful events (stressors) were assessed using the Spielberger Police Stress Survey, which is a 60-item questionnaire for assessing specific sources of stressors in police work occurring in the past month [14]. The 60 items cover three dimensions (stress subscales) of police stressors: administrative and organizational pressure (23 items), physical and psychological threat (24 items), and lack of support (13 items). For each item, the officers rated the stressfulness of the event (regardless of the occurrence of the event) on a scale from 0–100 (higher scale indicating a higher level of stress severity) and provided the frequency of occurrence of each event over the past month. For each officer, a mean stress severity score and a mean frequency of event occurrence were computed by summing the rating score or number of occurrences of individual items and dividing the sum by number of items with nonmissing values. The stress severity score and the frequency of occurrence of stressful events were derived for each stress subscale using the same method.

2.3. Assessment of sleep quality

Sleep quality was assessed using the PSQI, a 19-item questionnaire that evaluates various sleep quality–related factors over the previous 1-month period [16]. The PSQI items were grouped into seven components, each assessing different aspect of sleep quality on a four-point Likert scale (range: 0–3): subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. Each component was scored according to the method developed by Buysse et al. A global sleep quality score, a continuous variable, was computed by summing up the seven component scores with a range of 0–21 with higher scores indicating poorer sleep quality. A participant is considered to have poor sleep quality if the global score >5 [16].

2.4. Assessment of covariates and effect modifiers

Demographic characteristics, lifestyle behaviors, and medical history were obtained from officers who were given self- and interviewer-administered questionnaires. Physical activity (PA) index score was derived from the Seven-Day Physical Activity Recall questionnaire used in the Stanford Five-City Project [17]. The questionnaire collects information on three levels of PA intensity (moderate, hard, and very hard) and hours per week spent on three types of PA including occupational-, sports-, and house work–related activities at each intensity level. A total PA index score was computed by summing the products of hours spent on each type of PA multiplied by the intensity level (1 = moderate, 2 = hard, and 3 = very hard).

Police rank, race/ethnicity, years of service, smoking, and marital status were self-reported. Police rank was grouped into three categories for the current analysis: 1) patrol officer; 2) captain/sergeant/lieutenant; and 3) detective/other executive. Officers reported their smoking status as current, former, or never. Military experience was obtained by asking question "Were you ever in the military (yes/no)?" To assess workload in their districts, officers were asked to check one of the following: high workload (very busy, high crime area, and many complaints), moderate workload (moderate complaint rate and average crime), or low workload (not

busy and low crime area). The final workload variable was dichotomized into low/moderate and high workload groups to get a sufficient sample for each category. Shift work data were obtained from the City of Buffalo, NY payroll records, which provided a day-by-day account of shift history for each officer from May 1994 to the date of each officer's examination. Details on shift work derivation can be found in a previous BCOPS Study [18]. Since 1994, a fixed 10-hour-long and nonrotating schedule including 4 days of work, 4 days off work, 4 days of work, and 3 days off work was implemented in the police department. Three types of start time of work were scheduled around the clock and were used to classify the shift for the work done by each officer as day if the work started between 04:00 and 11:59 hours; afternoon if the work started between 12:00 and 19:59 hours; or night if the work started between 20:00 and 03:00 hours. For the present analysis, a dominant shift of day, afternoon, and midnight was assigned to each participant based on his/her largest percentage of hours worked on a specific shift.

2.5. Statistical analysis

Descriptive statistics were used to characterize the study population. Means (standard deviations) were calculated for the selected demographic and lifestyle characteristics and presented by sex. The mean stress rating score and mean frequency of stressors were reported for men and women separately. The Student t test was performed to test for the differences between men and women. Owing to the large scales of the stress rating score and the frequency of stressors and the small scale of the PSQI global score, the stress rating score and the frequency of stressors were standardized (z scores) before entry into the regression models. Unadjusted and multivariable-adjusted mean sleep scores across tertiles of the stress rating score and tertiles of the frequency of stressors were computed for descriptive purposes. Tests for a linear trend of sleep quality score across increasing values of the stress rating score or the frequency of stressors were obtained from linear regression models. Age, sex, race/ethnicity, and smoking status were controlled for in the multivariable-adjusted models because they were associated with stress or sleep quality parameters. Effect modification by workload, police rank, prior military experience, and shift work on the multivariable-adjusted associations was examined. For all tests, the cut point for statistical significance was set at alpha = 0.05, except for the interaction terms between the potential moderators and police stress, which were set at alpha = 0.20 due to the small sample size. All analyses were conducted using the SAS software, version 9.3 (SAS Institute, Cary NC).

3. Results

The demographic and lifestyle characteristics of the 356 study participants are presented in Table 1 separately for men and women. The mean age of the study population was 41.3 (standard deviation = 6.7) years, and there was no age difference between women and men. Most participants were patrol officers (71.9%) and did not have prior military experience (78.6%). A higher percentage of female officers worked the day shift than male officers (68.7% vs. 29.0%). Very few officers were on sleep medications (1.7%), and the average sleep quality score was 6.5 (standard deviation = 3.4) which was slightly higher among female officers than among male officers (7.0 vs. 6.3).

The mean stress rating score and the mean frequency of stressors are presented in Table 2. Compared to male officers, female officers reported a significantly higher rating score for physical/psychological danger (48.9 ± 25.1 vs. 43.3 ± 23.1, p = 0.042) and for lack of support (42.0 ± 23.7 vs. 35.5 ± 22.6, p = 0.016).

However, women and men did not differ significantly in the rating score for total stressors and for administrative/organizational subscale as well as in the frequency of total stressors and the frequency of the three subscale stressors.

3.1. Stress severity with sleep quality

The unadjusted, age-adjusted, and multivariable-adjusted mean sleep quality scores by tertiles of stress rating score and by tertiles of frequency of stressors occurring in the past month are reported in Table 3. The stress rating score for total stressors was positively and linearly associated with poor sleep quality, unadjusted for covariates. The sleep quality score increased 0.18 units (β = 0.18, p < 0.001) with respect to one standard deviation increase in stress rating score for total stressors. This association remained significant when controlling for age, sex, race/ethnicity, and smoking status. Similarly, the positive linear trend of sleep quality score was also evident with a one standard deviation increase in stress rating score for each of the three stress subscales (β = 0.19, p < 0.001 with respect to administrative/organizational pressure; β = 0.14, p = 0.007 to physical/psychological danger; and β = 0.19, p < 0.001 to lack of support). The models adjusted for potential confounders did not change the magnitude of the associations.

3.2. Frequency of stressors with sleep quality

The frequency of occurrence of total stressors occurring in the past month was also positively associated with poor sleep quality. The sleep quality score increased 0.12 units with respect to one standard deviation increase in the frequency of occurrence of total stressors (β = 0.12, p = 0.027). The association remained after controlling for potential confounders. Similar association was evident between the frequency of lack of support and poor sleep quality (β = 0.13, p = 0.011).

3.3. Influence of police work characteristics on the associations of stress severity and frequency of occurrence of stressors with sleep quality

3.3.1. Police work characteristics on the associations between stress severity and sleep quality
Table 4 presents results of effect modification by workload, police rank, military experience, and shift work in the associations of stress rating scores (for total stressors and for each of the three stress subscales) with sleep quality. Among the selected work characteristics, only workload exhibited statistically significant modification effects on the examined associations. It modified the association between stress rating score for total stressors and sleep quality (p-interaction = 0.109), between rating score for administration/organizational pressure and sleep quality (p-interaction = 0.163), and between rating score for physical/psychological threats and sleep quality (p-interaction = 0.088). After controlling for the potential confounders, the stress rating score for the total stressors was linearly and positively associated with poor sleep quality (β = 0.23, p = 0.001) among police officers reporting high workloads. Among the same group of officers, similar association was observed for each of the three stress subscales (β = 0.23, p < 0.001 with respect to administrative/organizational pressure; β = 0.20, P = 0.005 to physical/psychological threats; and β = 0.22, p = 0.001 to lack of support). The significant associations were not observed in those who reported low/medium workloads. We also observed a positive linear association between the stress rating score and poor sleep quality among patrol officers, detectives/other executives, those without

Table 1
Demographic, lifestyle, and police work characteristics of officers stratified by sex (BCOPS Study, 2004–2009)

Characteristics[*,†]	Total (n = 356)		Females (n = 100)		Males (n = 256)	
	n	Mean (SD) or %	n	Mean (SD) or %	n	Mean (SD) or %
Age (yrs)	356	41.3 (6.7)	100	41.1 (5.8)	256	41.4 (7.0)
Alcohol (drinks/week)	352	5.6 (9.4)	98	3.9 (6.3)	254	6.2 (10.2)
Physical activity index[‡]	353	21.4 (17.5)	99	21.5 (17.2)	254	21.3 (17.6)
PSQI global score	356	6.5 (3.4)	100	7.0 (3.7)	256	6.3 (3.2)
Marital status						
Single	43	12.1	23	23.0	20	7.8
Married	263	73.9	58	58.0	205	80.1
Divorced	50	14.0	19	19.0	31	12.1
Education						
High school/General Education Diploma	38	10.7	4	4.0	34	13.3
College <4 yrs	200	56.3	60	60.0	140	54.9
College 4 + yrs	117	33.0	36	36.0	81	31.8
Race						
Caucasian & Hispanics	279	79.5	72	72.0	207	86.3
African American	72	20.5	28	28.0	44	17.5
Smoking status						
Current	61	17.2	26	26.5	35	13.7
Former	82	23.2	29	29.6	53	20.7
Never	211	59.6	43	43.9	168	65.6
Years of police service						
0–9 yrs	96	27.0	34	34.0	62	24.2
10–14 yrs	85	23.8	20	20.0	65	25.4
15–19 yrs	79	22.2	22	22.0	57	22.3
20 + yrs	96	27.0	24	24.0	72	28.1
Workload						
Low/Moderate	224	63.8	50	52.1	174	68.2
High	127	36.2	46	47.9	81	31.8
Police rank						
Patrol officer	253	71.9	78	78.0	175	69.4
Captain/sergeant/lieutenant	56	15.9	13	13.0	43	17.1
Detective/executive	43	12.2	9	9.0	34	13.5
Prior military experience						
No	280	78.6	87	87.0	193	75.4
Yes	76	21.4	13	13.0	63	24.6
Shift work						
Day	142	40.1	68	68.7	74	29.0
Afternoon	127	35.9	18	18.2a	109	42.8
Midnight	85	24.0	13	13.1	72	28.2
Sleep medicine						
No	350	98.3	97	97.0	253	98.8
Yes	6	1.7	3	3.0	3	1.2

[*] For categorical variables, the values are frequency and percentage of participants.
[†] For continuous variables, the values are means (SD).
[‡] Derived from the Seven-Day Physical Activity Recall questionnaire used in the Standard Five-City Project [17]. The questionnaire collects information on three levels of PA intensity (moderate, hard, and very hard) and hours per week spent on three types of physical activity (PA) (occupational, sports related, and house work related) at each intensity level. A total PA index score was computed by summing the products of hours spent on each type of PA multiplied by intensity level (1 = moderate, 2 = hard, and 3 = very hard).
BCOPS, Buffalo Cardio-Metabolic Occupational Police Stress; PSQI, Pittsburgh Sleep Quality Index; SD, standard deviation.

prior military experiences, and those working the day or the night shift. However, the interaction tests involving the stress rating score with police rank, military experience, and shift work did not reach the statistically significant level.

3.3.2. Police work characteristics on the association between frequencies of stressors and sleep quality

Table 5 presents results of effect modification by selected police work characteristics in the associations between frequencies of

Table 2
Spielberger Police Stress Survey components by sex (BCOPS, 2004–2009)

Spielberger Police Stress Survey	Total (n = 356)	Women (n = 100)	Men (n = 256)	p
	Mean (SD)	Mean (SD)	Mean (SD)	
Stress rating				
Total stressors	39.2 (21.1)	42.6 (21.8)	37.9 (20.6)	0.057
Administrative/organizational pressure	34.3 (19.9)	36.2 (20.1)	33.6 (19.8)	0.259
Physical/psychological danger	44.9 (23.8)	48.9 (25.1)	43.3 (23.1)	0.042
Lack of support	37.4 (23.1)	42.0 (23.7)	35.5 (22.6)	0.016
Frequency of stressors occurring in the past month				
Total stressors	96.1 (60.6)	90.8 (61.4)	98.2 (60.3)	0.301
Administrative/organizational pressure	41.6 (29.8)	37.6 (28.5)	43.1 (30.2)	0.117
Physical/psychological danger	37.3 (25.2)	35.4 (25.7)	38.0 (25.0)	0.379
Lack of support	17.3 (13.9)	17.8 (13.9)	17.1 (13.9)	0.659

BCOPS, Buffalo Cardio-Metabolic Occupational Police Stress Study; SD, standard deviation.
Note: P-values were from the Student t test for the difference between men and women.

Table 3
Unadjusted and adjusted mean PSQI global scores by tertiles of Spielberger stress components (BCOPS Study, 2004—2009)

Spielberger Police Stress Survey	n	PSQI global score		
		Unadjusted mean (SD)	Age-adjusted mean (SE)	Multivariable-adjusted* mean (SE)
Stress rating				
Total				
Low	118	6.1 (3.3)	6.1 (0.3)	6.09 (0.32)
Middle	119	6.2 (3.2)	6.3 (0.3)	6.26 (0.31)
High	119	7.2 (3.5)	7.2 (0.3)	7.15 (0.31)
β		0.18 (0.05)	0.18 (0.05)	0.17 (0.05)
P-trend		<0.001	<0.001	0.002
Administrative/organizational pressure				
Low	117	6.0 (3.3)	5.9 (0.3)	5.9 (0.3)
Middle	121	6.2 (3.4)	6.2 (0.3)	6.2 (0.3)
High	118	7.4 (3.2)	7.4 (0.3)	7.4 (0.3)
β		0.19 (0.05)	0.19 (0.05)	0.18 (0.05)
P-trend		<0.001	<0.001	<0.001
Physical/psychological danger				
Low	118	6.1 (3.3)	6.01 (0.3)	6.1 (0.3)
Middle	118	6.3 (3.3)	6.3 (0.3)	6.4 (0.3)
High	120	7.1 (3.5)	7.1 (0.3)	7.1 (0.3)
β		0.14 (0.05)	0.14 (0.05)	0.14 (0.05)
P-trend		0.007	0.006	0.012
Lack of support				
Low	118	6.0 (3.4)	6.0 (0.3)	6.1 (0.3)
Middle	121	6.2 (2.9)	6.2 (0.3)	6.2 (0.3)
High	117	7.3 (3.6)	7.3 (0.3)	7.3 (0.3)
β		0.19 (0.05)	0.19 (0.05)	0.18 (0.05)
P-trend		<0.001	<0.001	<0.001
Frequency of stressors in the past month				
Total				
Low	117	5.8 (3.3)	5.8 (0.3)	5.8 (0.3)
Middle	120	7.1 (3.6)	7.1 (0.3)	7.1 (0.3)
High	119	6.6 (3.1)	6.6 (0.3)	6.6 (0.3)
β		0.12 (0.05)	0.13 (0.05)	0.13 (0.06)
P-trend		0.027	0.018	0.025
Administrative/organizational pressure				
Low	119	5.9 (3.4)	5.9 (0.3)	5.9 (0.3)
Middle	118	7.0 (3.5)	7.0 (0.3)	7.0 (0.3)
High	119	6.6 (3.1)	6.6 (0.3)	6.6 (0.3)
β		0.09 (0.05)	0.10 (0.05)	0.10 (0.06)
P-trend		0.078	0.059	0.071
Physical/psychological danger				
Low	118	6.2 (3.5)	6.1 (0.3)	6.1 (0.3)
Middle	118	6.6 (3.5)	6.6 (0.3)	6.7 (0.3)
High	120	6.7 (3.1)	6.8 (0.3)	6.8 (0.3)
β		0.10 (0.05)	0.11 (0.05)	0.11 (0.06)
P-trend		0.065	0.038	0.049
Lack of support				
Low	121	5.6 (3.0)	5.6 (0.3)	5.7 (0.3)
Middle	116	7.1 (3.5)	7.1 (0.3)	7.1 (0.3)
High	119	6.8 (3.4)	6.8 (0.3)	6.8 (0.3)
β		0.13 (0.05)	0.13 (0.05)	0.12 (0.05)
P-trend		0.011	0.012	0.021

* Adjusted for age, gender, race/ethnicity, and cigarette smoking status.
BCOPS, Buffalo Cardio-Metabolic Occupational Police Stress; PSQI, Pittsburgh Sleep Quality Index; SD, standard deviation; SE, standard error.
Note: β is the increase in the PSQI corresponding to one standard deviation increase in the mean stress rating or the mean frequency of occurrence of stressful events. P-values were from linear regression.

stressors occurring in the past month and sleep quality, controlling for age, sex, race/ethnicity, and smoking status. Workload significantly modified the association between the frequency of occurrence of physical/psychological threats and the sleep quality (p-interaction = 0.111). The frequency of physical/psychological threats was linearly and positively associated with poor sleep quality ($\beta = 0.19$, $p = 0.003$) among the officers who reported high workloads but not among those reporting low/moderate workloads. Police rank significantly modified the associations of the frequencies of total stressors (p-interaction = 0.076), administrative/organizational pressure (p-interaction = 0.124), and physical/psychological threats (p-interaction = 0.063) with poor sleep quality. Among detectives and other executives, after controlling

for the potential confounders, a significant increase in poor sleep quality was observed with respect to one standard deviation increase in the frequency of occurrence of total stressors ($\beta = 0.007$, $p = 0.004$), to administrative/organizational pressure ($\beta = 0.012$, $p = 0.013$), and to physical/psychological threats ($\beta = 0.02$, $p = 0.028$). The significant association was not evident among officers at the other ranks (i.e., patrol officers or captains/sergeants/lieutenants). We did not observe the significant modification effects of military experience and shift work on the associations.

4. Discussion

In the present study, we examined the associations of stress severity and the frequency of the occurrence (in the past month) for total stressors and the three stress subscales from the Spielberger Police Stress Survey questionnaire with sleep quality assessed using the PSQI global score in police officers. We also tested how police work characteristics (workload, police rank, military experience, and shift work) affected the associations.

4.1. The association between perceived stress severity and sleep quality

The results from the present study showed that high levels of perceived stress severity for total stressors and for the three stress subscales (i.e., administrative/organizational pressure, physical/psychological threats, and lack of support) were all significantly associated with poor sleep quality. The associations were independent of age, sex, race/ethnicity, and smoking status. Therefore, the first hypothesis that a high level of stress severity was associated with poor sleep quality was confirmed by the results. The findings were consistent with previous epidemiological studies conducted among various populations. Results from a longitudinal study among civil service workers in London showed that exposure to low organizational justice predicted sleep problems after 10—16 years [19]. Findings from Korean working population [20] suggested that a higher level of perceived administrative/organizational pressure was associated with higher odds of insomnia.

The underlying mechanisms have been proposed by previous researchers. Cognitive appraisal is a well-known model and has been tested in longitudinal studies. According to Everly and Lating [21], psychosocial stressors (either real or imagined events) per se cannot initiate a stress response without the intervening mechanism of cognitive appraisal. Whether or not the environmental stimuli are perceived as stressors varies by the individual. Among police officers, psychosocial stimuli such as administrative and organizational pressure, physical/psychological threats, and lack of support do not exert pathogenic effects directly on police officers, rather through the process of cognitive appraisal, i.e., how police officers interpret the stressors. The process may be influenced by biological predisposition, personality, learning history, and available resources for coping. This model suggests that the inverse association between stress severity and sleep quality in the present study could be mediated by several pathways. Stress coping style and resources available for stress coping for example could be used to attenuate the stress—sleep quality associations at the individual level and the organizational level. In addition to the effect of stress perception on poor sleep quality, it may also contribute to the police officer's overall physical health and well-being [21]. Sarkar and Fletcher [22] concluded that self-regulation of stress responses is one of the five categories that resilience training programs normally include. Other pathways may also link stress perception to sleep quality. Perseverative cognition (PC), i.e., "the repeated or chronic activation of the cognitive representation of one or more

Table 4
Multivariable-adjusted* mean PSQI global scores by tertiles of perceived stress severity stratified by work characteristics (BCOPS Study, 2004–2009)

Spielberger police stress rating	Workload				Police rank					
	Low/Moderate (n = 224)		High (n = 127)		Patrol officer (n = 253)		Captain/sergeant/lieutenant (n = 56)		Detective/executive (n = 43)	
	n	Mean (SE)	n	Mean (SE)	n	Mean (SE)	n	Mean (SE)	n	Mean (SE)
Total										
Low	43	6.8 (0.6)	72	5.8 (0.4)	85	6.1 (0.4)	17	6.9 (0.9)	16	5.8 (1.0)
Middle	38	6.7 (0.6)	80	6.1 (0.4)	90	6.0 (0.3)	13	7.8 (1.0)	15	5.9 (1.0)
High	46	7.3 (0.5)	72	7.0 (0.4)	78	7.2 (0.4)	26	7.0 (0.7)	12	7.7 (1.1)
β		0.05 (0.09)		0.23 (0.07)		0.15 (0.06)		0.17 (0.13)		0.31 (0.15)
P-trend		0.549		0.001		0.017		0.194		0.040
p-interaction	0.109				0.627					
Administrative/organizational pressure										
Low	42	6.6 (0.6)	72	5.7 (0.4)	85	6.1 (0.3)	18	6.7 (0.9)	14	4.8 (1.0)
Middle	43	7.1 (0.6)	77	5.7 (0.4)	88	5.9 (0.3)	12	7.8 (1.0)	18	6.4 (0.9)
High	42	7.1 (0.6)	75	7.5 (0.4)	80	7.3 (0.3)	26	7.2 (0.7)	11	8.1 (1.1)
β		0.08 (0.09)		0.23 (0.07)		0.17 (0.06)		0.14 (0.13)		0.40 (0.16)
P-trend		0.390		<0.001		0.009		0.261		0.013
p-interaction	0.163				0.378					
Physical/psychological danger										
Low	42	6.7 (0.6)	73	5.7 (0.4)	83	6.1 (0.4)	18	7.2 (0.9)	17	5.8 (1.0)
Middle	38	7.0 (0.6)	79	6.1 (0.4)	89	6.3 (0.3)	13	7.3 (1.0)	14	5.8 (1.1)
High	47	7.0 (0.6)	72	7.1 (0.4)	81	7.0 (0.4)	25	7.0 (0.7)	12	7.7 (1.1)
β		0.01 (0.09)		0.20 (0.07)		0.13 (0.07)		0.13 (0.13)		0.23 (0.14)
P-trend		0.913		0.005		0.057		0.294		0.113
p-interaction	0.088				0.807					
Lack of support										
Low	41	6.6 (0.6)	75	5.8 (0.4)	90	5.9 (0.3)	13	7.8 (1.0)	15	6.1 (1.1)
Middle	38	7.2 (0.6)	81	5.8 (0.4)	87	6.4 (0.3)	20	5.8 (0.8)	13	5.2 (1.1)
High	48	7.0 (0.5)	68	7.4 (0.4)	76	7.1 (0.4)	23	7.9 (0.7)	15	7.6 (1.0)
β		0.09 (0.08)		0.22 (0.07)		0.16 (0.06)		0.24 (0.13)		0.28 (0.15)
P-trend		0.305		0.001		0.016		0.072		0.060
p-interaction	0.204				0.683					

	Military experience				Shift work					
	No (n = 280)		Yes (n = 76)		Day (n = 142)		Afternoon (n = 127)		Night (n = 85)	
	n		n		n		n		n	
Total										
Low	84	5.9 (0.4)	34	6.6 (0.6)	45	6.0 (0.6)	32	5.7 (0.6)	39	6.3 (0.5)
Middle	100	6.4 (0.3)	19	5.5 (0.8)	41	6.6 (0.6)	53	6.2 (0.4)	25	6.7 (0.6)
High	96	7.3 (0.3)	23	6.4 (0.7)	56	6.8 (0.5)	42	6.6 (0.5)	21	8.5 (0.7)
β		0.20 (0.06)		0.06 (0.11)		0.20 (0.08)		0.12 (0.09)		0.30 (0.11)
P-trend		0.001		0.613		0.018		0.182		0.010
p-interaction	0.276				0.485					
Administrative/organizational pressure										
Low	85	5.7 (0.4)	32	6.5 (0.6)	45	5.9 (0.6)	35	5.7 (0.5)	35	6.3 (0.5)
Middle	99	6.5 (0.3)	22	5.0 (0.7)	50	6.8 (0.5)	45	5.6 (0.5)	26	6.6 (0.6)
High	96	7.4 (0.3)	22	7.2 (0.8)	47	6.9 (0.5)	47	7.2 (0.4)	24	8.3 (0.6)
β		0.20 (0.06)		0.11 (0.12)		0.17 (0.08)		0.16 (0.08)		0.33 (0.12)
P-trend		<0.001		0.377		0.046		0.054		0.005
p-interaction	0.476				0.458					
Physical/psychological danger										
Low	86	5.9 (0.4)	33	6.6 (0.7)	47	5.9 (0.5)	35	6.1 (0.6)	34	6.21 (0.53)
Middle	96	6.5 (0.4)	22	5.7 (0.8)	39	6.4 (0.6)	50	6.3 (0.5)	29	6.85 (0.57)
High	98	7.3 (0.3)	22	6.4 (0.8)	56	7.1 (0.5)	42	6.3 (0.5)	22	8.20 (0.67)
β		0.17 (0.06)		0.02 (0.11)		0.25 (0.11)		0.05 (0.10)		0.25 (0.11)
P-trend		0.006		0.883		0.031		0.640		0.031
p-interaction	0.242				0.353					
Lack of support										
Low	86	6.1 (0.4)	32	6.0 (0.6)	39	6.3 (0.6)	38	5.6 (0.5)	39	6.17 (0.49)
Middle	101	6.2 (0.3)	20	6.1 (0.8)	46	6.0 (0.5)	47	6.2 (0.5)	28	7.01 (0.58)
High	93	7.4 (0.4)	24	6.7 (0.7)	57	7.1 (0.5)	42	6.8 (0.5)	18	8.55 (0.72)
β		0.21 (0.06)		0.07 (0.11)		0.21 (0.08)		0.15 (0.09)		0.28 (0.11)
P-trend		<0.001		0.571		0.010		0.101		0.015
p-interaction	0.264				0.661					

* Adjusted for age, gender, race/ethnicity, and cigarette smoking status.
BCOPS, Buffalo Cardio-Metabolic Occupational Police Stress; PSQI, Pittsburgh Sleep Quality Index; SE, standard error.
Note: β is the increase in PSQI corresponding to one standard deviation increase in mean stress rating.
P-values were from linear regression models.

psychological stressors" (e.g., worry and rumination), has been hypothesized to mediate the effects of stressors on somatic diseases [23]. This hypothesis has been tested in the association between work-related stress severity and poor sleep in longitudinal studies. Radstaak et al [24] found that PC mediated the positive association between perceived severity score for distressing shifts and the length of sleep onset latency. Van Laethem et al [25] found that PC fully mediated the stress severity and poor sleep relationship.

4.2. Frequency of stressors and sleep quality

The hypothesis that high frequency of stressors is associated with poor sleep quality was supported by our results. We found that the higher frequency of total police stressors was significantly associated with poor sleep quality before and after controlling for potential confounders. Among the three stress subscales, only the frequency of lack of support was found to be significantly and

Table 5
Multivariable-adjusted* mean PSQI global scores by tertiles of Spielberger stress frequency stratified by work characteristics (BCOPS Study, 2004—2009)

Spielberger police stress frequency	Workload				Police rank					
	Low/Moderate (n = 224)		High (n = 127)		Patrol officer (n = 253)		Captain/sergeant/lieutenant (n = 56)		Detective/executive (n = 43)	
	n	Mean (SE)	n	Mean (SE)	n	Mean (SE)	n	Mean (SE)	n	Mean (SE)
Total										
Low	50	5.9 (0.5)	63	5.6 (0.4)	77	6.0 (0.4)	21	6.2 (0.7)	16	4.4 (0.9)
Middle	43	8.4 (0.6)	77	6.5 (0.4)	84	6.7 (0.4)	20	8.2 (0.8)	16	7.7 (0.9)
High	34	6.3 (0.6)	84	6.6 (0.4)	92	6.5 (0.3)	15	7.0 (0.9)	11	7.4 (1.1)
β		0.11 (0.12)		0.17 (0.06)		0.001 (0.001)		−0.0001 (0.003)		0.007 (0.002)
P-trend		0.368		0.007		0.168		0.967		0.004
p-interaction	0.640				0.076					
Administrative/organizational pressure										
Low	50	6.3 (0.6)	67	5.5 (0.4)	83	6.0 (0.4)	20	6.4 (0.8)	13	4.3 (1.0)
Middle	45	7.6 (0.6)	71	6.8 (0.4)	84	6.7 (0.3)	18	8.1 (0.8)	16	7.2 (0.9)
High	32	7.0 (0.7)	86	6.5 (0.3)	86	6.6 (0.3)	18	7.0 (0.8)	14	7.3 (1.0)
β		0.07 (0.11)		0.14 (0.06)		0.002 (0.002)		−0.001 (0.006)		0.012 (0.005)
P-trend		0.547		0.025		0.272		0.836		0.013
p-interaction	0.570				0.124					
Physical/psychological danger										
Low	54	6.8 (0.5)	60	5.4 (0.4)	68	6.0 (0.4)	23	6.8 (0.7)	24	5.7 (0.8)
Middle	48	7.4 (0.6)	70	6.2 (0.4)	85	6.5 (0.3)	19	7.8 (0.8)	14	6.6 (1.1)
High	25	6.4 (0.8)	94	6.9 (0.3)	100	6.6 (0.3)	14	6.8 (0.9)	5	8.8 (1.8)
β		−0.02 (0.12)		0.19 (0.07)		0.003 (0.003)		−0.001 (0.006)		0.02 (0.01)
P-trend		0.897		0.003		0.189		0.912		0.028
p-interaction	0.111				0.063					
Lack of support										
Low	49	5.7 (0.5)	70	5.5 (0.4)	88	5.6 (0.3)	16	6.4 (0.9)	16	5.4 (1.0)
Middle	44	7.9 (0.6)	70	6.9 (0.4)	77	7.3 (0.4)	25	7.0 (0.7)	12	5.9 (1.2)
High	34	7.6 (0.6)	84	6.5 (0.3)	88	6.5 (0.3)	15	8.2 (0.9)	15	7.7 (1.0)
B		0.25 (0.10)		0.11 (0.06)		0.01 (0.005)		0.005 (0.01)		0.02 (0.01)
P-trend		0.017		0.091		0.204		0.670		0.015
p-interaction	0.245				0.316					

Spielberger police stress frequency	Military experience				Shift work					
	No (n = 280)		Yes (n = 76)		Day (n = 142)		Afternoon (n = 127)		Night (n = 85)	
Total										
Low	80	5.7 (0.4)	37	5.9 (0.6)	63	5.9 (0.5)	26	5.1 (0.6)	26	6.2 (0.6)
Middle	97	7.1 (0.3)	23	7.6 (0.7)	47	7.3 (0.5)	46	6.8 (0.5)	27	7.2 (0.6)
High	103	6.8 (0.3)	16	5.2 (0.9)	32	6.7 (0.6)	55	6.2 (0.4)	32	7.4 (0.6)
β		0.13 (0.06)		0.09 (0.15)		0.003 (0.002)		0.002 (0.001)		0.001 (0.002)
P-trend		0.033		0.540		0.114		0.145		0.380
p-interaction	0.815				0.845					
Administrative/organizational pressure										
Low	86	5.9 (0.4)	33	5.9 (0.6)	63	6.1 (0.5)	24	4.8 (0.6)	31	6.4 (0.6)
Middle	91	7.0 (0.4)	27	7.2 (0.7)	47	7.0 (0.5)	48	6.8 (0.4)	22	7.0 (0.7)
High	103	6.7 (0.3)	16	5.5 (0.9)	32	6.6 (0.7)	55	6.3 (0.4)	32	7.4 (0.6)
β		0.09 (0.06)		0.13 (0.15)		0.005 (0.004)		0.004 (0.003)		0.002 (0.003)
P-trend		0.119		0.384		0.198		0.205		0.560
p-interaction	0.476				0.827					
Physical/psychological danger										
Low	82	5.9 (0.4)	36	6.4 (0.6)	72	6.2 (0.4)	26	5.4 (0.6)	18	6.6 (0.8)
Middle	92	6.9 (0.4)	26	6.1 (0.7)	43	6.5 (0.5)	45	6.7 (0.5)	30	6.9 (0.6)
High	106	6.8 (0.3)	14	6.1 (1.0)	27	7.2 (0.7)	56	6.2 (0.4)	37	7.2 (0.5)
β		0.12 (0.06)		0.05 (0.16)		0.005 (0.004)		0.003 (0.004)		0.004 (0.004)
P-trend		0.054		0.737		0.232		0.373		0.270
p-interaction	0.242				0.944					
Lack of support										
Low	86	5.6 (0.4)	35	5.7 (0.6)	51	5.5 (0.5)	32	4.8 (0.6)	37	6.2 (0.5)
Middle	92	7.0 (0.4)	24	7.5 (0.70)	51	7.2 (0.5)	42	7.0 (0.5)	22	7.9 (0.7)
High	102	7.0 (0.3)	17	5.7 (0.9)	40	6.9 (0.6)	53	6.4 (0.4)	26	7.2 (0.6)
B		0.15 (0.06)		0.02 (0.12)		0.012 (0.007)		0.011 (0.006)		0.005 (0.009)
P-trend		0.014		0.884		0.087		0.060		0.549
p-interaction	0.264				0.817					

* Adjusted for age, gender, race/ethnicity, and cigarette smoking status.
BCOPS, Buffalo Cardio-Metabolic Occupational Police Stress; PSQI, Pittsburgh Sleep Quality Index; SE = standard error.
Note: β is the increase in PSQI corresponding to one standard deviation increase in the mean frequency of occurrence of stressful events.
p-values were from linear regression.

independently associated with poor sleep quality. In general, our results are consistent with those of the recently published studies using national survey data. Van Laethem et al [26] found that high exposure to job demands was associated with poor sleep in Swedish workers. Johannessen and Sterud [27] found that a higher level of social support was associated with lower risk of sleep problems among male workers. Kim et al [28] have reported that job-related stressors such as high job demand and lack of reward

were associated with sleep disorders. Chazelle et al found that a higher level of exposure to psychological demands independently predicted increased risk of sleep disorders among French workers [29].

A potential mechanism linking high frequency of stressors to poor sleep quality has been suggested in a recent study [26], in which Van Laethem et al found that a higher frequency of job demands was longitudinally associated with work-related PC, and PC

was related to sleep disturbances and awakening problems after 2 years. The results indicate that mental representation of stressors may cause prolonged physiological activation and consequently affect sleep quality. According to the stressor–PC–poor sleep model, mindfulness may be effective for sleep promotion [30] in police officers.

4.3. Effect modification by workload, police rank, military experience, and shift work in the associations of stress severity and frequency of stressors with sleep quality

4.3.1. Effect modification by workload, police rank, military experience, and shift work in the associations between stress severity and sleep quality

The hypothesis that the association between stress severity and poor sleep quality would be modified by workload, police rank, prior military experience, and shift work was partially supported by our results. Workload significantly modified the association between stress severity and poor sleep quality. The linear increase in poor sleep quality with respect to the higher level of perceived stress severity rating score was significant only among participants reporting high workloads. The similar pattern was also observed between two stress subscales (i.e., administrative/organizational pressure and physical/psychological threats) and sleep quality. Our results are consistent with those of the previous studies. Hectic work has been associated with 39% higher odds of having sleep disturbances in the Swedish general population [11]. Another study among Dutch pilots reported that high workload was associated with self-reported poor sleep [24]. The combination of a high level of work stress with high workloads could worsen police officers' poor sleep. Police officers reporting high workload (those working in the areas with high crime rate) may benefit from sleep promotion or stress reduction programs. In addition, reducing workload such as increasing manpower may be considered in stress reduction and sleep promotion regimens.

Although we also observed significant positive associations of perceived stress severity for total stressors with poor sleep quality only among patrol officers, detectives/other executives, those without military experiences, and those working day or night shift, we hesitate to draw a conclusion that police rank, prior military experience, and shift work significantly modify the association between stress severity and sleep quality. The nonsignificant modification effect of shift work in the present study is consistent with the findings from a previous study in nurses that job stress severity is associated with poor sleep quality regardless of shift work [12]. Future epidemiological studies are warranted to investigate the role of police rank, military experience, and shift work in the association between stress severity and poor sleep quality with larger samples of police officers.

4.3.2. Effect modification by workload, police rank, military experience, and shift work in the association between frequency of stressors and sleep quality

The hypothesis that the association between frequency of stressors and poor sleep quality is stronger in the police officers reporting high workloads, holding higher police rank, not having prior military experience, and working the night shift is partially supported by our results. Workload significantly modified the association between frequency of physical/psychological threats and poor sleep quality.

Police rank was a significant effect modifier in the association of the frequency of total stressors, administrative/organizational pressure, and physical/psychological threats with poor sleep quality. Although the associations were statistically significant, the increase of poor sleep quality resulted from one standard deviation

increase of the frequency of total stressors, and the two subscale stressors were small. These results need to be confirmed in future epidemiological studies with a larger sample size.

4.4. Gender differences in the association between stress and sleep quality

Our exploratory analyses showed that male and female officers did not differ significantly in sleep quality (data not shown). Female officers perceived physical/psychological threats and lack of support more severe than their male counterparts did, but male and female officers were exposed to similar amount of stressors. Sex did not significantly modify any stress–sleep association. Our results are inconsistent with previous study findings. Among general working population in Norway, Johannessen and Sterud [27] analyzed the association between work-related psychological stressors and sleep disorder separately for men and women and found that men had more work-related stressors than women which predicted the risk of sleep disorder. Another study reported similar results among Korean working population [28]. The results from general working population may not be applicable to police officers. More studies in law enforcement are warranted to examine whether or not there is sex-specific stress–sleep association.

4.5. Limitations and strengths

The present study contributes to the literature in several ways. First, stress severity and the frequency of stressors were obtained using the Spielberger Police Stress Survey questionnaire, a validated questionnaire that captures a spectrum of police-specific stressors. Therefore, our findings may be more relevant to police communities. Second, to our knowledge, the present study was the first to investigate the joint effects of selected police work characteristics and police stress on sleep quality. Third, sleep quality was assessed using the PSQI, a validated questionnaire that has been used in various studies for poor sleep screening. Fourth, the stress severity and the frequency of stressors were investigated separately with poor sleep quality. The results show that both changing police officers' perception toward stressors and reducing the frequency of stressors, such as administrative/organizational pressure and lack of support, may promote sleep quality. Finally, shift work data were obtained from payroll records rather than from self-reported data, which may likely reduce measurement errors.

Several limitations of the present study need to be considered when interpreting our results. First, the cross-sectional study design precluded inferring any causal effects of police stress on sleep quality. Longitudinal analysis is warranted when the BCOPS Study follow-up data are available. Second, the relatively small sample size of officers who had prior military experience, held higher rank, and worked the night shift might reduce the statistical power to detect true modification effects. Third, self-reported sleep quality and stressful events might introduce recall bias. However, the stressful events were limited to the occurrence in the past month to minimize recall bias. Future studies using biological markers of stress such as cortisol and objectively measured sleep measurements are warranted.

In summary, results from the present study showed that a higher level of perceived stress severity is associated with poor sleep quality after controlling for age, sex, race/ethnicity, and smoking status. Only workload significantly modified the association between stress severity and poor sleep quality. In addition, the exposure to higher frequency of stressors was also positively and independently associated with poor sleep quality. Only police rank significantly modified the association. Police officers reporting high

workloads and holding high police rank would benefit from stress coping or sleep promotion regimens.

Conflicts of interest

All authors have no conflicts of interest to declare.

Acknowledgments

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.shaw.2018.07.004.

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