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Effects of sleep restriction on glucose tolerance and blood pressure in young adults

The stress of sleep loss under the demands of student life conditions, including exam sessions or social student activities is not possible to replicate in laboratory conditions, but would be worthy to study in order to estimate the impact of acute and chronic sleep deprivation on the health of medical students.

A group of SJSM students also wanted to determine whether sleep deprivation has effects on glucose tolerance and regulation of blood pressure in young adult healthy subjects.

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Effects of sleep restriction on glucose tolerance and blood pressure in young adults

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Introduction

Sleep deprivation is considered as an important stress inducer. Particularly, sleep deprivation has profound effects on several biologic processes, including memory consolidation, immunologic responses and neuroendocrine function (2).

There is a substantial body of empirical evidence indicating that sleep can influence glucose metabolism (3). Several cross-sectional and longitudinal studies have also demonstrated a link between short sleep duration, poor sleep quality and increased risk of obesity (4), diabetes (5), hypertension (6), cardiovascular disease and metabolic syndrome (7). By the present time there were only limited number studies measuring effect of sleep restriction on glucose metabolism in healthy young adult female population (8).

The stress of sleep loss under the demands of student life conditions, including exam sessions or social student activities is not possible to replicate in laboratory conditions but would worth to study in order to estimate impact of acute and chronic sleep deprivation on health of medical students.

Aim of the study

To determine whether sleep deprivation have effects on glucose tolerance and regulation of blood pressure in young adult healthy subjects.

Materials and Methods

Subjects: Volunteers were recruited from the Anguilla campus to take part in this study (n=5). Volunteers were between the ages of 21-39 with a BMI of less than 26, and consume less than two alcoholic or three caffeinated beverages per day, habitually sleep for at least 7 hrs/night, and have usual bedtime before 1 AM. Additional inclusion criteria included absence of cigarette smoking, and use of any prescription medication or non-prescription NSAIDs in the last 3 months. Volunteers were asked to carry out the following timelines of the study and reporting to the co-investigators at the end of each timeline

Monitoring of sleep duration: We asked the participants to complete a sleep diary and use iPhone/IPod application "SleepCycle" which allows monitoring of total sleep duration based on body motions pattern during bedtime.

Oral Glucose Tolerance Test :
Every individual was then given an oral glucose tolerance test (OGTT), which was used to categorize the participants into normal, pre-diabetic or diabetic classifications. Testing was performed using glucose measuring meters and testing strips. The blood glucose levels of subjects were measured after fasting 12hrs. Immediately following the fasting glucose measure, the participants were asked to drink 75g of glucose solution (75g/500mls water).
Two additional measurements were done at the 1-hour and 2-hour after glucose challenge. Systolic and diastolic blood pressures were taken by the manual sphygmomanometer before initiation of blood collection.

Statistical Analysis:
Statistical Analysis. For all measured parameters mean values ±SEM were calculated for each time point of BL, SR, and REC periods. In addition, SR and REC values were expressed as percentages of each individual participant's BL value, that is, normalized. We have compared SR and REC values to
BL values by applying paired t-tests for normally distributed differences and Wilcoxon signed ranks tests for differences that were not normally distributed. The normality of differences was checked using
Kolmogorov-Smirnov goodness of fit test. AP-value<.05 was considered to be statistically significant.
All statistical analyses were carried out using STATGRAPHICS PLUS 2.1.

Results

Table#1 Changes in Fasting Blood Glucose Levels before and after Sleep Restriction

Fasting Glucose, mg/dL	BL	SR	Rec
Participant1	115	111↓	85↓
Participant2	95	95-	80↓
Participant3	79	110↑	100↓
Participant4	75	100↑	89↓
Participant5	69	94↑	80↓
Mean	86.6	102	86.8
SD	18.56	8.1	8.28
SEM	8.30	3.62	3.70
SR vs BL p-Value		**0.28**	
REC vs SR p-Value			**0.059**

Table#1 Changes in Fasting Blood Glucose Levels before and after Sleep Restriction

2hrs Glucose Tolerance Test, mg/dL	BL	SR	Recovery
Participant1	128	134↑	110↓
Participant2	98	105↑	94↓
Participant3	54	60↑	89↑
Participant4	80	100↑	89↓
Participant5	115	127↑	118↓
Mean	95	105.2	100↓
SD	26.01	25.97	11.84
SEM	11.66	11.61	5.29
SR vs BL p-Value		**0.058**	
REC vs SR p-Value			0.59

Table#3 Sleep duration and Systolic Blood Pressure

Blood Pressure/systolic mm Hg	BL	SR	Recovery
Participant1	110	90	102
Participant2	118	120	115
Participant3	120	115	120
Participant4	110	115	110
Participant5	123	120	121
Mean	116.2	112	113.6
SD	5.30	11.22	7.0
SEM	2.37	5.01	3.1
SR vs BL p-Value		0.49	
REC vs SR p-Value			0.78
Blood Pressure/Diastolic	BL	SR	Recovery
Participant1	72	66	60
Participant2	78	80	75
Participant3	80	76	80
Participant4	80	75	74
Participant5	73	74	71
Mean	76.6	74.2	72
SD	3.4	4.5	6.6
SEM	1.5	2.0	2.9
SR vs BL p-Value		0.14	
REC vs SR p-Value			0.22

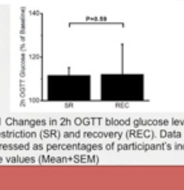

Figure 1 Changes in 2h OGTT blood glucose level after sleep restriction (SR) and recovery (REC). Data are expressed as percentages of participant's individual baseline values (Mean+SEM)

Results

Fig.2 Representative actigramms of the male volunteer. Base- Baseline 8hr sleep duration/ day, SR- Sleep Restriction (4hrs/day), REC – recovery (8 hrs/day)

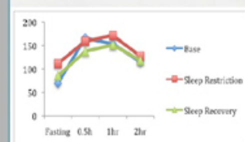

Figure 3 Results of OGTT in female participant (left) and male participant (right) whose sleep duration was monitored by utilizing actimetry method ("SleepCycle" application)

Conclusions:
1. Sleep Restriction to 4 hours/night for 4 consecutive days, causes a moderate disturbance in glucoregulatory response and may cause an insulin resistance in healthy, nonobese subjects, as assessed by fasting glucose and GTT
2. Sleep Restriction to 4 hours/night for 4 consecutive days
2. The sample size used in this experiment was too small (n=5) to generate a significant difference and so a future study must include a larger sample size.

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