



## Effect of sleep on glucose metabolism

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### Abstract:

**Background:** Glucose, the main metabolic fuel in our body is regulated by various factors inside and outside our body. These factors have become a leading cause in the development of diabetes in our society. One such hidden factor that most of us do not realise is sleep especially night sleep. Night sleep- is a state where most of the hormones in our body gets regulated. A good night sleep is required for maintenance of body's circadian rhythm, this rhythm gets disrupted when night sleep is lost, like persons working in shifts, rotational shifts and on continuous night shifts. This changes the lifestyle patterns in individuals and slowly drifts into a society. Most of these night shift workers become a diabetic at a very early state and suffer from occupational stress induced non-communicable diseases. We designed this study to compare the fasting plasma glucose level in day and night workers. **Materials and methodology:** This study included 80 subjects, 40 in both shifts and only males. Subjects suffering from diabetes, hypertension and chronic illness were excluded from this study. **Results:** The occurrence of impaired fasting glucose was found to be higher in night shift workers than in day shift workers.

**Keywords:** Night shift, sleep, melatonin, impaired glucose tolerance.

### Introduction:

Night shift workers do work at times that is supposed to be dedicated for sleep [1], They try to stay awake in the night and sleep in the day which is discontinuous and is disrupted by factors like light, noise, phone calls food and recreation.

Hormone that is regulated in the night majorly is melatonin, its secretion occurs during a good night sleep as they peak at midnight, and lights of natural or artificial source do not help in their secretion but they stop their production. Melatonin acting as a biological clock exerts its effects on various metabolic reactions inside the body including carbohydrate metabolism.

Cortisol a hormone of stress and fright is known to get increased when there is lack of sleep [2]. It is also said that with decrease in sleep there is increase in ghrelin production that increases appetite. When night sleep is disturbed, the body's circadian rhythm is changed; the hormones that need this rhythm for their production get affected. It is found that insulin secretion follows a circadian rhythm in synchronisation with melatonin. But in our study we have not analysed all these variables, we designed a

pilot study to see if there is any rise of glucose levels on comparison between the shifts.

### Materials and Methods:

This cross sectional study was done from January 2015 to march 2015; which included subjects in two categories only day shift and only night shift for a duration of 6months. The first group (day shift workers) was chosen from persons attending master health check-up at Chettinad hospital and research institute and the second group(night shift workers) was chosen from nearby company, where people were doing continuous night shifts for a period of 6 months. Persons previously diagnosed with any disease diabetes, hypertension, CKD, hepatic failure, tuberculosis or people on vitamin D supplements and females were excluded from this study. After getting consent, questionnaire were distributed to the subjects, waist circumference was recorded using an inch tape. 5ml blood was drawn by a skilled phlebotomist using vacutainer with grey top for measuring – fasting plasma glucose. This study was approved by the ethical board of Chettinad academy of research and institute.

**Statistical analysis:**

It was done by SPSS software version 21 and mean standard deviation and student p test was performed and presented as percentages%. Independent sample student T-test was used to compare means between both shifts. Significance was set at  $P < 0.05$ .

**Results:****Table 1:** Comparison between night shift and day shift

	Shift				Independent Samples t-test	
	Night		Day		t-value	Sig.
	Mean	SD	Mean	SD		
Age	21.93	2.27	30.62	5.00	-9.693	0.000
Sleep Hours/day	6.65	1.14	9.59	1.38	-1.02	0.000
Physical activity	3.5	0.7	5.1	0.8	6.1	0.001
Waist circumference	97.03	8.47	91.6	13.83	2.064	0.042
FPG	99.8	8.86	97.2	8.37	-1.42	0.07

**Discussion:**

This study showed significant p value for the following variables- age, sleep hours, physical activity and waist circumference. It was difficult to obtain woman doing continuous night shifts and hence we designed this study with only males. Sleep hours showed a major significant difference between the groups. National sleep foundation suggests that minimum requirement of night sleep should be 7-9 hours of per day and sleep hours of 5.5 or less than that impacts the health of a person. In our study we found there was 6.65 hours of sleep during day time among night shift workers but still they showed some effects on the body [3]. This may be due to discontinuous sleep patterns which unfortunately we did not analyze in depth and is a major limitation in our study. Physical activity was one of the variables that showed significant difference. Physical activity is defined as any body movement that works your muscles and requires more energy than resting. An average of at-least 150 minutes of brisk walking or 75 minutes of jogging and other strengthening exercises are required by the body per week [4]. Physical activity invariably gets reduced in night shift workers as they tend to sleep the whole day. The average of 5 hours per week got in the day shift workers is only due to minimal walk around the work place. The outcome

of the above stated variables was reflected badly on waist circumference in our study. According to WHO [5] and revised NCEP ATP III guidelines [6] it insists on waist circumference instead of BMI as one of the criteria for metabolic syndrome. The recommended reference range for Asian men is 89cm. We chose waist circumference over BMI because in a study done by Sahar Dalvand et al it is said that waist circumference predicts visceral obesity better than BMI [7]. Though there was significant p value in waist circumference between both the groups i.e. an average of 97cm in night shift workers and 91 cm in day shift workers we can see that both the groups had higher range than the reference value, this may be due to poor lifestyle pattern in day shift workers. On comparison of waist circumference between the groups we found that night workers have higher average waist circumference which might be pointing to other hormonal factors like melatonin, which is produced only in night sleep in complete darkness, melatonin has a link on various metabolisms in our body. Melatonin acts through MT1 and MT2 membrane receptors that acts through cAMP, cGMP, and IP3 signaling pathways and regulates insulin secretion. It also regulates the growth and differentiation of pancreatic  $\beta$ cells by stimulating IGF receptors and Insulin receptors. It also activates two intracellular signaling pathways: PI3K/AKT (involved with cell metabolism) and MEK/ERKs (involved in cell proliferation, growth and differentiation). When there is lack of sleep there is decreased production of melatonin this in-turn leads to insulin resistance and diabetes [8]. "Insufficient sleep, poor sleep quality, including sleep apnoea, and irregular sleep-wake cycles such as those that occur in shift work have all been linked to an increased risk of type 2 diabetes," said sleep researcher Eve Van Cauter of the University of Chicago [9]. Cortisol levels also go high when there is lack of sleep. Cortisol has negative impact on insulin action. Ultimately all these factors increase the circulating levels of glucose [10]. Ghrelin a hormone of appetite is known to get increased when there is lack of sleep. The food patterns alter in shift workers, they tend to eat more to stay awake in night and most of it is loaded with carbohydrates. Excess carbohydrate enters the body, underutilized and stored as triacylglycerol in central adipose tissue because of the above mentioned hormonal interactions and may increase waist circumference. We did not get significant difference in FPG levels among both shifts may be due to small sample size, but when we analyzed the night shift workers samples we found that most of them had high fasting plasma glucose levels. More than 50% of them showed impaired fasting

glucose levels in night shift workers and their mean was 105mg/dL. Melatonin is involved in the synthesis and secretion of insulin [11] they also regulate expression of transporter of glucose GLUT4 and triggers phosphorylation of insulin receptors through tyrosine kinase helping in insulin action. Hence reduction in melatonin can lead to insulin resistance. All these naturally lead to increase in glucose levels in the body. Here many factors play a role like low melatonin, increased food intake at night, and lack of physical activity. Continuous follow up of these night shift workers for a year showed up that 1 person became a diabetic and 3 more fell into the impaired fasting glucose category. We couldn't analyze further in the same group by changing their shift patterns or increasing physical activity as they all moved to their native. Low sample size, inadequate details in questionnaire on sleep quality was our major limitation.

### Conclusion:

Though we couldn't get statistically significant p value for FPG, we like to emphasize that individual analysis shows 50% of night shift workers had impaired fasting glucose. Sleep may trigger the development of disease such as insulin resistance, independently of factors such as job strain and physical activity.

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