Section: Physiology

Original Research Article

EFFECT OF SLEEP DEPRIVATION ON CARDIOVASCULAR PARAMETERS IN YOUNG ADULTS

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ABSTRACT

Sleep is a normal physiological phenomenon which is important for both the normal physical and mental wellbeing. Sleep is also important for higher cognitive function and for restoring memory. Sleep deprivation causes autonomic imbalance, endocrine dysfunction and disrupts cardiovascular homeostasis resulting in sympathetic over activity. Sleep debt decreases HRV which is a potent marker of autonomic imbalance. Among the medical fraternity, the nurses are the population mostly exposed to sleep deprivation due to shift/night duties in hospitals. Sleep deprivation can easily be measured by Pittsburgh Sleep Quality Index PSQI through questionnaire. Our study aimed at calculating the PSQI and recording the different time domain and frequency domain parameters of HRV and to find out the correlation.

INTRODUCTION

Modern lifestyles and occupational demands have led to rising prevalence of insufficient sleep. The World Health Organization recognizes sleep disorders and deprivation as emerging contributors to non-communicable diseases, including cardiovascular disease.

Sleep is a normal physiological phenomenon crucial for both physical and mental wellbeing. It plays a critical role in maintaining autonomic balance and cardiovascular homeostasis. Sleep debt disrupts endocrine function, leading to elevated cortisol and impaired glucose metabolism—both of which contribute to cardiovascular strain.[1] This concept was further expanded by Mullington by showing that sleep deprivation triggers inflammatory responses and sympathetic overactivity, increasing blood pressure and heart rate.[2]

It was found that even short-term sleep loss impairs endothelial function, a key factor in vascular health.[3] One study emphasized the psycho-neuro-immunological pathways linking poor sleep to cardiovascular disease,[4] while another study highlighted the role of slow-wave sleep in regulating nocturnal blood pressure.[5]

Two studies Lusardi et al. (1999) and Tochikubo et al. (1996) found that insufficient sleep elevates blood pressure, even in hypertensive patients.[6,7] Even one night of sleep deprivation increases sympathetic tone and reduces parasympathetic activity, leading to tachycardia and elevated BP.[8]

One study found that sleep deprivation reduces HRV: an established marker of autonomic imbalance emphasizing the role of vagal tone in emotional regulation and cardiovascular health.[9] Shaffer and Ginsberg provided a comprehensive overview of HRV metrics, reinforcing its utility in assessing stress-related cardiovascular changes.[10]

In 1989, the Pittsburgh Sleep Quality Index (PSQI), was introduced as a validated tool for quantifying sleep quality, which has been widely used in clinical and occupational studies.[11]

Healthcare professionals, particularly nurses, are disproportionately affected by irregular work schedules, night shifts, and extended duty hours. These occupational demands often result in insufficient sleep, circadian rhythm disruption, and heightened stress levels. Young female nurses represent a unique population in this context: they are exposed to demanding shift work during the early stages of their careers, while also experiencing gender-specific physiological factors that may influence cardiovascular responses to sleep loss. Fatigue and poor sleep among nurses significantly impair occupational performance and increase health risks.[12]

Despite extensive literature on the cognitive and psychological effects of sleep deprivation, fewer studies have focused on its direct cardiovascular impact in young female nurses. Understanding these effects is crucial, as early physiological changes may serve as predictors of long-term cardiovascular morbidity. This study aims to address this gap by

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systematically evaluating cardiovascular parameters under conditions of sleep deprivation in this vulnerable occupational group. Such studies on sleep deprivation and its effect on HRV are rare specialy in North-east India including Assam. Therefore we decided to carry out the study on this vulnerable yet very important group of population in healthcare industry with the following objectives.

Objectives:

1. To calculate the Pittsburgh Sleep Quality Index of the nurses
2. To record the Heart Rate Variability
3. To evaluate the correlation between HRV parameters and the PSQI.

MATERIALS AND METHODS

IEC clearance: 190/2007/Pt II/Nov 2025/14 dated 16/12/2025

Study Design: Cross-sectional study.

Study Setting: Dept of Physiology, Guwahati Medical College & Hospital, Assam, India.

Study Duration: 6 months

Study Sample: Nurses aged 22–35 with <6 hours sleep/night for ≥5 consecutive days

Sample size: 30

- **Inclusion Criteria**:
  - Female nurses working in hospital settings with night shifts
  - No history of cardiovascular or endocrine disorders
- **Exclusion Criteria**:
  - Use of antihypertensives or stimulants

Measurements

- **Sleep Quality**: Pittsburgh Sleep Quality Index (PSQI)
- **Cardiovascular Parameters**:

Methodology: After getting the IEC clearance, written consent were obtained from volunteering participants. The participants were explained about the entire procedures in detail. They were asked to fillup the PSQI questionnaire from which their PSQI was calculated.

- Resting Heart Rate was recorded by ECG
- Systolic and Diastolic Blood Pressure were recorded by automated BP monitor
- Heart Rate Variability (HRV) was recorded by using mobile ECG apps

Pittsburgh Sleep Quality Index questionnaire:

Sleep quality was assessed by Pittsburgh Sleep Quality Index questionnaire.

The Pittsburgh Sleep Quality Index (PSQI) is a validated instrument utilized to distinguish between individuals exhibiting suboptimal or optimal sleep quality through the assessment of seven distinct dimensions: subjective sleep quality, sleep latency, sleeps duration, habitual sleep efficiency, sleep disturbances, consumption of sleep medication, and daytime dysfunction experienced over the preceding month. This instrument comprises 19 meticulously formulated questions, each of which is assigned a specific weight and score, culminating in a total score that ranges from 0 to 21. Elevated scores (5-21) are indicative of compromised sleep quality, whereas diminished scores (0-4) suggest favourable sleep quality.[13]

0=never
1=almost never
2=sometimes
3=fairly often
4=very often

Individual component scores are added up to obtain the Global PSQI score. Good sleepers have global PSQI score less than or equal to five (PSQI≤5) indicating good sleep quality and the poor sleepers have PSQI score more than five (PSQI>5).[14]

Heart Rate Vriability parameters:

Time Domain Parameters

Time domain parameters		Significance
SDRR(ms)	Standard deviation of R-R intervals	Reflects total HRV
RMSSD(ms)	Root square of the mean of the sum of squares of differences between adjacent R-R intervals	With normal sinus rhythm reflects vagal activity
pRR50(%)	Percentage of RR intervals >50 ms different from previous (RR)	With normal sinus rhythm reflects vagal activity

Frequency Domain Parameters

Frequency domain parameters	Frequency	Mediated by
HF	0.15–0.4 Hz	Reflect parasympathetic activity
LF	0.04–0.15 Hz	Reflect sympathetic activity
LF/HF		Sympatho-vagal balance

Notable: Our observations as regards to all HRV parameters will be according to the normal range practised in the Autonomic Function Test Lab at NIMHANS, Bengaluru.[15]

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RESULTS

Table1: Mean Values of Vital Parameters

Parameter	Mean±SD
HR	80.9±5.720
SBP	123.733±8.366
DBP	75.333±6.354
PSQI	9.2±3.067

Table 2: Mean Values of HRV Parameters without Sleep Deprivation

HRV parameters	Mean±SD
RMSSD	34.001±9.006 (increased)
SDRR	43.468±12.191(decreased)
LF/HF ratio	1.285±0.430 (increased)

Table 3: Mean Values of HRV Parameters Post Sleep Deprivation

HRV parameters	Mean±SD
RMSSD	34.152±5.270 (normal)
SDRR	38.499±12.372(decreased)
LF/HF ratio	0.913±0.429(normal)

Table 4: Value and Pearson's Correlation Coefficient of PSQI with HRV Parameters without Sleep Deprivation

HRV parameters	P value with PSQI	Pearson's correlation coefficient
RMSSD	>0.1	0.0430
SDRR	>0.1	-0.008
LF/HF	>0.1	0.076

Table 5: Pearson's Correlation Coefficient of PSQI with HRV Parameters Post Sleep Deprivation

HRV parameters	P value with PSQI	Pearson's correlation coefficient
RMSSD	>0.1	-0.115
SDRR	>0.1	-0.160
LF/HF	>0.1	-0.060

DISCUSSION

Our study found that HRV parameters varied post sleep deprivation. Prior to sleep deprivation the time domain RMSSD parameter showed increasing trend than previous value however within the normal range. Similarly LF/HF ratio also showed an increasing trend prior to sleep deprivation. Post sleep deprivation both RMSSD and LF/HF ratio showed a decline to normal value, however within normal range.

Before sleep deprivation, the Pearson's correlation coefficient between PSQI and RMSSD and LF/HF showed a positive correlation but statistically insignificant, while correlation between PSQI and SDRR was negative.

Post sleep deprivation, RMSSD showed a negative correlation with PSQI indicating increased parasympathetic dominance correlate with decreased PSQI values or better sleep quality. LF/HF ratio and SDRR also showed a negative correlation with PSQI values which were however statistically insignificant.

Similarly studies found various results. One study found that compared to good sleepers, LF decreased and HF increased statistically. This finding confirmed several studies that indicated that the power spectrum analysis of insomniacs usually increases LF, which means increased sympathetic nervous activity, decreased HF, and decreased parasympathetic nervous activity.[16,17]

Limitation: There were many limitations of our study as regards to the sample size, gender etc. also we focused only on PSQI while there are many other elements of sleep quality such sleep latency, sleep efficiency etc.

CONCLUSION

Sleep deprivation activates the sympathetic nervous system, elevates circulating catecholamines and increases cortisol secretion. These changes can result in elevated blood pressure, increased resting heart rate, reduced heart rate variability and impaired vascular function: all markers of cardiovascular strain. Our study tried to evaluate how sleep deprivation may affect the different parameters of Heart Rate Variability in young, which itself is a crucial tool for diagnosis of dysautonomia as regards to cardiovascular health. But we need to do more research in this regard.

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