Cardiac autonomic activity in young adults with short sleep

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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 >7 hours (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. In preschool children shortening of nocturnal sleep has been associated with both sympathetic and parasympathetic hypoactivity. Insomnia patients with short sleep duration, have been reported to have reduced parasympathetic activity. Effect of chronic sleep deprivation on cardiac autonomic activity has been less studied. 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/m²) was calculated. Self reported duration of sleep...
Grouping of subjects was done based on average sleep duration per day with >7 hours (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 (ms²), high frequency power (HF) (ms²), low frequency power (LF) (ms²), and LF/HF ratio. Components for HRV analysis were expressed in absolute (ms²) 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.(8)

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 (58 men 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**

<table>
<thead>
<tr>
<th></th>
<th>Adequate sleep (n=51)</th>
<th>Inadequate sleep (n=44)</th>
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<tbody>
<tr>
<td>Age (years)</td>
<td>20.068 ± 1.4531</td>
<td>19.7058 ± 1.3159</td>
</tr>
<tr>
<td>Males (%)</td>
<td>56.86</td>
<td>65.90</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>25.39 ± 9</td>
<td>24.39 ± 3.7</td>
</tr>
<tr>
<td>SBP (mm. Hg)</td>
<td>116.43 ± 20.17235</td>
<td>120.42 ± 11.64965</td>
</tr>
<tr>
<td>DBP (mm. Hg)</td>
<td>75.08 ± 10.015</td>
<td>75.52 ± 7.800</td>
</tr>
<tr>
<td>Sleep duration (Hrs)</td>
<td>7.37 ± 0.51</td>
<td>6.02 ± 0.63*</td>
</tr>
<tr>
<td>Heart rate</td>
<td>79.38 ± 10.6</td>
<td>82.36 ± 9.16</td>
</tr>
<tr>
<td>TP (ms²)</td>
<td>2443.62 ± 1734.66</td>
<td>2550.90 ± 2070.717</td>
</tr>
<tr>
<td>log TP</td>
<td>7.53 ± 0.786</td>
<td>7.54 ± 0.8039</td>
</tr>
<tr>
<td>log LF</td>
<td>6.181 ± 0.849</td>
<td>6.1968 ± 0.7874</td>
</tr>
<tr>
<td>LF (nu)</td>
<td>41.94 ± 17.987</td>
<td>45.04 ± 16.7734</td>
</tr>
<tr>
<td>Log HF</td>
<td>6.386 ± 1.074</td>
<td>6.187 ± 1.147</td>
</tr>
<tr>
<td>HF (nu)</td>
<td>48.104 ± 16.88</td>
<td>43.21 ± 15.74</td>
</tr>
<tr>
<td>LF/HF</td>
<td>1.19 ± 1.088</td>
<td>1.316 ± 0.946</td>
</tr>
</tbody>
</table>

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 (<7 hours) 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.(1, 2, 9, 10)

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, 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. (7)

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. (2)

Tochikubo and colleagues(9), 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.(10)

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

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. (4)

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. (12)

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. (13)

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

<table>
<thead>
<tr>
<th>Sleep Duration</th>
<th>Total Sample (N = 44)</th>
<th>Sleep Duration &lt;7 Hours (N=95)</th>
<th>Sleep Duration &gt;7 Hours (N=51)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR</td>
<td>-0.162</td>
<td>-0.28</td>
<td>0.108</td>
</tr>
<tr>
<td>LF</td>
<td>0.052</td>
<td>0.27</td>
<td>0.107</td>
</tr>
<tr>
<td>HF</td>
<td>-0.031</td>
<td>-0.31</td>
<td>-0.15</td>
</tr>
<tr>
<td>LF/HF</td>
<td>0.046</td>
<td>0.24</td>
<td>0.05</td>
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</table>

Limited 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. (4, 14)

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

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References


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