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Original Article

# Separate and Joint Associations of Shift Work and Sleep Quality with Lipids

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ABSTRACT

*Background:* Shift work and/or sleep quality may affect health. We investigated whether shift work and sleep quality, separately and jointly, were associated with abnormal levels of triglycerides, total cholesterol (TC), and low-and high-density lipoprotein cholesterol in 360 police officers (27.5% women).
*Methods:* Triglycerides, TC, and high-density lipoprotein were analyzed on the Abbott Architect; low-density lipoprotein was calculated. Shift work was assessed using City of Buffalo payroll work history records. Sleep quality (good, $\leq 5$; intermediate, 6–8; poor, $\geq 9$) was assessed using the Pittsburgh Sleep Quality Index questionnaire. A shift work + sleep quality variable was created: day plus good sleep; day plus poor sleep; afternoon/night plus good; and poor sleep quality. Mean values of lipid biomarkers were compared across categories of the exposures using analysis of variance/analysis of covariance.
*Results:* Shift work was not significantly associated with lipids. However, as sleep quality worsened, mean levels of triglycerides and TC gradually increased but only among female officers (age- and race-adjusted $p = 0.013$ and 0.030, respectively). Age significantly modified the association between sleep quality and TC. Among officers $\geq 40$ years old, those reporting poor sleep quality had a significantly higher mean level of TC (202.9 $\pm$ 3.7 mg/dL) compared with those reporting good sleep quality (190.6 $\pm$ 4.0 mg/dL) (gender- and race-adjusted $p = 0.010$). Female officers who worked the day shift and also reported good sleep quality had the lowest mean level of TC compared with women in the other three categories ($p = 0.014$).
*Conclusion:* Sleep quality and its combined influence with shift work may play a role in the alteration of some lipid measures.


## 1. Introduction

Cardiovascular disease (CVD) is the leading cause of morbidity and mortality in the United States and in other countries [1]. CVD risk factors include elevated levels of certain lipid biomarkers such as triglycerides and low-density lipoprotein (LDL) cholesterol, low levels of high-density lipoprotein (HDL) cholesterol [2–6], and exposure to shift work [7,8]. Abnormal levels of certain lipids are relatively common among Americans. Using the National Health and Nutrition Examination Survey data, Carroll and colleagues [9] found that an estimated 12.9% of US adults, aged 20 years and older (11.1% of men and 14.4% of women), had a high level of total cholesterol (TC) in 2011–2012, and this percentage had not changed since 2009–2010. Approximately 17% of adults (about 25% of men and < 10% of women) had low HDL cholesterol during the same period.

Police officers have a high prevalence of CVD and its associated risk factors such as hypertension, hyperlipidemia, and metabolic

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syndrome [10]. Their occupational exposures may contribute to these adverse health conditions. Police officers are exposed to many psychological and organizational stressors such as violence, traumatic events, and shift schedules [10], and perhaps more so than many other occupational groups [11].

Shift work is one of the occupational factors that has been shown to be associated with elevated levels of triglycerides and TC [8,12–16]. In the epidemiologic literature, the association between sleep quality and lipid levels has shown mixed results [17–20]. Using data from the Coronary Artery Risk Development in Young Adults Sleep Study (2003–2005), Petrov and colleagues [17] did not find a significant association between self-reported poor sleep quality and 10-year changes in lipid levels. In addition, among a group of 143 law enforcement officers, sleep quality was not significantly related to any of the individual components of metabolic syndrome, including elevated triglycerides and reduced HDL cholesterol [18]. However, among 3,435 Taiwanese adults, low HDL cholesterol was an independent predictor of having a higher global sleep score (i.e., being a poor sleeper), as measured by the Pittsburgh Sleep Quality Index (PSQI) [19]. Moreover, a study conducted in Republic of Korea showed that individuals reporting poor sleep quality had a higher prevalence of elevated triglycerides and low HDL cholesterol [20].

Not surprisingly, night shift work is generally associated with poor sleep quality [21,22]. We could not find any evidence of the combined adverse impact of shift work and poor sleep quality on lipid biomarkers in the epidemiological literature. Therefore, this study aims to evaluate the separate and joint associations of shift work and sleep quality with four lipid biomarkers, triglycerides, TC, and HDL cholesterol and LDL cholesterol, among police officers. Even though this topic could have been studied on many different groups, we used police officers because (1) police officers experience a high degree of stress in their jobs and, therefore, may be more likely to reveal adverse health effects of stress and (2) they are an understudied occupational group. In addition, this study is unique in that the influence of both shift work and poor sleep quality is jointly being examined in relation to their potential adverse effects on lipids. We hypothesized that officers who worked the afternoon/night shift and reported poor sleep quality would have higher mean levels of triglycerides, TC, and LDL cholesterol and lower mean levels of HDL cholesterol. This association may differ by age, gender, and/or use of lipid-lowering medications. At different ages, sleep needs and metabolic function may vary. It is possible that, at younger ages, lipid metabolism may be less susceptible to the effects of an irregular shift schedule or poor sleep quality. Different lifestyle habits or hormonal reactions among men and women may strengthen or attenuate the association between the exposures and lipids. In addition, use of lipid-lowering medications would most likely obscure any association of shift work or sleep quality with lipids. Therefore, a secondary aim is to investigate whether effect modification by age, gender, and use of lipid-lowering medications exists in these associations.

## 2. Materials and methods

### 2.1. Study design and participants

Participants in this cross-sectional study were police officers employed at the Buffalo Police Department, New York. From June 2004 through October 2009, 464 active-duty and retired police officers (from an estimated 710 officers in 2004) were recruited and examined in the Buffalo Cardio-metabolic Occupational Police Stress (BCOPS) study. The BCOPS study was undertaken to investigate associations between work-related stressors and health outcomes including subclinical measures of CVD [23]. Female officers who were pregnant at the time of examination were excluded. The officers reviewed and signed informed consent forms prior to the examinations. The data were collected at the Center for Health Research, School of Public Health and Health Professions, University at Buffalo, State University of New York [23]. The Institutional Review Boards at the University at Buffalo and the National Institute for Occupational Safety and Health approved the study. From the original sample of 464, officers were excluded if they had retired by 2009 or if information was not collected on shift work, sleep quality, or any of the lipid measures ($n = 104$). Analysis for this study was conducted on 360 police officers, 99 women and 261 men.

### 2.2. Shift work

Electronic work history data from 1994 to 2010 were available from the City of Buffalo payroll records. The database contained information regarding the daily activities of each officer and included the start and end time of work, type of activity (i.e., regular work, overtime work, and court appearances), type of leave (i.e., weekend, vacation, work-related injuries, and other types of sick leave), and number of hours worked on each activity. The time the participants started their regular scheduled shift was used to classify each record into one of the following three shifts: day shift, if the start time of the record was between 4:00 AM and 11:59 AM; afternoon shift, if the start time was between 12:00 PM and 7:59 PM; and night shift, if the start time was between 8:00 PM and 3:59 AM. The majority (> 90%) of officers who were classified as day shift workers began work at 7:00 AM or 8:00 AM. An officer's dominant shift was defined as the shift on which he/she worked the highest percentage of hours. For example, the dominant shift would be night shift for an officer who worked 10% on the day shift, 5% on the afternoon shift, and 85% on the night shift. We used data on the dominant shift worked during the previous year (from time of blood collection) since this length of time would be sufficient to study associations with lipids.

### 2.3. Sleep quality

Sleep quality was assessed using the PSQI questionnaire [24]. Sleep quality was measured from 19 self-rated items that assessed various sleep quality-related factors over the previous month. These 19 items were grouped into seven components that include subjective sleep quality, sleep latency (i.e., time taken to fall asleep), sleep duration, habitual sleep efficiency (i.e., number of hours slept/number of hours spent in bed), sleep disturbances, use of sleep medications, and daytime dysfunction. Each component was scored by summing the scores of relevant items. Each item was weighted equally on a 0–3 scale. A global PSQI score was derived by summing up the scores of the seven components, with a possible range of 0–21; a global score of $\leq 5$ indicated good sleep quality [24]. The PSQI global score provides a single overall assessment of sleep quality, allows direct comparisons among groups, and identifies groups that differ in the quality of sleep. Studies have shown that the PSQI has high internal homogeneity, reliability, and validity [24,25].

### 2.4. Lipids

All officers were required to fast for at least 12 hours before blood specimens were taken. Serum specimens were used for all lipid measures. TC, HDL cholesterol, and triglycerides were analyzed on the Abbott Architect (Abbott Diagnostics, Abbott Park, IL, USA). LDL cholesterol was calculated from measurements obtained for TC, HDL cholesterol, and triglycerides using the following formula: $LDL = TC - HDL - triglycerides/5$ (mg/dL).