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Relationship of lipid profile and cortisol circadian rhythm in Rotating Night shift and Day shift police workers

[1]Mrs Bharti Maan, Department of Physiology, J.L.N Medical College, Ajmer, Rajasthan, India.
[2]Dr Garima Bafna, Department of Physiology, J.L.N Medical College, Ajmer, Rajasthan, India.
[3]Dr Teena Sogan, Department of Physiology, J.L.N Medical College, Ajmer, Rajasthan, India.
[4]Dr Sarita Sharma, Department of Physiology, J.L.N Medical College, Ajmer, Rajasthan, India.
[5]Dr Mukesh Chaturvedi, Department of Physiology, S.M.S Medical College, Jaipur,
Corresponding Author: Dr Mukesh Chaturvedi, Department of Physiology, S.M.S Medical College, Jaipur,

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Abstract

Introduction: Night shift work has been associated with several negative effect on health. The health of night shift workers may affect possibly due to circadian desynchronization, sleep deprivation and suppression of nocturnal melatonin secretion including exposure to the light during the night shift. In addition, it is implicated in higher rates of the metabolic disorder and cardiovascular disease.

Aims and objective: The aim of our study was to find out the relationship of lipid profile and cortisol circadian rhythm in night and day shift workers.

Method: Blood samples was obtained from 60 individuals (30 individuals of night shift workers and 30 individuals of day shift workers) from the Abhay command centre (police officers) with no history of chronic disease. Demographic and personal information were obtained through a self-administrative questionnaire. After obtaining all parameters were noted.

Result: The serum cortisol level was found highly significant difference $p<0.00001$ in Night shift workers as compared to day shift workers and total cholesterol, HDL, LDL and VLDL were also found statistically significant in night shift workers.

Conclusion: Night shift work can impact sleep altering the circadian clock, disconnecting the environment cycle (dark light) from the biological cycle (sleep-wake). Night shift work is also associated with dyslipidemia. The increasing prevalence of shift work worldwide and heavy economic burden of cardiovascular diseases that may be promoted by dyslipidemia in shift workers, So the present study concluded that the good quality of sleep after night shift is necessary to minimize the negative impact on the worker's health and facilitate the recovery of the hypothalamic-pituitary axis.

Keywords: shift work, night shift, circadian rhythms, cortisol, sleep, Desynchronization.

Introduction

Sleep is a state of transient unconsciousness from which the person can be aroused by sensory or other stimuli.[1] Till the middle of the 20th century, sleep was thought to be a passive process. It was a common belief that our

neurons become inactive and undergo a dormant phase. But recent studies showed that "during sleep our neurons are constantly in a firing state". The role of sleep in balancing the mental and physical wellbeing of the individual is just beginning to gain importance as an area of research. Sleep is under the control of circadian rhythm.

Human natural body rhythms are called circadian rhythms which are regulated by a "circadian clock"; located in the hypothalamus. This biological clock is synchronized by receiving the photic information from light sensitive ganglion cells in the retina, thereby entraining individuals' physiology and behavior to the external day–night cycle.[2,3] Nearly all of the biological processes including the sleep-wake cycles, body temperature, energy metabolism, cell cycle and hormone secretion have a circadian rhythm and are controlled by this circadian clock.[4,5]

Cortisol is an excellent marker of circadian rhythm.[6] It is controlled by the hypothalamic-pituitary-adrenal (HPA) axis and has anti-inflammatory, metabolic and immunosuppressive effects.[7,8] Cortisol levels usually peak in the morning and decrease throughout the day; concentrations are minimal at night. This cycle has what is known as response to cortisol awakening (CAR), a peak in cortisol production that occurs 20 to 30 minutes after awakening.[8] Factors that influence cortisol secretion include daytime rhythm, alertness and the sleep-wake cycle, along with neural pressure signs.[7]

Changes in the light-dark synchronization due to continuous exposure to light can contribute to a loss of synchronization of the biological clock. Evidence suggests that circadian desynchronization, sleep deprivation and suppression of nocturnal melatonin release by exposure to light are the main pathological mechanisms through which night-shift work produces harmful effects on worker's health.[9]

Some physiological mechanisms have been proposed to explain links between shift work and adverse health outcomes. Among others, shift work-caused disruption of the circadian time organization is one core explanation, which exerts far-reaching effects at the molecular and cellular levels. Exposure to shift work during one's occupational career, through the close physiological interaction of circadian clock-related and cell-cycle factors, may result in a variety of processes that initiate epigenetic modifications, with malignant potential. Supportively, expression and methylation of circadian genes, such as BMAL1 and PER1, are evident among shift workers in recent years.[10-12] Meanwhile, melatonin which is produced in the pineal gland and circulated during darkness has received significant attention in shift work research. It exerts broad effects, via specific receptors or entry into cells directly as a small lipophilic molecule, playing a crucial role in regulating the circadian time organization. Commonly co-existing with circadian disruption, "melatonin hypothesis" was formulated in 1987 to link melatonin suppression and cancer risk.[13]

The aim of our study was to find out the relationship of lipid profile and cortisol circadian rhythm in rotating night shift and day shift workers.

Material & Methods The study was conducted in Department of Physiology, J.L.N Medical College Ajmer & attached hospital.

Study design: This was a Prospective observational study which carried out in Abhay command centre (Integrated command and control centre) Ajmer.

Informed written consent was taken from all subjects after ethical clearance by the ethical committee of

Jawaharlal Nehru Medical college Ajmer, Rajasthan India.

Study population and sample size: Subject between 25 to 45 years of age with rotating night shift and day shift workers.

Inclusion criteria: Total 60 samples were collected and divided into two groups:

Group A- Included 30 subjects of rotating night shift workers.

Group B- Included 30 subjects of day shift workers.

Exclusion criteria: Alcoholic and smoker, Chronic disorders.

Day shift workers and Night shift workers:

Each study subject had a 7 consecutive days of duty

Day shift workers were defined as those individuals who worked from (9am to 2pm).

Rotating Night shift workers were defined as those who worked from (10:00pm to 7:00am).

Collection of data: Data were collected by a structured interview questionnaire, included demographic data, working conditions, occupational history and health related behaviors.

Anthropometric measurements, such as height, weight, body mass index (BMI) were taken by trained hospital staff.

BMI was calculated by the using the following equation: BMI = weight (kg) / height (m2) (Bray, 1993).

1. **Serum Cortisol level:-** Blood sample was collected in the morning in between (7am to 9 am) with overnight fasting of 12 hours undergo serum cortisol.

2. **Lipid profile Screening Protocol:-** A serum lipid profile, including total cholesterol, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol and triglyceride (TG), and very low density lipoprotein (VLDL) was collected from subjects after fasting for 12 hours, and the laboratory results were assessed.

Both the test was done by chemiluminescent enzyme immunoassay method.

- According to Adult Treatment Panel (ATP) III (2003), normal ranges of lipid profile are: Lipid Guidelines 2018: Updates from ACC/ AHA Guidelines 2013 was Total Cholesterol: <200, Triglycerides: <150, LDL Cholesterol: <100, HDL Cholesterol: >40

Results

Table 1: Comparison of mean values of Anthropometric Data in Rotating Night shift workers and Day shift workers

Sn.	Variable	Rotating Night shift workers	Day shift workers	P-value
1.	Age	31.83±7.51	33.70±7.00	0.16
2.	Weight	73.06±8.85	75.1±9.71	0.19
3.	Height	1.70±0.06	1.75±0.08	0.006*
4.	BMI	25.10± 4.99	24.30± 3.34	0.06

*=p value is significant

Table 1 showed mean Age, weight, height and BMI, there was no statistically significant result observed in age, weight and BMI with ($p>0.05$). The mean Height showed the significant result with $p<0.006$.

Table 2: Comparison of mean values of serum cortisol level in Rotating Night shift workers and Day shift workers

Sn.	Variable	Rotating Night shift workers	Day shift workers	P-value
1.	Serum Cortisol	17.76 ± 3.64	8.01± 2.91	0.00001**

**= p value is highly significant

In Table 2 and Figure 1 showed that the mean Serum cortisol level was highly significant among rotating night

shift workers as compared to day shift workers (17.76±3.64 compared to 8.01 ±2.91) with p<0.00001.

Figure 1: Comparison of mean values of serum cortisol level in Rotating Night shift workers and Day shift workers

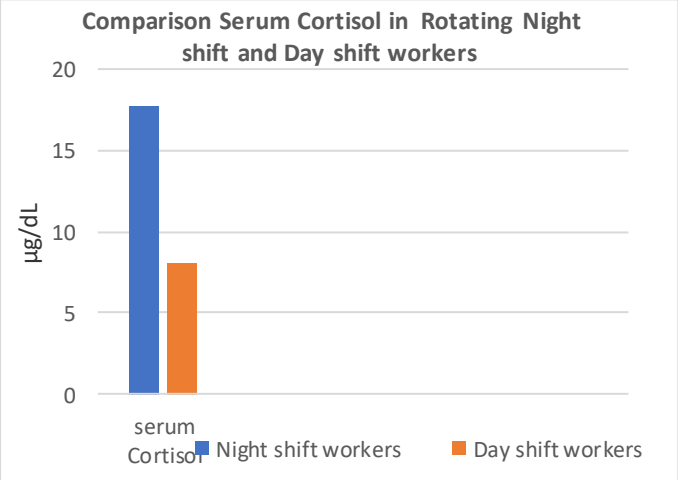


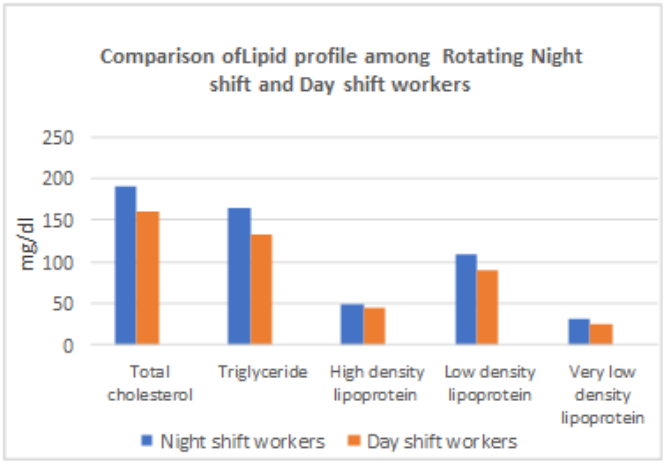
Table 3: Comparison of mean values of lipid profile in Rotating Night shift workers and Day shift workers

Sn.	Variable	Rotating Night shift workers	Day shift workers	P-value
1.	TC	190.78±41.47	161.59±20.6	0.001**
2.	TG	165.0±60.32	132.67±47.4	0.02*
3.	HDL	48.50± 8.35	45.63± 7.07	0.15
4.	LDL	108.83±31.4	90.43± 22.8	0.01*
5.	VLDL	31.67± 9.18	25.87± 9.09	0.01*

*= p value is significant, **= p value is highly significant.

TC- Total cholesterol, TG- Triglyceride, HDL- High density lipoprotein, LDL- Low density lipoprotein, VLDL- Very low density lipoprotein.

Figure 2: Comparison of mean values of lipid profile in Rotating Night shift workers and Day shift workers



In Table 3 and Figure 2 showed that the mean of total cholesterol was significantly higher among rotating night shift workers compared to day shift workers (190.78±41.47 compared to 161.59 ±20.6) with p<0.001. The mean triglyceride was also significantly higher in rotating night shift workers compared to day shift workers (165.0± 60.32 compared 132.67± 47.4). The mean LDL was significantly higher in rotating night shift workers compared to day shift workers (108.83 ±31.4 compared to 90.43±22.8) with p <0.01. The mean VLDL was significantly higher in rotating night shift workers as compared to day shift workers (31.67 ±9.18 compared to 25.87± 9.09). There was no significant difference was observed HDL in rotating night shift workers as compared to day shift workers (48.50±8.35 compared to 45.63± 7.07) with p>0.15.

Discussion

The aim of present study was to examine the effect serum cortisol level in rotating night shift workers and day shift workers. Drawing on a sample of police officers from Abhay command centre Ajmer, we found that rotating night shift workers has higher level of serum cortisol level as compare to day shift workers (p= 0.00001). The present study was consistent with Kudielka et al. (2007)

studied on German workers in an electronic manufacturing plant for 2 months, and reported that salivary cortisol was significantly increased in the group of night shift[14] similarly, Lammers-van der Holst HM et al. (2015) a Dutch study in police officers suggested waking salivary cortisol began to rise from baseline to significantly higher levels at one-year follow-up after they started shift duty, then declined slightly at two-year follow-up.[15] However, Copertaro et al. (2011) did not confirm any significant association of shift work with serum cortisol among Italian nurses with one-year follow-up.[16]

The night shift workers had less hours of sleep compared to people who worked in the daytime. They also presented more obesity, overweight and higher AC. Night shift workers also had worse associations between BP and sleep. The night shift workers, even though sleeping more on their days off, did not regain the sleep deficit produced by the working days. Sleep debt may be due to many reasons, mainly the presence of light during the time for sleeping, the increased temperature and an altered cortisol secretion.[17]

The present study also found that the mean values of total cholesterol (p=0.001), triglyceride (p=0.02), LDL(p=0.01), VLDL(p=0.01) were statistically higher in rotating night shift workers as compare to day shift workers, whereas the mean value of HDL was nonsignificant among the both groups. This study is consistent with Lennernas et al (1994), they documented that dietary intake is lower during night shift than during morning and afternoon shifts. According to them, the redistribution of food intake from diurnal eating to nocturnal eating is related to serum total cholesterol, LDL- cholesterol. Even if the dietary intake and quality are similar in day workers as well as shift workers, there are still differences in eating habits that might contribute to differences in levels of serum lipids.[18]

Gadallah et al., (2017) also found that the proportion of shift nurses with abnormal LDL (≥130 mg/dl) was significantly higher than the corresponding proportion among day shift nurses (43% compared to 26.6%).[19]

Raouf et al, (2020) stated that LDL ≥130 mg/dl, percentage of shift workers with LDL ≥130 mg/dl was significantly higher than percentage of daytime workers (34.5% compared to 15.4%) In that study, there was no significant differences were found in HDL levels between shift workers and daytime workers.[20]

The increased values of lipid profile in rotating night shift workers probably due to desynchronization of rhythmic physiological functions, that also impairs the duration and quality of sleep, interferes in the control of food intake, manifested metabolically by the increased levels of ghrelin and reduced levels of leptin, and may contribute to possible pathological mechanisms.[21]

Shift work also disrupts behavioral rhythms such as the timing of meals, which a growing body of research suggests has consequences for metabolic processes and health (Banks et al. (2015);[22] Skene et al. (2018)[23]. In a study of police officers on rotating shift schedules, Kosmadopoulos et al. (2020)[24] found that caloric intake was significantly more dispersed across the 24-hrs day, with a greater proportion of caloric intake at night, on night-shift days than other types of days. The cause of this impairment of metabolism is hypothesized to be due to the circadian misalignment of peripheral clocks in the liver, pancreas, and gastrointestinal tract due to changes in the fasting/feeding cycle.[25,26]

Conclusion and recommendation

This study concluded that rotating shift work especially night shifts has negative effects on health as it contributes in developing of metabolic syndrome. So prevention

programs should be implemented for high risk persons. Health practitioners should be aware of this association and be able to advice to minimize hazards of rotating shifts. In this context, adequate and good quality sleep after night shifts is necessary to minimize the negative impacts on workers' health and facilitate recovery of the HPA axis.

Primary prevention through lifestyle modifications (such as sleep hygiene practices, light therapy, eating and exercise habits, pharmaceuticals) is the best way to address both the quality of life and the long-term health care burdens in rotating shift workers.

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