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# Sleep restriction and its influence on blood pressure

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**Abstract** Sleep is a major modulator of cardiovascular function. Since it's more difficult to maintain adequate sleep duration among night watchmen during their working schedule, so in this study, we hypothesized that, the short sleep duration (<3 h) for 7 days in their night shift schedule, may possibly influence BMI, blood pressure and pulse wave analysis (PWA). In order to test this, we measured, anthropometric variable, heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse pressure (PP) and mean arterial pressure (MAP), along with measurement from pulse wave analysis (PWA) such as augmentation pressure (AP), augmentation index (AIx), AIx normalized to a heart rate of 75 beats per minute (Alx@75%) and subendocardial viability ratio (SEVR) in nigh watchmen at 1st day, 4th day and 7th day of restricted sleep periods. We observed, among restricted sleep individuals, sleepiness was significant increase at 4th and 7th day when compare to normal sleep individuals, and apart from DBP, there was significant increase in, HR, SBP, PP and MAP, only at 7th day of restricted sleep period. However, the entire anthropometric variable and PWA analysis such as AP, Alx, Alx@75% and SEVR in sleep restricted individuals was comparable to normal sleep individuals in all restricted sleep periods. In summary, sleep restriction could play a role in the etiology of increased blood pressure and may have an impact to increase cardiovascular risk. This knowledge will be useful, to enabling risk factors and to improve health outcomes among night watchmen with early accomplishment.
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## Introduction

In recent years, loss of sleep duration appears to be endemic in modern society, due to in excess of workload. Limitation of the sleep time period is thought to be harmful. Adequate sleep duration are important for the normal functioning of healthy life and however it can be affected by short-sleep duration and disruption of circadian rhythms.[1] Sleep restriction occurs when an individual fails to get sufficient sleep. Sleep restriction is limit of sleep for less than 4 h of normal sleep duration (8–10 h).[2] There is however, collective suggestion that sleep loss may be harmful not only to neurocognitive functions but also to the cardiovascular system.[3,4] Short-sleep may lead to a variety of cardio-metabolic risk factors, such as increased body weight, glucose intolerance and high blood pressure(BP).[2,5] The epidemiological studies have interrelated short hours of sleep (5 h) to increased risk of developing hypertension.[6,7] Blood pressure (BP) is physiologically regulated by Cardiac contractility (the force of cardiac ejection of blood into the systemic circulation), cardiac output (blood volume pumped in liters per minute), and peripheral vascular resistance. These are under autonomic nervous control and linked to BP via a feedback baroreflex mechanism.[8] Endothelial cells are differing in structure and function depending on the vascular tree.[9] Therefore, the functional impact of arterial dysfunction associated with partial sleep deprivation, as opposed to the venous dysfunction, is trying to be addressed in this study.

Nowadays, measurement of the elasticity or stiffness of the arteries is part of routine clinical practice. Pulse wave analysis (PWA) is a noninvasive practice, measures peripheral pulse waveforms[10] and being used for measuring arterial distensibility to assess cardiovascular health.[11] The recording and analysis of the pulse waveform in an artery allow to derives measures of hemodynamic status, enabling derivation of arterial stiffness including, augmentation pressure (AP), augmentation index (AIx), and subendocardial viability ratio (SEVR) which are directly related to vascular elasticity and may allow assessment of cardiovascular risk.[12,13] AP is well-defined as the difference between the primary (forward) and reflected systolic peak in central aortic pressures. It is a measure of central aortic pressure wave reflection in the vasculature and is a marker of adverse cardiovascular event.[14] AIx, is a composite measure of central arterial stiffness and peripheral wave reflection. The reflected waves cause changes in pulse wave morphology that affects hemodynamic performance and vascular compliance. AIx is the difference between the pulse height of the primary (forward) systolic and reflected peak pressure waves divided by the central pulse pressure and expressed as a percentage.[15] The augmentation index is the augmentation pressure expression as a proportion of the pulse pressure (PP).[14] SEVR is Buckberg area ratio % of the systolic and diastolic in the aortic root pulse wave and expressed as a ratio of diastolic pressure time interval (DPTI) to systolic pressure time interval (SPTI) [Diastolic area: DPTI $\div$ Systolic area: SPTI $\times$ 100]. It is a marker of myocardial oxygen supply and demand of subendocardial.[16] Since subendocardial among the cardiac muscle is that, ischemic likely to occur compared to upper epicardium. SEVR is an indicator of myocardial ischemia due to arteriosclerosis, and can be correlated with risk factor of ischemic heart disease.[16] A higher SEVR is better in terms of cardiovascular health, as lower values (at $\sim$50%) indicate decreased diastolic perfusion times and reduced coronary perfusion.[17]

Since it's more difficult to maintain adequate sleep duration among night watchmen during their working schedule, so in this study, we hypothesized that, the restriction of sleep duration at work, may possibly influence anthropometric variables, measurements of BP and PWA analysis.

## Methods

### Ethics declaration

The study was approved by the local research advisory committee of People College of Medical Science and Research Center (PCMS/OD/2015/1056). The study was performed in accordance with the Declaration of Helsinki.

### Participants

#### Inclusion and exclusion criteria

All Participants (watchmen) employed in Peoples University and nearby Community were recruited for the study. Participants meeting the following criteria were included; healthy, good sleeper, non-smoker, and free from medications, no history of depression, neurological disease, or chronic pain and underwent a medical interview to ensure that they had a regular sleep/wake schedule. Initially 70 young (age = 18–35 years) participants volunteer to participate, 20 were eliminated due to exclusion criteria or inability to follow schedule. The remaining 50 participants completed the one-week protocol. All selected participants gave written informed consent. The participants were divided into two groups.

Group I-(Normal sleep) (n = 28) – Twenty-eight watchman working in day time and used to have normal sleep in night ($\geq$8 h).

Group II-(Restricted sleep) (n = 22) – Twenty-two watchman working in night time and used to have restricted sleep in night ($\leq$3 h).

### Protocol

#### Sleep schedule assessment

The participants were instructed to maintain a regular sleep–wake schedule and were monitored. No stimulant of any kind was allowed during the study. For the tests obtained in normal rested condition, instructed to participants to maintain normal sleep in night every day. In sleep restriction condition, participants were also instructed to sleep in night less than three hours (<3 h) for one week in their night shift schedule. All the participants were not allowed to sleep in day time. Participants slept at home and completed scheduled sleep diaries, regularly while at home, the duration of sleep was self-monitored. Total time in bed was recorded with a click button by the subject

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