

# Cardiac autonomic activity in young adults with short sleep

**Pushpa Krishna, Vishal V. Navekar, S. Shwetha**

Department of Physiology, Kempegowda Institute of Medical Sciences, 24<sup>th</sup> Main, Banashankari 2<sup>nd</sup> Stage, Bangalore - 560070

*Indian J Sleep Med 2011; 6.1, 20-23*

## Abstract

Sleep deficit has been associated with autonomic imbalance. This study aimed to evaluate the effect of sleep duration on cardiac autonomic activity as determined by heart rate variability (HRV) in young adults.

**Method:** Heart rate and frequency domain measures of HRV were evaluated from short-term electrocardiographic recordings (5 min each) of **95 medical students (37 women)** in the age group of 18 to 22 years. Self reported duration of sleep during the previous month were noted. The data was analysed by grouping and comparing the subjects according to average sleep duration per day with >7hours (n=51) and <7 hours (n=44) as adequate and inadequate sleep respectively.

**Results:** No difference was found in HRV indices and in heart rate between the sleep groups. The subjects with inadequate sleep had lower HF, HF in normalized units and higher values of LF, LF/HF ratio compared to adequate sleep group.

**Conclusion:** Sleep deprivation over a month period do not alter cardiac autonomic activity in young adults as assessed by short-term heart rate variability.

**Keywords:** sleep, heart rate variability (HRV), cardiac autonomic activity, low frequency power (LF), high frequency power (HF)

## Introduction

Acute sleep restriction/deprivation over the course of different time periods has resulted in alterations of sympatho vagal balance assessed in terms of HRV in healthy adults.<sup>(1-4)</sup> In preschool children shortening of nocturnal sleep has been associated with both sympathetic and parasympathetic hypoactivity.<sup>(5)</sup> Insomnia patients with short sleep

duration, have been reported to have reduced parasympathetic activity.<sup>(6)</sup> Effect of chronic sleep deprivation on cardiac autonomic activity has been less studied.<sup>(7)</sup> The aim of the present study was to evaluate the effect of sleep duration during previous one month on cardiac autonomic activity in terms of heart rate variability indices among young adults.

## Method

This study included **95 medical students (58 men: 37 women)** in the age group of 18 to 22 years. All subjects underwent a detailed medical history and examination. Height (metre), weight (kg), BP (mmHg) were recorded using standardized methods. Body mass index (BMI kg/m<sup>2</sup>) was calculated. Self reported duration of sleep

*Address for correspondence*

**Dr. Pushpa Krishna**, Professor  
Dept.of Physiology, Kempegowda Instt of Medical Sciences, 24<sup>th</sup> Main, Banashankari 2<sup>nd</sup> Stage  
Bangalore - 560070. Ph: 9343812306  
Email: pushatte@yahoo.co.in  
vishalvng@gmail.com, shwetha\_1403@yahoo.co.in

for previous month was noted. Grouping of subjects was done based on average sleep duration per day with >7hours (n = 51) and <7 hours (n = 44) as adequate and inadequate sleep group respectively.

An institutional ethics committee approved this study, and all subjects gave informed consent for participation.

### ECG recording and analysis of HRV

Each subject underwent, standard, resting lead II electrocardiography (ECG) performed in supine position with the portable ECG (Powerlab, AD instruments, Australia) for 5 minutes duration.

Computerized ECG tracings were subjected to analysis using software (Labchart 6 PRO, (ADinstruments, Australia.) to measure frequency domain of HRV, after exclusion of artifacts automatically. Frequency domain measures obtained are total power ( $ms^2$ ), high frequency power (HF) ( $ms^2$ ), low frequency power (LF) ( $ms^2$ ), and LF/HF ratio. Components for HRV analysis were expressed in absolute ( $ms^2$ ) and normalized units (nu; in %). As HRV values were skewed these were transformed to logarithmic values. All data acquisition and analyses were carried out in accordance with established standards.<sup>(8)</sup>

Subjects were asked to abstain from tobacco, caffeinated beverages on the test day. All of the ECG recordings were done between 1 pm and 2 pm after a light meal and by the same person.

### Statistical analysis

The analysis of the data was done by grouping the subjects according to, average sleep duration per day with < 7 (n = 44) and >7 hours sleep (n = 51).

Data presented as mean± standard deviation. Differences between groups were tested using two-sample *t* test/ ANOVA. Pearson correlation coefficient was calculated to determine the relationship of the *p* value, A *P* value of < 0.05 was considered significant.

### Results

Total of 95 subjects (58men and 37 women) studied, 51 had adequate sleep (29 men and 22 women) and 44 had inadequate sleep.

No significant gender difference was observed in sleep duration so the data was pooled for further analysis. Subject characteristics by grouping according to sleep duration along with HRV measures within the groups

are presented in Table 1. The groups were similar with respect to age, BP and BMI.

There was significant difference in mean sleep duration between adequate and inadequate sleep groups (*pd* – 0.005).

HRV indices and HR were not significantly different between the two groups. However, the subjects with inadequate sleep had lower HF, HF in normalized units and higher values of LF, LF/HF ratio and increased heart rate compared to adequate sleep group (Table 1).

**Table 1** : Participant's characteristics and heart rate variability by sleep group

	Adequate sleep (n=51)	Inadequate sleep (n=44)
Age	20.068 ± 1.4531	19.7058 ± 1.3159
Males (%)	56.86	65.90
BMI (kg/m <sup>2</sup> )	25.39±9	24.39±3.7
SBP (mm. Hg)	116.4348 ± 20.17237	120.4286 ± 11.64965
DBP (mm. Hg)	75.0869 ± 10.015	75.5238 ± 7.800
Sleep duration (Hrs)	7.3725 ± 0.51	6.025 ± 0.63*
Heart rate	79.38 ± 10.6	82.36 ± 9.16
TP ( $ms^2$ )	2443.62 ± 1734.66	2550.90 ± 2070.717
log TP	7.53 ± 0.786	7.54 ± 0.8039
log LF	6.181 ± 0.849	6.1968 ± .7874
LF (nu)	41.942 ± 17.987	45.049 ± 16.7734
Log HF	6.386 ± 1.074	6.187 ± 1.147
HF (nu)	48.104 ±16.88	43.21 ± 15.74
LF/HF	1.19 ± 1.088	1.316 ± 0.946

Results expressed in mean ± SD . \* *P* < .05.

There were no significant associations between sleep duration and HRV measures. On restricting analysis to inadequate sleep group with sleep duration(<7 hrs)was inversely related to heart rate and HF and directly to LF and LF/HF ratio.

### Discussion

The present study assessed cardiovascular autonomic function as HRV measures in association with sleep duration.

There was no significant difference in the frequency domain HRV measures between the adequate and inadequate sleep groups. Results indicate that short sleep duration (<7hours) over a month period does not alter cardiac sympathetic and parasympathetic activity.

Previous results of significant increase in sympathovagal balance and a decrease in parasympathetic activity on acute sleep restriction/deprivation ranging

from 12 hours to 6 nights could not be confirmed in our study.<sup>(1, 2, 9, 10)</sup>

However Zhong et al reported that increased LF, LF/HF and decreased HF were found at 12-24 hours of sleep deprivation (SD) and do not consistently extend through 36 hours of SD,<sup>(1)</sup> thus indicating that acute effect of SD may be different from long term effect.

In healthy male college students ranging from 20 to 24 years of age, sleep deprivation for 4 weeks has been shown to cause an autonomic imbalance by decreasing time and frequency domain indices of HRV, but the study was made during the 4 weeks before and immediately after college finals exams.<sup>(7)</sup>

Sauvet and his coworkers found a significant increase in HR, HRV after sleep deprivation, suggesting a significant activation of sympathetic activity within 32 h of TSD.<sup>(2)</sup>

Tochikubo and colleagues<sup>(9)</sup>, measured increases in HRV, LF/HF during normal activities in young men after sleep restriction. Sleep restriction over the course of 6 nights resulted in increased sympathetic modulation as assessed by HRV analysis.<sup>(10)</sup>

Following acute moderate sleep deprivation of (2-4 hours), HRV was significantly reduced compared to 8-10 hours of sleep eliciting autonomic imbalance.<sup>(11)</sup>

HRV decreased in patients who underwent sleep restriction of 4 hours for just 5 nights indicating a shift of autonomic nervous system into high sympathetic mode.<sup>(4)</sup>

The difference in the results could be because of self reporting of sleep duration for past month. The previous studies were based on acute effects of sleep restriction and total sleep deprivation on HRV compared to baseline measures in the same subjects.

Other reasons for no change in HRV parameter among the groups are the sample being unpaired and role of recovery sleep / restorative sleep which have not been looked into. In a study on depressed patients during recovery sleep, cortisol secretion returned to baseline values though during the night of sleep deprivation, cortisol levels were significantly higher suggesting that the short-term effects of sleep deprivation may differ from their long-term effects.<sup>(12)</sup>

In the present study, we have not assessed the quality of sleep. Average sleep quality has been better related to health, than average sleep quantity indicating importance

of sleep quality in addition to sleep quantity to understand the role of sleep in various conditions.<sup>(13)</sup>

Though no significant group differences were observed in the present study it is interesting to note the relationship observed between short sleep duration and HRV measures (Table 2). The high LF, LF/HF ratio and heart rate and low HF in subjects with sleep duration < 7 hours per day compared to who sleep > 7 hours suggest short sleep duration is associated with altered cardiac autonomic modulation with increased sympathetic and decreased parasympathetic activity.

**Table 2 :** Correlation between frequency domains and sleep duration

	Sleep Duration Total Sample (N = 44)	Sleep Duration <7 Hours (N=95)	Sleep Duration >7 Hours (N=51)
HR	-0.162	-0.28	0.108
LF	0.052	0.27	0.107
HF	-0.031	-0.31	-0.15
LF/HF	0.046	0.24	0.05

### Limitations of the study

Nocturnal sleep duration only and not the total duration in relation to cardiac autonomic function was evaluated in this study.

Results observed in young subjects cannot be generalized to older subjects as HRV is found to be related to age. Age was associated with a significantly different cardiovascular response to sleep restriction.<sup>(4, 14)</sup>

### Conclusion

The present data suggest that sleep deprivation over a month do not alter cardiac autonomic activity in young adults as assessed by short-term heart rate variability. The short-term effects of sleep duration on the cardiac autonomic balance may differ from the long-term effects. Further studies are needed to evaluate the chronic effect of sleep quantity in a larger sample.

### Acknowledgments

The authors thank the medical students for volunteering and for their cooperation during the study.

## References

1. **X. Zhong**, H. J. Hilton, G. J. Gates, S. Jelic, Y. Stearn, M. N. Bartels, R. E. et al., Increased sympathetic and decreased parasympathetic cardiovascular modulation in normal humans with acute sleep deprivation. *J. Appl. Physiol.* 98(6): 2024-2032.
2. **Sauvet F**, Leftheriotis G, Gomez-Merino D, Langrume C, Drogou C, Van Beers P, Bourrilhon C, Florence G, Chennaoui M. Effect of acute sleep deprivation on vascular function in healthy subjects. *J Appl Physiol.* 2010 Jan;108(1):68-75.
3. **Zhong X**, Xiao Y, Huang R, Huang XZ. The effects of overnight sleep deprivation on cardiovascular autonomic modulation]. *Zhonghua Nei Ke Za Zhi.* 2005 Aug; 44(8):577-80.
4. Sleep restriction may reduce heart rate variability. *SLEEP* 2007: the 21st Annual Meeting of the Associated Professional Sleep Societies: Abstract 0089. Presented June 13, 2007.
5. **Sampei M**, Muruta K, Dakeishi M, Wood D C. Cardiac autonomic hypofunction in preschool children with short nocturnal sleep. *Tohoku J Exp Med.* 2006; 208(3):235-242.
6. **Spiegelhalder K**, Fuchs L, Ladwig J et al., Heart rate and heart rate variability in subjectively reported insomnia. *J Sleep Res.* 2011; 20:137-145.
7. **Takase B**, Akima T, Satomura K, Ohsuzu F, Mastui T, Ishihara M, Kurita A. Effects of chronic sleep deprivation on autonomic activity by examining heart rate variability, plasma catecholamine, and intracellular magnesium levels. *Biomed Pharmacother.* 2004 Oct; 58 Suppl 1:S35-9.
8. **Task Force.** Heart rate variability: standards of measurement, physiological interpretation and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. *Circulation* 1996; 93:1043-1065.
9. **Tochikubo O**, Ikeda A, Miyajima E, and Ishii M. Effects of insufficient sleep on blood pressure monitored by a new multibiomedical recorder. *Hypertension* 27:1318-1324.
10. **Spiegel K**, Leproult R, and Van Cauter E. Impact of sleep debt on metabolic and endocrine function. *Lancet* 354: 1435-1439, 1999.
11. **Moffit, Julia A.**; Jepson, Amanda J.; Decker, Emily S. Acute Moderate Sleep Deprivation Attenuates Physiological and Psychological Function at Rest and During Exercise.
12. **Voderholzer U**, Hohagen F., Klein T., Jungnickel J, Kirschbaum C, Berger M, Riemann D, Impact of Sleep Deprivation and Subsequent Recovery Sleep on Cortisol in Unmediated Depressed Patients. *Am J Psychiatry* 161:1404-1410.
13. **Pilcher JJ**, Ginter DR, Sadowsky B. Sleep quality versus sleep quantity: relationships between sleep and measures of health, well-being and sleepiness in college students. *J Psychosom Res.* 1997 Jun; 42(6):583-96.
14. **I. Antelmi**, R.S. de Paula, A. R. Shinzato, C. A. Peres, A. J. Mansur, and C. J. Grupi. Influence of age, gender, body mass index, and functional capacity on heart rate variability in a cohort of subjects without heart disease. *Am. J. Cardiol.*, 2004; 93(3):381-385.