HHS Public Access

Author manuscript

J Occup Environ Med. Author manuscript; available in PMC 2017 March 01.

Published in final edited form as:

J Occup Environ Med. 2016 March ; 58(3): e66–e71. doi:10.1097/JOM.0000000000000620.

Shift Work and Sleep Quality Among Urban Police Officers:

The BCOPS Study

Dr. Desta Fekedulegn, PhD, **Dr. Cecil M. Burchfiel, PhD**, **Dr. Luenda E. Charles, PhD**, **Dr. Tara A. Hartley, PhD**, **Dr. Michael E. Andrew, PhD**, and **Dr. John M. Violanti, PhD**

Biostatistics and Epidemiology Branch (Dr Fekedulegn, Dr Burchfiel, Dr Charles, Dr Hartley, Dr Andrew), Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Morgantown, West Virginia; Department of Epidemiology and Environmental Health (Dr Violanti), School of Public Health and Health Professions, The State University of New York at Buffalo

Abstract

Objective—The aim of the study was to examine association of shift work with sleep quality in police officers.

Methods—Data were obtained from the Buffalo Cardio-Metabolic Occupational Police Stress study (n =363). An electronic work history database was used to define shift as day, afternoon, or night for three durations: past month, 1 year, and 15 years. Sleep quality was determined using the Pittsburgh Sleep Quality Index.

Results—The overall prevalence of poor sleep quality was 54%; 44% for day, 60% for afternoon, and 69% for night shift. Poor sleep quality was 70% more prevalent among night-shift officers (P <0.001) and 49% higher among those on the afternoon shift (P =0.003) relative to officers working on the day shift.

Conclusions—Night and evening work schedules are associated with elevated prevalence of poor sleep quality among police officers.

Shift work has increasingly become an integral part of a wide range of occupations especially among first responders (eg, police, firefighters, and emergency services) where there is an obvious need for a 24-hour service. There is growing evidence that links shift work to numerous adverse health outcomes including risk factors for cardiovascular disease,[1–4] metabolic syndrome,[5,6] diabetes,[7] specific types of cancer,[8,9] fatigue,[10] on-duty injury,[11] and autoimmune hypothyroidism.[12] Therefore, shift work, particularly night or rotating shift, has long been considered a significant occupational exposure. The association of shift work with poor sleep quality is also well documented in the literature. Working on night shifts has been associated with insomnia,[13–15] shorter sleep duration,[16–18] day time sleepiness,[14,19] and overall poor sleep quality[16,20–24]; however, there are limited

Address correspondence to: Desta Fekedulegn, PhD, National Institute for Occupational Safety and Health, HELD/BEB, MS L-4050, 1095 Willowdale Rd, Morgantown, WV 26505-2888 (djf7@cdc.gov).

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health. The authors alone are responsible for the content and writing of the paper.

The authors report no conflicts of interest.

epidemiologic studies that estimated prevalence of poor sleep quality and examined its association with shift work among law enforcement officers, especially studies where shift work was objectively assessed for longer durations.

Assessment of the extent of poor sleep quality among law enforcement officers, who work for long hours under high-risk and uncontrolled environments, engage in extended driving, and often need to make on-the-spot decisions in complex and ambiguous situations, is particularly important. This is because poor sleep quality and fatigue in police officers elevates the risk of fatal and non-fatal injuries to both the officers and the general public,[20,25,26] in addition to being a risk factor for numerous chronic health conditions.[27] Results from prior studies of shift work and sleep quality among law enforcement officers are conflicting; some reported a significant and negative impact of shift work on overall sleep quality or component(s) of sleep quality,[28–31] whereas others[32–36] were either inconclusive or did not find significant differences in poor sleep quality between shift working versus day time officers. Most of the previous studies have shortcomings including assessment of shift work through self-reports, small sample sizes, limited details on prevalence estimates of poor sleep quality and the associated confidence limits, and frequently the duration of shift-work exposure that the study participants experienced was unspecified. This investigation, therefore, examines the association between shift work and sleep quality among police officers, using long-term daily electronic work history records from which work schedules (shifts worked) for the past month, 1 year, and 15 years were objectively ascertained. We present prevalence estimates by work schedule and hypothesize, consistent with evidence in other populations, that officers working predominantly on night or afternoon shifts had higher prevalence of poor sleep quality compared with day-shift workers after accounting for differences in demographic and lifestyle variables.

METHODS

Study Population

Participants were officers enrolled in the Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) study. The BCOPS study was a cross-sectional study aimed at investigating the associations of occupational stressors with the psychological and physiological health of police officers. A total of 710 police officers who worked with the Buffalo, New York Police Department were invited to participate in the BCOPS study; 464 (65.4%) officers agreed to participate and were examined during the period of June 4, 2004, to October 2, 2009. Details of the BCOPS study including recruitment, data collection, and variables assessed are described elsewhere.[37,38] A written informed consent was collected from each participant. The study was approved by the internal review boards of the State University of New York at Buffalo, and the National Institute for Occupational Safety and Health (NIOSH).

Measures and Study Design

Data for the current analyses originated from two sources. The BCOPS study provided data on demographic, lifestyle, physical, occupational, and psychosocial characteristics of the study participants. The outcome (sleep quality: good/poor) was determined using the Pittsburgh Sleep Quality Index (PSQI) questionnaire administered as part of the BCOPS

study protocol. The Buffalo, New York police payroll department provided day-by-day work history records of the participants for the past 15 years (1994 to date of the BCOPS study examination). These work history data were used to derive the exposure variable (shift work) with three categories (day, afternoon, and night).

Shift Work

The work history records were available in an electronic format and contained a day-by-day account of activities, for each officer, including the start time of work, the type of activity (eg, regular work, overtime work), the type of leave (eg, sick, injury, or vacation), and the number of hours worked during each shift for the past 15 years. The work history records were available for the time period spanning from May 31, 1994, to October 2, 2009. Examination of the distribution of work start times for the regularly scheduled work activity showed that nearly all officers (99%) started their work at one of the following times: 07:00, 08:00, 16:00, 20:00, or 21:00 hours, consistent with standard shift start times. The start times of work were then used to classify the shift for a given day into one of the following three categories: day shift (start times between 04:00 and 11:00 hour); afternoon shift (between 12:00 and 19:00 hour); and night shift (between 20:00 and 03:00 hour). Although officers were scheduled on permanent non-rotating shifts since 1994, they occasionally worked on shifts other than their permanent shift to cover for other officers who may have been on leave (sick, injury leave, or vacation) or to earn additional income by working on their day off. To account for this, we derived a new variable (the dominant shift) that represents the shift during which a participant spent the majority of his/her work hours. The dominant shift was derived for three different time periods: (1) past month, (2) past year, and (3) past 15 years. For example, for an officer who was examined on October 2, 2009, the 1 month period consists of work history records from September 2 to October 2, 2009, the past year period consists of work history records from October 2, 2008, to October 2, 2009, and the 15 year period consists of data from May 31, 1994, to October 2, 2009. To define the dominant shift for a particular time period, the total hours worked by each participant during that time period was partitioned into hours worked on the day, afternoon, and night shift. Then a dominant shift for each subject was defined as the shift that had the largest percentage of the total hours worked. For example, an officer who worked 10% on day, 80% on the afternoon, and 10% on night shift is classified as an afternoon-shift worker (the dominant shift).

Sleep Quality

Sleep quality was estimated using the PSQI, one of the most widely used self-report questionnaires designed to assess sleep quality during the past month.[39] The PSQI consists of 19 items and a five-item rating made by a bed partner that is not included in scoring. Respondents indicate the amount of sleep they obtained and rate the extent to which various factors interfered with their sleep on a four-point Likert-type scale. The 19 items were then grouped into seven components or subscales. These were subjective sleep quality (0 =very good, 1 = fairly good, 2 =fairly bad, 3 =very bad), sleep efficiency (0 = at least 85%, 1 =75% to 85%, 2 =65% to 75%, 3 = less than 65%), sleep latency (0 =less than 15 minutes, 1 =15 to 30 minutes, 2 = 30 to 60 minutes, 3 = more than 60 minutes), sleep duration (0 =more than 7 hours, 1 =6 to 7 hours, 2 = 5 to 6 hours, 3 =less than 5 hours), sleep disturbance, sleep medication use, and daytime dysfunction due to sleepiness where the last three were rated

as: 0 =not during the past month, 1 =less than once a week, 2 = once or twice a week, and 3 =three or more times a week. The subscales yield a score from 0 to 3 and were summed to obtain a total score (global PSQI score) ranging from 0 to 21, with higher total scores indicating poorer sleep quality. A participant is considered to have poor sleep quality if the global PSQI score was more than 5.[39]

Assessment of Covariates

Questionnaires were administered to collect demographic and lifestyle characteristics including age, gender, race/ethnicity, years of police service, rank, years of education, marital status, smoking, workload, alcohol consumption, and physical activity. Height and weight were measured with shoes removed and recorded to the nearest half centimeter and rounded up to the nearest quarter of a pound, respectively. Height and weight were converted to meters and kilograms, respectively. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Hours of physical activity were assessed using the Seven-Day Physical Activity Recall questionnaire developed in the Stanford Five-City Project.[40] Workload was assessed by asking the officers the question “What is the work activity level at your district?” to which they responded by selecting one of the following: high work load (very busy with frequent complaints, high crime area); moderate work load (moderate complaint rate, average crime); or low work load (precinct not busy, low crime area).

Statistical Analysis

Sleep quality (good/poor) assessed using PSQI served as the binary outcome variable. PSQI estimates the quality of sleep during the 1-month period prior to date of examination. To match the assessment period of the outcome with that of the exposure variable (for cross-sectional analyses), shift work derived using work history records during the 1-month prior to date of examination was considered as the main exposure variable of interest. Shift work based on work history records from the past 1 year or the past 15 years were treated as secondary exposure variables. Of the 464 BCOPS study participants, 363 (260 men and 103 women) who had non-missing data on both the primary exposure and outcome were used for the current analyses. Initial analyses included descriptive results to characterize the study sample and examined the association of demographic and lifestyle characteristics with the exposure of interest (shift work) and the outcome variable (sleep quality) using chi-square tests and analysis of variance.

The association between shift work and poor sleep quality (assessed using all seven components of PSQI) was examined using Poisson regression with a robust error variance.[41,42] Prevalence ratios (PRs) and their 95% confidence intervals (CIs) were then computed as measures of association. Similar analyses were also conducted to examine the association between shift work and prevalence of self-rated fairly bad or very bad sleep quality in the past month that represents the first component of PSQI (subjective sleep quality). Recall that the first component of sleep quality (ie, subjective sleep quality) was assessed by asking the participants to rate their overall sleep quality during the past month as very good, fairly good, fairly bad, or very bad. The unadjusted, age- and multivariate-adjusted PRs were estimated. The multivariate model adjusted for the following covariates:

age, gender, race/ethnicity, rank, workload, BMI, and alcohol consumption. A characteristic was considered to be a potential confounder (covariate) for adjustment in the multivariate model based on prior evidence from the literature and whether it was associated with either the exposure or outcome in the current analyses. The demographic and lifestyle factors were first tested for potential effect modification by including their interaction terms in a multivariable model. For all tests, statistical significance was assessed at the 5% level. All analyses were conducted using the SAS system, version 9.3.

RESULTS

Demographic and Lifestyle Characteristics

The demographic and lifestyle characteristics of the sample (n =363) and their association with shift work are presented in Table 1. The study population consists of 72% men and the majority was white (77%), married (72%), overweight or obese (81%, BMI at least 25), and had a rank of patrol officer (72%). The mean age was 41.2 years (range: 27 to 66). Nearly half (49.6%) worked dominantly on the day shift, whereas 28% and 22% of the officers worked on afternoon and night shifts, respectively. Participants on the day shift were significantly older with longer years of service, and had a higher percentage of women (43%) and Blacks/Hispanics (33%) compared with the afternoon- and night-shift groups (Table 1). Night-shift workers were composed of a higher proportion of patrol officers (83%) and reported greater prevalence of high workload (75%) relative to day-shift officers. Officers on the afternoon shift had a higher BMI compared with those on day shift. Comparison of the study sample (n =363) and those excluded from the study (n =101) showed that the subjects excluded were older with longer years of service and were composed of significantly lower proportions of women, Blacks/Hispanics, and patrol officers but a significantly higher proportion of former smokers compared with the analysis sample (data not shown).

Shift Work and Poor Sleep Quality (PSQI Score More Than 5)

The prevalence of poor sleep quality (PSQI score >5) in the study sample was 53.9% (95% CI: 49.1, 59.4). For officers working dominantly on the day shift during the past month, the prevalence of poor sleep quality was 43.9% (95% CI: 37.2 to 51.8), 59.8% (51.0 to 70.1) for those on afternoon shift, and 69.1% (59.8 to 80.0) for night-shift officers (Table 2). There was a significant association between shift work in the past month and prevalence of poor sleep quality (Table 2). After adjusting for age, gender, race/ethnicity, rank, workload, BMI, and alcohol consumption, the prevalence of poor sleep quality was 72% higher (PR =1.72, 95% CI: 1.35, 2.20) among night-shift officers relative to those working on the day shift. Officers working on the afternoon shift had 49% (PR =1.49, 1.15, 1.93) higher prevalence of poor sleep quality compared with those on day shift; however, there was no statistically significant differences in prevalence of poor sleep quality between night and afternoon-shift officers (PR =1.16, 95% CI: 0.92 to 1.45). None of the demographic and lifestyle variables showed significant interaction with shift work (interaction P value >0.05).

The shift-work variables assessed based on data during the prior 1-year and the past 15 years also showed significant associations with sleep quality (Table 2). After adjusting for

demographic and lifestyle factors, poor sleep quality was 47% more prevalent among officers who worked on afternoon shift during the past year (PR =1.47, 95% CI: 1.13 to 1.92) and 61% more prevalent for those working the night shift during the past year (PR =1.61, 95% CI: 1.25 to 2.08) compared with day-shift officers. The night and afternoon-shift officers, however, did not differ significantly in prevalence of poor sleep quality (PR =1.09, 95% CI: 0.87 to 1.38). Similarly, there was a significant association between shift work during the past 15 years and sleep quality (Table 2). The prevalence among night-shift officers was 60% (PR =1.60, 95% CI: 1.21 to 2.11) higher, whereas those on afternoon shift had a 38% (PR =1.38, 95% CI: 1.05 to 1.81) higher prevalence compared with day-shift workers. The night versus afternoon comparison was not significant (PR =1.16, 95% CI: 0.93 to 1.45).

Shift Work and Self-Rated Fairly Bad or Very Bad Sleep Quality

The prevalence of self-rated fairly bad or very bad sleep quality in the study sample was 40.2% (95% CI: 35.5, 45.6). The prevalence did not differ significantly across dominant shift in the past month except for the night versus day comparison (Table 3); 36.7% for day shift, 41.2% for afternoon, and 46.9% for night-shift officers. For officers working the night shift during the past month, the prevalence of self-rated fairly bad or very bad sleep quality was 44% higher compared with those working on the day shift (PR =1.44, 95% CI: 1.04 to 2.00) after adjusting for covariates. Differences in prevalence across shift were also not statistically significant when using shift-work data from the past year and past 15 years (except for the night vs day comparison). When shift-work data from the past 15 years were considered, the prevalence was 57% higher among night-shift officers compared with those who predominantly worked on day shift (PR =1.57, 95% CI: 1.11 to 2.22).

DISCUSSION

In the current study, we estimated the prevalence of poor sleep quality and its association with work schedule (shift work) in a mid-sized urban population of police officers. The overall prevalence of poor sleep quality was 54%; 44% for day shift, 60% for afternoon shift, and 69% for those working the night shift. After multivariable adjustment, the prevalence of poor sleep quality was 70% higher among officers working the night shift and 49% higher among those on the afternoon shift compared with officers on day shift. Results on associations between shift work and sleep quality were generally consistent for all three time periods (prior month, 1 year, and 15 years) used to define shift work but the associations were generally less strong when self-rated fairly bad or very bad sleep quality was used as an indicator of quality of sleep compared with overall sleep quality (PSQI global score >5).

Previous studies on police officers have reported significantly poorer overall sleep quality or component of sleep quality in shift-working officers compared with those on the day shift. In a study of Chinese policemen,[31] officers involved in shift work had significantly higher sleep quality scores compared with those on day shift. In our study, we also observed significantly higher global sleep quality scores among shift workers (covariate adjusted means ± SE were as follows: day—5.91 ± 0.27, afternoon—6.64 ± 0.35, and night—7.55

± 0.38, P =0.003). A survey that compared shift-working officers with those on the day shift indicated that symptoms of insomnia and insufficient sleep are more frequent among shift workers.[43] In a study of Italian officers,[34] the prevalence of sleep disorders was 35.7% among shift workers compared with 26.3% in non–shift workers. Another study of Italian officers reported a significant association between night-shift work and excessive daytime sleepiness.[28] Studies based on US and Canadian police officers also reported similar findings. In a cross-sectional study of male officers from Iowa,[32] the age-adjusted prevalence of sleeping less than 6 hours per day was 14 times larger (PR =14.3, 95% CI: 1.98 to 102, P <0.001, n = 85) among officers on non–day shifts compared with officers on the day shift but the estimate has low precision as evidenced by the wide CI. In our study, sleeping less than 6 hours was 55% more prevalent in afternoon- and night-shift officers combined compared with those on day shifts (PR =1.55, CI: 1.16 to 2.08, P =0.003). The large difference in the magnitude of the prevalence ratios (PRs) between the current study and that reported by Ramey et al[32] is likely due to the difference in sample size between the two studies (n =85 vs 363). A previous baseline study of Buffalo police officers (n =111) showed that, after multivariate adjustment, prevalence of snoring was 16% larger, whereas prevalence of sleeping less than 7 hours per night was 44% higher among night-shift officers compared with those on day and afternoon shifts combined.[44] A study that compared subjective sleepiness, vigilance, and driving performance of officers under two conditions (after working 5 consecutive nights vs after 3 consecutive days off duty) reported higher subjective sleepiness and degraded simulated driving performance and psychomotor vigilance following 5 consecutive night shifts compared with 3 consecutive days off duty.[29] An intervention study that compared sleep and subjective alertness of officers before and after a series of 7 consecutive night shifts showed that daytime sleep duration and quality as well as sleep onset latency were significantly reduced in shift-working police officers who are not adapted to shift work.[29] The findings from our study are consistent with results reported by these previous studies. Although generally meaningful comparisons can be made across studies, results may not always be directly comparable due to differences in measures for assessment of sleep quality and/or shift work, sample size, and study design.

Other studies were either inconclusive or did not find significant differences in sleep quality between shift-working officers and those on day shifts. In the study of Iowa police officers, differences in the prevalence of overall poor sleep quality (day shift =15%, non–day shift =29%, P =0.137) and mean global sleep quality score (day =5.8 ±3.0, non–day =6.1 ±2.6, P = 0.629) were not statistically significant.[32] This is in contrast to findings from the current study in which both the prevalence of poor sleep quality and mean global sleep quality score were significantly higher in shift-working officers. In addition, the prevalence estimates for poor sleep quality in their study are noticeably smaller compared with our estimates regardless of shift. Difference in results could be likely a result of variation in sample size, gender composition, and assessment of shift work between the two studies. In a study of police officers from New York and California, the prevalence of poor sleep quality did not differ significantly between officers on variable shift (64.1%) and stable day shift (63.7%)[33]; however, the magnitude of the prevalence estimates they reported is consistent with our estimates. Daytime sleepiness assessed using the Epworth Sleepiness Scale did not differ between shift-working and non–shift-working officers.[34] A polysomnography-based study

of shift-working officers and age-matched controls showed that during night sleep, breathing parameters including total sleep time and arousal index did not differ between the two groups.[35] Another polysomnography-based study indicated that night-shift work did not increase obstructive sleep apnea in officers.[36]

It is important to note that the magnitude of prevalence estimates as well as the statistical significance of the association between shift work and sleep quality could depend on a number of parameters including the location and cultural background, methods used for assessment of shift work and sleep quality, sample size, shift schedules compared, gender composition, potential confounders considered, and the study design. Some of the variability in results across studies could be attributable to these differences. The choice of the indicator of quality of sleep (overall sleep quality vs self-rated fairly bad or very bad sleep quality) appeared to have an impact on the magnitude of the prevalence estimate in our analysis. More importantly, the significantly lower prevalence of self-rated fairly bad or very bad sleep quality relative to overall poor sleep quality among shift workers may suggest that shift workers may not be aware of the existence of other components within the PSQI, and therefore assessment of quality of sleep using a single-item questionnaire may underestimate the prevalence in shift workers.

Poor sleep quality is a serious public health concern in United States.[45] The prevalence is higher among officers relative to the general population. A study by Neylan et al[33] estimated a prevalence of 64% in US police officers compared with 45% prevalence among those not involved in emergency services. In a study of officers from US and Canada, 40% had at least one sleep disorder, 34% had obstructive sleep apnea, 29% reported excessive sleepiness, and 26% reported falling asleep while driving at least once in a month.[26] Studies show that poor sleep quality is linked to numerous chronic health conditions[27] and also elevates the risk to both fatal and non-fatal injuries.[11,20,25,26] These adverse influences of poor sleep can be exacerbated among policing where the occupation consists of known inherent stressors and elevated prevalence of traditional risk factors for CVD.[46]

Poor sleep quality may be caused by a broad range of occupational factors of which shift work, extended work hours, and stress may play an important role. Although the exact biological mechanism is not entirely understood, it is commonly hypothesized that shift work is linked to poor sleep quality via disruption of the circadian rhythms related to exposure to light and other biological rhythms.[47] In addition, behavioral risk factors are also believed to be another mechanism through which shift work is linked to poor sleep quality; although in our study, BMI was the only lifestyle factor that differed across shift, whereas smoking and physical activity levels did not.

The current study has several strengths including the use of objective daily work history records that spanned multiple years from which shift work was ascertained, a relatively large population-based sample, and the collection of sleep-quality data following a standardized protocol. In addition, a large number of covariates were collected as part of the BCOPS Study, allowing us to adjust for multiple potential confounders. Despite these strengths, the findings from this study still need to be interpreted in the context of potential limitations. The study is based on urban police officers from the eastern United States, and therefore

may have limited generalizability to all officers in the Unites States. From a methodological viewpoint, the association of sleep quality with shift work in the past month (rather than shift work in the past year or past 15 years) yields a cross-sectional design because both were assessed for the same time span (past month). The cross-sectional study design limits casual inference.

In conclusion, in the current population-based study of police officers, poor sleep quality was more prevalent among officers who were engaged in shift work. The findings are consistent with prior evidence that night shift carried the greatest risk of poor sleep quality because night-shift officers have to make some adaptations that compensate for their natural circadian patterns. This study adds to the body of knowledge regarding the prevalence of poor sleep quality and the association of short and long-term shift work with poor sleep quality among high-stress occupations. These findings may have future implications that ultimately lead to interventions that could improve shift workers' health. Efforts to reduce the consequences of shift work in law enforcement could be a complex undertaking that needs to be addressed through a collaborative and multifaceted effort among policy makers, managers, researchers, and police officers. This recommendation has long been recognized for professionals confronted with both shift work and customer-focused jobs such as police, prison guards, and nurses.[48] Comprehensive fatigue management programs that include education on the health and safety consequences of shift work, workplace interventions that improve alertness, and screening for common sleep disorders are essential to minimize the negative consequences associated with shift work. In addition, understanding the behavioral and biological factors that determine tolerance to shift work[48,49] and the role of family support[50] could aid decision making in shift-work scheduling. In a laboratory study of healthy police officers, Boudreau et al[30] demonstrated that officers with circadian adaptation to night-shift work showed better performance, alertness and mood levels, and longer daytime sleep compared with officers who were "non-adapted." Future studies with larger sample size and a prospective design that take into account potential confounders, mediators, and effect modifiers are worthwhile and could provide better insight into the likely casual pathways.

Acknowledgments

This research was conducted at The State University of New York at Buffalo, Buffalo, NY, and was funded by the National Institute for Occupational Safety and Health (NIOSH), contract no. 200-2003-01580.

References

1. Frost P, Kolstad HA, Bonde JP. Shift work and the risk of ischemic heart disease: a systematic review of the epidemiologic evidence. Scand J Work Environ Health. 2009; 35:163–179. [PubMed: 19387517]
2. Wang XS, Armstrong ME, Cairns BJ, Key TJ, Travis RC. Shift work and chronic disease: the epidemiological evidence. Occup Med (Lond). 2011; 61:78–89. [PubMed: 21355031]
3. Wang A, Arah OA, Kauhanen J, Krause N. Work schedules and 11-year progression of carotid atherosclerosis in middle-aged Finnish men. Am J Ind Med. 2015; 58:1–13. [PubMed: 25349029]
4. Ramin C, Devore EE, Wang W, Pierre-Paul J, Wegrzyn LR, Schernhammer ES. Night shift work at specific age ranges and chronic disease risk factors. Occup Environ Med. 2015; 72:100–107. [PubMed: 25261528]

5. Ye HH, Jeong JU, Jeon MJ, Sakong J. The association between shift work and the metabolic syndrome in female workers. Ann Occup Environ Med. 2013; 25:33. [PubMed: 24472469]
6. Kawabe Y, Nakamura Y, Kikuchi S, et al. Relationship between shift work and clustering of the metabolic syndrome diagnostic components. J Athero-sclerThromb. 2014; 21:703–711.
7. Knutsson A, Kempe A. Shift work and diabetes: a systematic review. Chronobiol Int. 2014; 31:1146–1151. [PubMed: 25290038]
8. Straif K, Baan R, Grosse Y, et al. Carcinogenicity of shift-work, painting, and fire-fighting. Lancet Oncol. 2007; 8:1065–1066. [PubMed: 19271347]
9. Bonde JP, Hansen J, Kolstad HA, et al. Work at night and breast cancer: report on evidence-based options for preventive actions. Scand J Work Environ Health. 2012; 38:380–390. [PubMed: 22349009]
10. Shen J, Botly LC, Chung SA, Gibbs AL, Sabanadzovic S, Shapiro CM. Fatigue and shift work. J Sleep Res. 2006; 15:1–5. [PubMed: 16489996]
11. Violanti JM, Fekedulegn D, Andrew ME, et al. Shift work and the incidence of injury among police officers. Am J Ind Med. 2012; 55:217–227. [PubMed: 22228219]
12. Magrini A, Pietroiusti A, Coppeta L, et al. Shift work and autoimmune thyroid disorders. Int J Immunopathol Pharmacol. 2006; 19:31–36. [PubMed: 17291404]
13. Drake CL, Roehrs T, Richardson G, Walsh JK, Roth T. Shift work sleep disorder: prevalence and consequences beyond that of symptomatic day workers. Sleep. 2004; 27:1453–1462. [PubMed: 15683134]
14. Waage S, Pallesen S, Moen BE, et al. Predictors of shift work disorder among nurses: a longitudinal study. Sleep Med. 2014; 15:1449–1455. [PubMed: 25441751]
15. Vallières A, Azaiez A, Moreau V, LeBlanc M, Morin CM. Insomnia in shift work. Sleep Med. 2014; 15:1440–1448. [PubMed: 25277664]
16. Garde AH, Hansen AM, Hansen J. Sleep length and quality, sleepiness and urinary melatonin among healthy Danish nurses with shift work during work and leisure time. Int Arch Occup Environ Health. 2009; 82:1219–1228. [PubMed: 19396613]
17. Paech GM, Jay SM, Lamond N, Roach GD, Ferguson SA. The effects of different roster schedules on sleep in miners. Appl Ergon. 2010; 41:600–606. [PubMed: 20089244]
18. Lombardi DA, Jin K, Vetter C, et al. The impact of shift starting time on sleep duration, sleep quality, and alertness prior to injury in the People's Republic of China. Chronobiol Int. 2014; 31:1201–1208. [PubMed: 25216207]
19. Dinges DF, Pack F, Williams K, et al. Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4–5 hours per night. Sleep. 1997; 20:267–277. [PubMed: 9231952]
20. Vila B. Impact of long work hours on police officers and the communities they serve. Am J Ind Med. 2006; 49:972–980. [PubMed: 17006951]
21. Lin PC, Chen CH, Pan SM, et al. Atypical work schedules are associated with poor sleep quality and mental health in Taiwan female nurses. Int Arch Occup Environ Health. 2012; 85:877–884. [PubMed: 22207296]
22. De Martino MM, Abreu AC, Barbosa MF, Teixeira JE. The relationship between shift work and sleep patterns in nurses. Cien Saude Colet. 2013; 18:763–768. [PubMed: 23546203]
23. Huth JJ, Eliades A, Handwork C, Englehart JL, Messenger J. Shift worked, quality of sleep, and elevated body mass index in pediatric nurses. J Pediatr Nurs. 2013; 28:e64–e73. [PubMed: 23545126]
24. Yazdi Z, Sadeghniiat-Haghighi K, Loukzadeh Z, Elmizadeh K, Abbasi M. Prevalence of sleep disorders and their impacts on occupational performance: a comparison between shift workers and nonshift workers. Sleep Disord. 201410.1155/2014/870320
25. Vila B, Kenney DJ. Tired cops: the prevalence and potential consequences of police fatigue. NIJ J. 2002; 248:16–21.
26. Rajaratnam SM, Barger LK, Lockley SW, et al. Harvard Work Hours, Health and Safety Group. Sleep disorders, health, and safety in police officers. JAMA. 2011; 306:2567–2578. [PubMed: 22187276]

27. Buxton OM, Marcelli E. Short and long sleep are positively associated with obesity, diabetes, hypertension, and cardiovascular disease among adults in the United States. Soc Sci Med. 2010; 71:1027–1036. [PubMed: 20621406]
28. Garbarino S, Repice AM, Traversa F, et al. Commuting accidents: the influence of excessive daytime sleepiness. A review of an Italian Police officers population. G Ital Med Lav Ergon. 2007; 29:324–326. [PubMed: 18409708]
29. Waggoner LB, Grant DA, Van Dongen HP, Belenky G, Vila B. A combined field and laboratory design for assessing the impact of night shift work on police officer operational performance. Sleep. 2012; 35:1575–1577. [PubMed: 23115407]
30. Boudreau P, Dumont GA, Boivin DB. Circadian adaptation to night shift work influences sleep, performance, mood and the autonomic modulation of the heart. PLoS One. 2013; 8:e70813. [PubMed: 23923024]
31. Wu H, Gu G, Yu S. Effect of occupational stress and effort-reward imbalance on sleep quality of people's policeman. Chin J Prev Med. 2014; 48:276–280.
32. Ramey SL, Perkhounkova Y, Moon M, Budde L, Tseng HC, Clark MK. The effect of work shift and sleep duration on various aspects of police officers' health. Workplace Health Saf. 2012; 60:215–222. [PubMed: 22515415]
33. Neylan TC, Metzler TJ, Best SR, et al. Critical incident exposure and sleep quality in police officers. Psychosom Med. 2002; 64:345–352. [PubMed: 11914452]
34. Garbarino S, De Carli F, Nobili L, et al. Sleepiness and sleep disorders in shift workers: a study on a group of Italian police officers. Sleep. 2002; 25:648–653. [PubMed: 12224843]
35. Klawe JJ, Laudencka A, Miśkowiec I, Tafil-Klawe M. Occurrence of obstructive sleep apnea in a group of shift worked police officers. J Physiol Pharmacol. 2005; 56:115–117. [PubMed: 16204784]
36. Tafil-Klawe M, Laudencka A, Klawe JJ, Miśkowiec I. Does night work favor sleep-related accidents in police officers? J Physiol Pharmacol. 2005; 56:223–226. [PubMed: 16204797]
37. Hartley TA, Burchfiel CM, Fekedulegn D, Andrew ME, Violanti JM. Health disparities in police officers: comparisons to the U.S. general population. Int J Emerg Ment Health. 2011; 13:211–220. [PubMed: 22900455]
38. Charles LE, Violanti JM, Gu JK, Fekedulegn D, Andrew ME, Burchfiel CM. Sleep duration and biomarkers of metabolic function among police officers. J Occup Environ Med. 2011; 53:831–837. [PubMed: 21785371]
39. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989; 28:193–213. [PubMed: 2748771]
40. Sallis JF, Haskell WL, Wood PD, et al. Physical activity assessment methodology in the Five-City Project. Am J Epidemiol. 1985; 121:91–106. [PubMed: 3964995]
41. Zou G. A modified poisson regression approach to prospective studies with binary data. Am J Epidemiol. 2004; 159:702–706. [PubMed: 15033648]
42. Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. BMC Med Res Methodol. 2003; 3:21. [PubMed: 14567763]
43. Santorek-Strumillo E, Zawilska JB, Misiak P, Jabloński S, Kordiak J, Brocki M. Influence of the shift work on circadian-rhythms compare survey on health service employees and policemen. Przegl Lek. 2012; 69:103–106. [PubMed: 22764651]
44. Charles LE, Burchfiel CM, Fekedulegn D, et al. Shift work and sleep: the Buffalo Police health study. Policing. 2007; 30:215–227.
45. Institute of Medicine. Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem. Washington, DC: The National Academies Press; 2006.
46. Zimmerman FH. Cardiovascular disease and risk factors in law enforcement personnel: a comprehensive review. Cardiol Rev. 2012; 20:159–166. [PubMed: 22314143]
47. Arendt J. Shift work: coping with the biological clock. Occup Med (Lond). 2010; 60:10–20. [PubMed: 20051441]

48. Prunier-Poulmaire S, Gadbois C, Volkoff S. Combined effects of shift systems and work requirements on customs officers. Scand J Work Environ Health. 1998; 24:134–140. [PubMed: 9916830]

49. Tamagawa R, Lobb B, Booth R. Tolerance of shift work. Appl Ergon. 2007; 38:635–642. [PubMed: 16996472]

50. Holland DW. The effect of shiftwork related fatigue on the family life of train operators: implications for safety and health professionals. Work. 2006; 26:115–121. [PubMed: 16477103]

J Occup Environ Med. Author manuscript; available in PMC 2017 March 01.

TABLE 1

Demographic and Lifestyle Characteristics of Study Participants by Shift Work (Past Month), BCOPS Study, 2004 to 2009

	All (n =363)		Day Shift (n =180)		Afternoon Shift (n =102)		Night Shift (n =81)		
Characteristics	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	***P* Value[a]**
Gender									
Women	103	28.4	78	43.3	8	7.8	17	21.0	<0.0001
Men	260	71.6	102	56.7	94	92.2	64	79.0	
Race									
White	274	76.5	118	67.1	90	89.1	66	81.5	<0.0001
Black/Hispanic	84	23.5	58	32.9	11	10.9	15	18.5	
Education									
≤High school	38	10.5	20	11.2	10	9.8	8	9.9	0.6546
College <4 yrs	207	57.2	108	60.3	56	54.9	43	53.1	
College 4+ yrs	117	32.3	51	28.5	36	35.3	30	37.0	
Marital status									
Single	50	13.8	22	12.2	10	9.8	18	22.2	0.1075
Married	262	72.2	134	74.4	78	76.5	50	61.7	
Divorced	51	14.0	24	13.3	14	13.7	13	16.1	
Smoking status									
Current	61	16.9	27	15.2	15	14.7	19	23.5	0.2767
Former	81	22.4	46	25.8	20	19.6	15	18.5	
Never	219	60.7	105	60.0	67	65.7	47	58.0	
Rank									
Patrol officer	261	71.9	119	66.1	75	73.5	67	82.7	0.0201
Other [*]	102	28.1	61	33.9	27	26.5	14	17.3	
Work load (high)	229	64.0	106	60.2	62	61.4	61	75.3	0.0529
Sleep quality (poor)	196	54.0	79	43.9	61	59.8	56	69.1	0.0003
Age (in yrs)	363	41.2 ±6.6	180	42.8 ±6.4	102	40.4 ±6.2	81	38.6 ±6.6	<0.0001
Years of service	363	14.4 ±6.8	180	16.2 ±6.5	102	14.3 ±6.7	81	10.7 ±6.2	<0.0001
Body mass index (kg/m^2)	362	29.2 ±4.7	180	28.6 ±4.8	102	30.4 ±4.2	80	29.0 ±4.9	0.0093
Hours of physical activity/week [†]	362	15.4 ±13.1	180	15.3 ±12.4	102	16.0 ±15.4	80	14.8 ±11.7	0.8199

Characteristics	All (n =363)		Day Shift (n =180)		Afternoon Shift (n =102)		Night Shift (n =81)		
	n	%	n	%	n	%	n	%	*P* Value[a]
No. of alcohol drinks/week	358	5.5 ±9.4	177	5.4 ±11.0	101	6.2 ±7.9	80	4.9 ±7.1	0.6248

[*] Other includes sergeant, lieutenant, captain, and detective.

[†] Physical activity hours include occupational, household, and leisure time activities.

[a] *P* values are from χ^2 tests of independence or Fisher exact test for categorical variables and from analysis of variance testing differences in means across dominant shift for continuous variables. Results for the continuous variables are means ± SD.

TABLE 2

Prevalence and PR* of Poor Sleep Quality (Global PSQI Score >5) by Shift Work, BCOPS Study, 2004 to 2009

Period	Shift	N	Prevalence of Poor Sleep Quality (95% CI)	Unadjusted PR (95% CI)	Age-Adjusted PR (95% CI)	Multivariate†- Adjusted PR (95% CI)
Past month	Day	180	43.9 (37.2, 51.8)	Referent	Referent	Referent
	Afternoon	102	59.8 (51.0, 70.1)	1.36 (1.08–1.71)	1.38 (1.09–1.74)	1.49 (1.15–1.93)
	Night	81	69.1 (59.8, 80.0)	1.58 (1.26–1.96)	1.60 (1.28–2.01)	1.72 (1.35–2.20)
Past year	Day	176	44.9 (38.1, 52.9)	Referent	Referent	Referent
	Afternoon	98	60.2 (51.3, 70.7)	1.34 (1.07–1.69)	1.36 (1.07–1.71)	1.47 (1.13–1.92)
	Night	89	65.2 (56.0, 75.9)	1.45 (1.16–1.82)	1.48 (1.17–1.87)	1.61 (1.25–2.08)
Past 15 years	Day	143	44.8 (37.3, 53.7)	Referent	Referent	Referent
	Afternoon	130	56.9 (49.0, 66.1)	1.27 (1.01–1.61)	1.30 (1.02–1.65)	1.38 (1.05–1.81)
	Night	90	64.4 (55.3, 75.1)	1.44 (1.13–1.83)	1.48 (1.15–1.90)	1.60 (1.21–2.11)

BCOPS, Buffalo Cardio-Metabolic Occupational Police Stress; CI, confidence interval; PR, prevalence ratio; PSQI, Pittsburgh Sleep Quality Index.

*The prevalence, PRs, and their 95% CI were estimated using the Poisson regression model.

†Adjustment was made for age, gender, race/ethnicity, rank, workload, body mass index, and alcohol consumption.

TABLE 3

Prevalence and PR* of Self-Rated Fairly Bad or Very Bad Sleep Quality in the Past Month (a Component of PSQI) by Shift Work, BCOPS Study, 2004 to 2009

Period	Shift	N	Prevalence of Poor Sleep Quality (95% CI)	Unadjusted PR (95% CI)	Age-Adjusted PR (95% CI)	Multivariate†- Adjusted PR (95% CI)
Past month	Day	180	36.7 (30.0, 44.4)	Referent	Referent	Referent
	Afternoon	102	41.2 (32.7, 51.9)	1.12 (0.83–1.52)	1.14 (0.84–1.54)	1.32 (0.94–1.86)
	Night	81	46.9 (37.2, 59.1)	1.28 (0.95–1.73)	1.31 (0.96–1.79)	1.44 (1.04–2.00)
Past year	Day	176	37.5 (31.0, 45.4)	Referent	Referent	Referent
	Afternoon	98	41.8 (33.1, 52.8)	1.12 (0.83–1.51)	1.13 (0.83–1.54)	1.31 (0.93–1.84)
	Night	89	43.8 (34.6, 55.4)	1.17 (0.86–1.58)	1.20 (0.87–1.63)	1.34 (0.95–1.88)
Past 15-years	Day	143	37.8 (30.1, 46.6)	Referent	Referent	Referent
	Afternoon	130	37.7 (30.2, 47.0)	1.00 (0.74–1.35)	1.02 (0.75–1.40)	1.26 (0.89–1.78)
	Night	90	47.8 (38.5, 59.3)	1.27 (0.94–1.71)	1.31 (0.95–1.79)	1.57 (1.11–2.22)

BCOPS, Buffalo Cardio-Metabolic Occupational Police Stress; CI, confidence interval; PR, prevalence ratio; PSQI, Pittsburgh Sleep Quality Index.

*The prevalence, PRs, and their 95% CI were estimated using the Poisson regression model

†Adjustment was made for age, gender, race/ethnicity, rank, workload, body mass index, and alcohol consumption.

J Occup Environ Med. Author manuscript; available in PMC 2017 March 01.