National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

Effect of shift work on physiological parameters: A study among security personnel

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Received: September 17, 2018, **Accepted:** November 22, 2018

ABSTRACT

Background: Circadian rhythm is the natural internal clock that controls the release of various hormones and enzymes that govern the body's daily physiological and psychological activities. When there is a distortion of this natural rhythm as in shift workers, the resulting circadian dysrhythmias impact negatively on their health and social well-being. The incidence of health conditions, such as heart disease or digestive disorders, is increased due to the stress of shift work. **Aims and Objectives:** The aim of the study was to investigate the changes in physiological parameters (i.e., body composition, pulse rate, and blood pressure [BP]) among the security personnel who were having shift work schedule. **Materials and Methods:** A total of 70 security personnel of which 35 were having shift work schedule and remaining were controls were included in our study after applying inclusion and exclusion criteria. Anthropometric measurements, body composition indices, average pulse rate, and BP were recorded. The data were then statistically analyzed. **Results:** Our study revealed that shift workers had a statistically significant increase in diastolic BP (DBP) compared to day workers, while the average pulse rate and systolic BP (SBP) showed the non-significant difference. We found a significant positive correlation of BMI with waist circumference, body fat and total body water in both the group of the study population, while BMI was significantly correlated with SBP and DBP only in shift workers. **Conclusion:** Shift workers are more prone to develop overweight, obesity, and hypertension than the day workers.

KEY WORDS: Shift work; Obesity; Body Composition

INTRODUCTION

As per the International Labour Office,[1] "A method of work organization under which groups of workers succeed each other at the same workstations to perform the same operations" is called shift work.

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2019.9.0929422112018	

Shift work schedule which is very common these days had been prevalent since the Roman times. In the developed countries, due to rapid industrialization in the past few decades, there has been a tremendous increase in the population of shift workers, the developing countries are also facing the same situation.[2] The shift workers include health-care professionals especially those involved in emergency care, police personnel, pilots and crew members, Business process outsourcing employees, and security guards. The security personnel plays an integral proactive part in creating a safe working environment of university campus and hospital round the clock, but they are usually unaware of the deleterious effect of shift work schedule on their health.

The psychology and psychophysiology of working in shift are closely associated with the rhythmic timing system of humans, particularly that having a 24 h period, the circadian system. It has its neural basis in the lower frontal hypothalamus, situated above the optic chiasma.[3] These suprachiasmatic nuclei produce a cyclic oscillation with a period of 24 h. Although the rhythm is rather stable, it may be modified by environmental synchronizers such as light, sleep, and food.

Shift work results in disruption of the circadian rhythm which leads to not only sleep disorders and exhaustion but they also face many domestic, social, and various health problems such as breast cancer,[4] cluster headache,[5] ischemic heart disease,[6] widespread complaints of fatigue, stress, and decreased sexual performance.[7] Accidents are increased as a result of shift duty.

The present study is aimed to investigate the changes in physiological parameters of the security personnel who were involved in shift work schedule.

MATERIALS AND METHODS

This case–control observational study was conducted in the department of physiology after taking clearance from Institutional Ethical Committee and written informed consent from the participants of the study. The security personnel of Swami Vivekanand University campus was included in the study.

The study was done on a total of 70 apparently healthy adult male subjects aged 26–50 years. The subjects were divided into study group (35 subjects) and control group (35 subjects). The study group comprised those who were doing shift duty for a period of >1 year. Control group comprised those who were working only during daytime (7 am–7 pm) for >1 year. Those with a history of preexisting conditions such as diabetes, hypertension, congestive heart disease, sleep disorders, psychiatric illness, other endocrine disorders, medication, and alcohol intake were excluded from the study.

The various physiological parameters such as pulse rate, blood pressure (BP) (systolic and diastolic), and body composition were recorded at the end of their respective duty. Pulse rate was recorded manually for 1 min. Three readings at an interval of 1 min each were recorded, and the average of all the readings was calculated to get the average pulse rate at a time. BP was recorded with the help of digital sphygmomanometer (OMRON model-HEM-7120). The BP was measured thrice 15 min apart. Then, the mean value of the three readings was taken. Body composition indices were recorded by Bodystat Quadscan 4000 multi-frequency analyzer. Parallel plane stadiometer was used to measure height. The height was measured without shoes with a correction of 0.5 cm. Weight was taken with minimal clothing. Hip circumference and waist circumference (WC) were measured. Two measurements were made on each site and third reading was taken if they differed by >1 cm. Subjects were asked to refrain themselves from coffee, alcohol, and exercises. They were asked to report with light breakfast subjects. During the measurement, subjects were not allowed to wear any metallic thing or mobile. Subject has to lie supine on a wooden couch with arms and ankles apart from each other and trunk. We cleaned the site of the electrode with alcohol, and the red electrode was placed on the knuckles and black on the wrist in the right upper limb. In the right lower limb red lead was placed behind the toes and black in between the medial and lateral malleoli. Bioelectric impedance analysis was done with Quadscan within 5 min of lying down. The parameters recorded were: Body fat in kg, lean body mass, total body water (TBW), body mass index (BMI), and waist-hip ratio (WHR).

Statistical Analysis

Data were analyzed using GraphPad InStat version 3.10, 32 bit for windows. The publisher is GraphPad software Inc. Comparisons were done between basal values of control and test group by applying Student's *t*-test (unpaired). The statistical significance level was considered at $P < 0.05$.

RESULTS

In our study, 70 male subjects aged 26–50 years were included after applying both inclusion and exclusion criteria, out of which 35 were in the control group and remaining 35 were in the study group. Table 1 shows the demographic profile of the control and study group. Table 2 shows that overweight and obesity are more common in shift workers than the day workers. The percentage of underweight subjects was same (5.71%) in both groups. However, in day workers 68.57% had normal weight while it was 54.28% in shift workers. The percentage of overweight subjects in day workers was 25.71%, while in shift workers it was 28.57%. There were no obese in day workers whereas in shift workers 8.57% were obese Grade I and 2.85%

Table 1: Comparison of demographic profile between the control and study group

Attribute	Day workers	Shift workers	*P* value
	Mean±SD	Mean±SD	
Age (years)	37.257±9.372	39.4±8.994	0.333
Weight (kg)	64.943±11.492	71.043±14.566	0.056
Height (cm)	169.028±6.767	168.857±5.225	0.906
WC (cm)	86.6±7.175	90.028±8.803	0.079
Hip circumference (cm)	93.628±5.626	95.771±7.1	0.166
WHR	0.92±0.038	0.932±0.044	0.207
Duration of work (years)	5.614±4.495	6.371±4.854	0.501

WHR: Waist-hip ratio, SD: Standard deviation, WC: Waist circumference

Table 2: Frequency of overweight and obesity among the subjects

BMI classification	Presumptive diagnosis	Day workers (*n*=35)	Shift workers (*n*=35)
		Frequency (%)	Frequency (%)
<18.5	Underweight	2 (5.71)	2 (5.71)
18.5–24.9	Normal	24 (68.57)	19 (54.28)
25.0–29.9	Overweight	9 (25.71)	10 (28.57)
30.0–34.9	Obese Grade I	0	3 (8.57)
35.0–39.9	Obese Grade II	0	1 (2.85)
>40.0	Obese Grade III	0	0

were obese Grade II. Table 3 shows a significant difference in the mean value of body fat and BMI between the two groups while there is no significant difference in other parameters of body composition between the two groups.

Table 4 compares the average pulse rate, systolic, and diastolic BP (DBP) between the day and shift workers. The average pulse rate range between 55 and 102 beats/min in day workers with a mean value of 77.814, while in shift workers it varied between 57 and 109 beats/min with a mean of 76.057. The systolic BP (SBP) and DBP of day workers varied between 96 and 153 mm of Hg and 55 and 100 mm of Hg with a mean of 124.628 and 77.657, respectively, while in shift workers SBP and DBP varied between 97 and 178 mm of Hg and 61–119 mm of Hg with a mean of 127.8 and 84.486, respectively. On comparison of two groups, average pulse rate and SBP showed no significant difference while it was significantly different in DBP.

Table 5 demonstrated a significant positive correlation of BMI with WC, body fat and TBW in both groups, while BMI was significantly correlated with SBP and DBP only in shift workers. No significant correlation of BMI with duration of work was seen. Table 6 demonstrated a significant positive correlation of WHR with SBP and DBP in both the groups. Table 7 demonstrated a significant positive correlation of WC with SBP and DBP in both the groups.

DISCUSSION

In our study, we compared the changes in physiological parameters in shift workers to that of day workers. Our study revealed that BMI and body fat is significantly higher in shift workers than day workers. The shift workers also showed higher WC than day workers but were statistically nonsignificant. Furthermore, we found a strong positive correlation between WC and BMI. The prevalence of obesity was found to be higher in shift workers. The higher prevalence of obesity in shift workers has been attributed to increased calorie intake,[8] having more snacks and alteration in the circadian cycle of dietary intake,[8-10] decreased bodily exercise,[8] and altered sleeping pattern.[8] We also found that the average pulse rate is lower in those who are working in shifts than those working in daytime ($P = 0.518$). In our study, the mean value of both systolic and diastolic component of BP was higher in shift workers than day workers, but a significant increase was found only in DBP.

Table 3: Body composition parameters of the two groups

Variables	Day workers (*n*=35)	Shift workers (*n*=35)	*P* value
	Mean±SD	Mean±SD	
Body fat (kg)	11.52±4.275	14.657±6.706	0.023*
LBM (kg)	54.611±9.769	55.611±9.769	0.8
TBW (lt)	40.706±5.289	41.231±4.648	0.66
BMI (kg/m^2)	22.674±3.221	24.888±4.894	0.029*
WHR	0.92±0.038	0.932±0.044	0.207

LBM: Lean body mass, TBW: Total body water, BMI: Body mass index, WHR: Waist-hip ratio, SD: Standard deviation

Our results are consistent with Kouchaki *et al*.[11] in that a significantly higher BMI was found in shift workers than day workers after controlling the confounding factors. Similarly, Marqueze *et al*.[12] also concluded that there is greater increase in BMI and weight gain in night shift workers to those in day workers. In this respect, our study differs from that of Zamanian *et al*.[13] observed that there is no change in BMI between the shift and day workers. In our study, we found that the average pulse rate in shift workers is lower than the day workers ($P = 0.518$). Nicoletti *et al*.[14] observed that during night shifts the average increase in heart rate (HR) over resting condition was lower as compared to the day shifts ($P < 0.01$). Hansen *et al*.[15] found that after 7 days of working night shifts, there was no change in BP and HR, they concluded that either the main modulator was the higher activity at night or the circadian drive did not significantly affect HR and BP. In our study, mean value of both systolic and diastolic component of BP was found to be higher in shift workers than day workers, but significant increase was found only in DBP which is consistent with Sookoian *et al*.[16] who showed that shift workers higher diastolic arterial BP ($P = 0.033$) compared with day workers. Singh and Kwatra[17] also found a significant change in physiological parameters, that is, HR, BP denoting their stress, and fatigue due to rotational job demand. Our study is not consistent with Gholami Fesharaki *et al*.[18] who found no significant relationship between shift work and BP.

Table 4: Physiological variables of the two groups

Variables	Day workers (*n*=35)	Shift workers (*n*=35)	*P* value
	Mean±SD	Mean±SD	
Average pulse rate (bpm)	77.814±11.089	76.057±11.535	0.518
SBP (mm of Hg)	124.628±13.061	127.8±17.992	0.402
DBP (mm of Hg)	77.657±9.010	84.486±13.576	0.016*

SBP: Systolic blood pressure; DBP: Diastolic blood pressure, SD: Standard deviation, bpm: Beats per minute

Table 5: Main Pearson's correlation (*r* value) of BMI with WC, body fat, TBW, duration of work, SBP, DBP in both the groups

Parameters	Day workers (*n*=35)	Shift workers (*n*=35)
	r value	*r* value
WC (cm)	0.846***	0.874***
Body fat (kg)	0.773***	0.901***
TBW (Lt)	0.549***	0.461**
Duration of work (years)	0.039	0.331
SBP (mm of Hg)	0.295	0.558***
DBP (mm of Hg)	0.310	0.381*

BMI: Body mass index, WC: Waist circumference, TBW: Total body water, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Table 6: Main Pearson's correlation of WHR with SBP, DBP in both the groups

Parameters	Day workers (*n*=35)	Shift workers (*n*=35)
	r value	*r* value
SBP (mm of Hg)	0.42*	0.401*
DBP (mm of Hg)	0.338*	0.336*

WHR: Waist-hip ratio, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Table 7: Main Pearson's correlation of WC with SBP, DBP in both the groups

Parameters	Day workers (*n*=35)	Shift workers (*n*=35)
	r value	*r* value
SBP (mm of Hg)	0.392*	0.515**
DBP (mm of Hg)	0.395*	0.397*

WC: Waist circumference, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Our study design was unique as the shift workers were actually doing rigorous rotational shift work where they have to be attentive at all the times. In our study, we had incorporated the general and physiological parameters which may be affected due to the shift work. Most of our respondents were not very well educated, and they were ignorant about their health problems. Most of our subjects were having a history of smoking which may be the confounding factors.

CONCLUSION

We concluded that there are a lot of problems faced by the shift workers that others do not face. They are faced with many physiological and psychological alterations due to the rotational job demand. Shift workers are more prone to develop health-related complaints, overweight and obesity, hypertension, and increased blood sugar than the day workers. Furthermore, shift workers who are prone to the circadian rhythm alteration suffer more from fatigue, depression, and stress. There is deterioration in the memory performance and psychological health of the shift workers when compared to day workers. All these problems arise due to alteration in working, eating, and sleeping patterns.

The ideal solution of all the problems faced due to shift work is to change the working schedule, but this is not usually practically feasible. The other ways by which problems faced by shift workers can be reduced are: by providing better facilities at workplace, educating them, helping them to get better sleep nap, a healthier diet, and reduction of stress.

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How to cite this article: Hussain MS, Tyagi R. Effect of shift work on physiological parameters: A study among security personnel. Natl J Physiol Pharm Pharmacol 2019;9(2):103-107.

Source of Support: Nil, **Conflict of Interest:** None declared.