SLEEP DISORDERS IN POLICEMEN CAN LEAD TO ENHANCED ATHEROSCLEROSIS

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Abstract:

Police officers are exposed to several occupational stressors such as long work hours, sleep deprivation, traumatic and unpredictable events, shift work (defined as work occurring outside typical daytime working hours), chemical hazards, and other organizational stressors. Occupational stressors like these make the police officers prone to sleep loss and sleep fragmentation. In most cases, either the police officers are not diagnosed with sleep disorders or do not take regular treatment for it. Obstructive sleep apnoea is the most prevalent sleep disorder among police officers. Working out of phase from their habitual hours is another. The pooled prevalence of bad sleep quality in police officers was reported as 51%. One of the pathways mediating the relationship between sleep fragmentation and atherosclerosis is increased cortisol from increased stress degranulates more neutrophils, causing increase in the proinflammatory marker Nuclear Factor Kappa Beta. This is known to enhance atherosclerosis. There is a need for assessment of interventions to address sleep irregularities among policemen, and whether they can reduce cardiovascular disease risk over the long term.

Key words: Police officers, sleep fragmentation, cardiovascular disease.

Introduction

Sleep disorders are common and are largely undiagnosed and untreated in police officers. A comprehensive sleep disorders screening program found that 40.4% of police officers reported symptoms consistent with at least one sleep disorder. The majority reported not having been diagnosed in the past or not taking regular treatment. Police officers who screened positive for a sleep disorder were likely to report more actual and near-miss administrative errors and safety violations. The loss of even 2 hours of nightly sleep for one week is associated with decrements in performance comparable with those seen after 24 hours of continuous wakefulness. Sleep disorders resulting in chronic sleep efficiency may therefore adversely effect on-the job performance.

Yoo et al., 2007, studied changes in the amygdala with functional magnetic resonance imaging and reported that those in a sleep deprived state were unable to appropriately govern behavioural responses to negative emotional stimuli. This may also explain the self-reported increased number of citizen complaints filed against those officers who screened positive for a sleep disorder, although further studies are required to test this potential mechanism. Many police officers are at an even greater risk of these outcomes because they are often required to work overnight, on rotating shifts, or both. Impaired cardiometabolic responses are observed in healthy volunteers scheduled to eat and sleep out of phase from their habitual times, and night work greatly increases the risk of progression to diabetes. These findings may at least in part explain the increased risk of

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cardiovascular disease and diabetes in shift workers, in particular police officers. Physical activity and diet may also account for the observed increased risk.

Obstructive sleep apnoea is the most prevalent sleep disorder among police officers, with one-third of officers screening positive. Given that obesity is a major risk factor for OSA and that one-third of police officers have a BMI of 30 or higher, the high prevalence of OSA can be anticipated. Although only a subset of patients with OSA report excessive sleepiness, many describe related symptoms (eg, fatigue, nonrestorative sleep, inattention). The prevalence of OSA without a complaint of excessive sleepiness, even in 1993, was 24% in men and 9% in women (Young et al., 1993). Today, it is likely even higher, given that the prevalence of some of the major risk factors for OSA (eg, aging and obesity) is increasing. In addition, recent improvements in diagnostic technology would likely yield higher apnea prevalence estimates. Obstructive sleep apnea exposes individuals to increased sleepiness and a 2- to 3-fold higher risk of motor vehicle crashes Although in-the-line-of-duty death rates in police have decreased by almost half since 1972, the proportion of deaths due to unintentional injury have shown little change and in 2003 were greater than the rate of felonious deaths in the US (Vila, 2006).

Cardiovascular diseases (CVDs) have now become the leading cause of mortality in India. The Global Burden of Disease study estimate of age-standardized CVD death rate of 272 per 100? 000 population in India is higher than the global average of 235 per 100? 000 population. In India, there has been a sudden epidemiological transition from infectious disease conditions to non-communicable diseases. The progression of the epidemic is multifactorial. Epidemiological reports have proved a strong link between both quality and quantity of sleep and CVDs and metabolic syndrome. Alteration in duration of sleep is associated with increased cardiovascular morbidity, incidence of cardiovascular disease (CVD), and major risk factors for CVD such as high cholesterol, incidence of Type 2 diabetes, and metabolic syndrome. Cardiovascular risk parameters used include age, sex, previous myocardial infarction and stroke, diabetes mellitus, smoking, systolic blood pressure, diastolic blood pressure, total and HDL cholesterol, and carotid intima-media thickness.

Studies suggest that common carotid artery intima-media thickness (IMT) is nearly as predictive of atherosclerosis as all nine of the other risk factors combined. There is an inverse linear association between objectively measured sleep duration and maximum IMT. An association has been established between sleep duration and abdominal obesity, elevated fasting glucose and hypertriglyceridemia, thus indicating that the odds of developing metabolic syndrome vary with alteration in duration of sleep. Police officers are exposed to several occupational stressors such as long work hours, sleep deprivation, traumatic and unpredictable events, shift work (defined as work occurring outside typical daytime working hours), chemical hazards, and other organizational stressors. Sleep disorders have been associated with an increased prevalence of self-reported comorbid physical and mental health conditions such as diabetes, CVD, and depression among North American police officers (Elliott &Lal, 2016)

Several studies have been conducted to establish the association of sleep duration and sleep quality with increased risk for metabolic and cardiovascular disorders. One of the studies

demonstrated that short sleep duration significantly increased the risk of all-cause mortality. 35 hours or less of sleep was associated with heart disease when compared to a duration of 8 hours of sleep (Ayas et al., 2006). A cross-sectional study concluded that when compared with sleep duration of 7 hours, there was a positive association between both shorter and longer sleeps durations and CVD in a representative sample of US adults. They found both short and long sleep durations to be independently associated with CVD, independent of age, sex, race-ethnicity, smoking, alcohol intake, body mass index, physical activity, diabetes mellitus, hypertension, and depression. Compared with a sleep duration of 7 hours (referent), the multivariate odds ratio (95% confidence interval) of CVD was 2.20, 1.33, 1.23, and 1.57 for sleep duration and < or = 5 hours, 6 hours, 8 hours, and > or = 9 hours respectively (Sabanayagam & Shankar, 2010). Short sleep duration is also linked to increased risks of hypertension (Gottlieb et al., 2006), and may be a significant risk factor for high cholesterol (Gangwisch et al., 2005).

Police officers have been reported to exhibit a high incidence of pathologies, which present prematurely in an otherwise healthy population. The pooled prevalence of bad sleep quality in police officers was reported as 51% [95% CI :42-60%] (Garbarino & Magnavita, 2015)

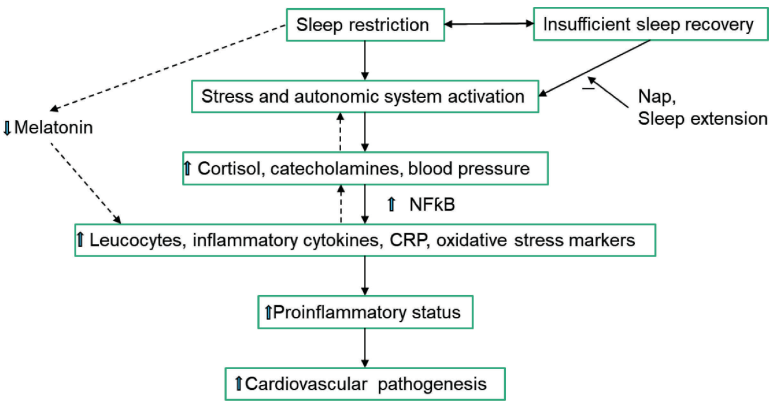

Figure 2: *Potential pathway(s) by which sleep restriction (SR) and insufficient sleep recovery lead to cardiovascular pathologies. Sleep restriction with insufficient recovery sleep enhance the activity of the autonomic and stress systems. Increased blood pressure causes vascular shear stress and leads to inflammation in the vascular wall potentially leading to the endothelial production of inflammatory mediators. The stress mediators cortisol/catecholamine can mobilize leukocytes in the blood circulation; among leukocyte subtype neutrophil degranulation can trigger an oxidative burst and the release of oxidative stress markers. Nap and its slow wave sleep (SWS) component can blunt the stress response e.g., reduce cortisol release with subsequent decreased leukocyte mobilization. Catecholamine can enhance the expression of nuclear factor-kappa B (NF-kB), an activator of pro-inflammatory gene expression, e.g., pro-inflammatory cytokines. All these physiopathological altered pathways following SR contribute to a chronic pro-inflammatory status ultimately leading to the development of cardiovascular pathologies. Abbreviations: C-reactive protein (CRP). Faraut B, Boudjeltia KZ, Vanhamme L, Kerkhofs M. Immune, inflammatory and cardiovascular consequences of sleep restriction and recovery. Sleep Med Rev. 2012 Apr;16(2):137-49. doi: 10.1016/j.smrv.2011.05.001. Epub 2011 Aug 10. PMID: 21835655.*

In 2012, (Faraut et al., 2012) the potential pathway(s) (Figure 2) by which sleep restriction and insufficient recovery sleep lead to cardiovascular pathologies were discussed. Sleep restriction coupled to insufficient recovery sleep enhance the activity of the autonomic and stress systems. Vascular shear stress exacerbated by increased blood pressure lead to inflammation in the vascular wall potentially leading to the endothelial production of inflammatory mediators. While the

physiological underpinnings of the sleep and CVD relationship are not yet well defined, one plausible mechanism may be endothelial dysfunction, which is found in the early stages of atherosclerosis. Circulating markers of endothelial cell activation and damage (e.g. von Willebrand factor, endothelin-1) are increased among patients with obstructive sleep apnea (OSA) compared to healthy controls and among relatively healthy adults with increased sleep disturbance according to both self-reports (von Känel et al., 2007) and polysomnography-derived indices of sleep (e.g., latency in rapid eye movement or REM sleep) (Mills et al., 2007).

The stress mediators cortisol/catecholamine can mobilize leukocyte in the blood circulation; among leukocyte subtype neutrophil degranulation can trigger an oxidative burst and the release of oxidative stress markers. Nap and its slow wave sleep (SWS) component can blunt the stress response e.g., reduce cortisol release with subsequent decreased leukocyte mobilization. Catecholamine can enhance the expression of nuclear factor-kappa B (NF-kB), an activator of pro-inflammatory gene expression, e.g., pro-inflammatory cytokines. All these physiopathological altered pathways following sleep restriction contribute to a chronic pro-inflammatory status ultimately leading to the development of cardiovascular pathologies.

Nakazaki et al, in 2012 found that IMT was significantly greater and sleep efficiency was significantly lower in subjects with Total Sleep Time ≤5 ours than those with Total Sleep Time >7 hours with no significant differences in hypertension, diabetes, hyperlipidemia, smoking, or alcohol consumption. (Nakazaki et al., 2012)

In 2013, Ma et al, examined the association of objectively measured actigraphic data and self-reported sleep duration with carotid artery intima media thickness (IMT) among 257 police officers, a group at high risk for cardiovascular disease (CVD) (Young et al., 1993). They found that officers who had fewer than 5 hours or more than 8? hours of objectively measured sleep duration had significantly higher maximum IMT values, independent of age. Self-reported sleep duration was not associated with either IMT measure (Cc et al., 2013).

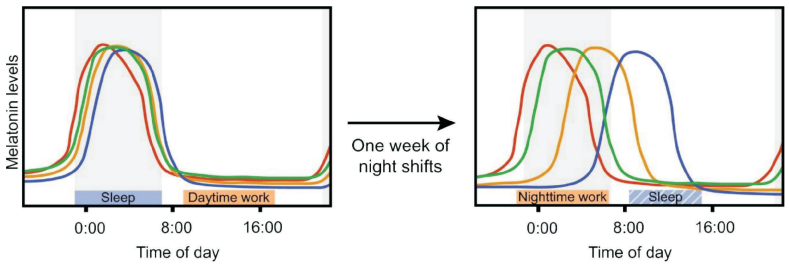

Figure 1: *Effect of circadian misalignment on individual melatonin levels. Each line represents melatonin levels of individuals. Grey area is the habitual sleep period. Left panel: Regular melatonin peaks synced with sleep. The panel on the right indicates different adjustment in each individual after several days of night shifts. Due to the shifted work schedule, sleep now occurs outside the biological night, potentially leading to shorter and more fragmented sleep. Reproduced with permission from: Kervezee et al. European Journal of Neuroscience, Volume: 51, Issue: 1, Pages: 396-412, First published: 25 October 2018, DOI: (10.1111/ejn.14216).*

Kervezee et al, in their article discussed the evidence for the contributions of circadian disruption and associated sleep disturbances to the risk of metabolic and cardiovascular health problems in shift workers. Disruption of the internal circadian timing system and concomitant sleep

disturbances (Figure 1) is thought to play a critical role in the development of these health problems. Controlled laboratory studies have shown that short-term circadian misalignment and sleep restriction independently impair physiological processes, including insulin sensitivity, energy expenditure, immune function, blood pressure and cardiac modulation by the autonomous nervous system. If allowed to persist, these acute effects may lead to the development of cardiometabolic diseases in the long term. (Kervezee et al., 2018)

In 2006, The Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) study, one of the first population-based studies to integrate psychological, physiological, and subclinical measures of stress, disease, and mental dysfunction, was undertaken to establish a methodology and descriptive results for a larger police study. They found that compared to populations of similar age, police officers had slightly lower FMD, lower carotid IMT, elevated BMI, and higher reported rates of depression and PTSD. Standardized physiological and psychological data collection and descriptive results confirmed that the methodology of the study was feasible in a working police population (Rajaratnam et al., 2011).

Butt et al in 2011, studied the association between obstructive sleep apnea and increased cardiovascular morbidity and mortality by studying myocardial perfusion using real time quantitative myocardial contrast echocardiography with concurrent assessment of macrovascular and microvascular endothelial dysfunction in subjects with obstructive sleep apnoea (OSA) and found a positive association between the two (Butt et al., 2011).

In 2016, Yadav et al had worked on both female and male police officers on their sleep quality working out-of-phase. Various questionnaires were used PSQI, ESS, FSS, and categorized into good and poor sleepers. At the beginning of the study, the existing duty schedule of these subjects was OP and lasted for 4 days (OP1). Thereafter, they were allotted their preferred (IP) duty schedule for 4 days, followed by OP2 for further 4 days. Over the 12-day period, subjects were monitored for their BP and sleep-wake cycle. Results showed that the poor sleepers improved their sleep quality and HR during IP duty schedule; however, good sleepers were not affected significantly (Yadav et al., 2016).

In 2017, Farooqui et al conducted an observational case control study in which they assessed the endothelial function using flow mediated dilation (FMD), peripheral arterial tonometry (PAT) and carotid artery ultrasound was used to measure CIMT in OSA patients constituting the study and non OSA subjects as control group at AIIMS, New Delhi. They found that endothelial function is significantly impaired in moderate to severe OSA patients without comorbidities. They also showed evidence of subclinical atherosclerosis in the form of increased CIMT (Farooqui et al., 2017).

There are several interventions and policy changes that might lead to improved sleep pattern and decreased cardiovascular disease risk among policemen. The department can instate a physical fitness program, which provides fitness facilities and the opportunity to exercise at all stations during work time. If a program already exists, it can be upgraded. Job performance standards, the annual performance report should include reports on physical ability and physical fitness.

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