

ORIGINAL ARTICLE

# Shift works impact on health outcomes of a non hazardous industrial employees

John Kirubakaran<sup>1\*</sup>, Rabiya Ahamed<sup>1</sup>, Urvasi Palli<sup>1</sup>, Magharla Dasaratha Djanaraju<sup>1</sup>, Qudsia Fathima<sup>1</sup>, Srirama Teja Makineedi<sup>1</sup>

<sup>1</sup> Department of Pharmacy Practice, GIET School of Pharmacy, Rajahmundry

## ABSTRACT

Working time is the period of time that a person spends at paid labour. For every shift our body needs to adopt to the external changes. This may cause dreadful disruption of circadian rhythm which maintains all the biological responses including sleep-wake cycle, hormone induction-inhibition, hunger, growth and other cellular processes. Hence preventing the disruption of the circadian rhythm can prevent the disturbances in biological responses. The specific objectives include numerating the working pattern of general and shifting workers. To compare food habits, incidence of various health effects such as Cardiovascular risks, Sleep wake disorders, Endocrinological disorders (Diabetes, Cholesterol), Obesity, BMI, Blood Pressure among general and shift workers. An observational prospective study was carried out by approaching the workers, by a standard questionnaire which was designed to collect the data of the employees from the company and data was analyzed using statistical software. The observed values have shown that out of 302 workers general workers were 112 and shift workers were 190 and P-value <0.001 which is found to be significant. This study shows that the diabetic status, sleep disorders, appetite and GERD disturbances of the workers are dependent on the shift pattern being followed by them. There was a significant difference between shift and general workers in terms of Glucose levels, Blood Pressure, Total Cholesterol levels and GIT disturbances. Conclusion of our study revealed that people working in shifts tend to have higher risk of prevalence of disorders such as Hypertension (Blood Pressure compared), Diabetes (Random Blood Sugar compared), Sleep and GIT disturbances. Body Mass Index, Total cholesterol levels of both general and shift workers did not show any high significance when compared. The risk of metabolic disorders was higher among those working in shift work rather than in the general workers.

**Keywords:** "Shift Work, Circadian Rhythm, Endocrinological disorder, Obesity, Blood Pressure, occupational health".

## Introduction

With the advent of modernization, the working habits have evolved tremendously. To keep in pace with the demands of the establishment the system of shift working had pioneered (Bruce, 2015). Working time

is the period of time that a person spends at paid labour. Standard working hours enables a legislation to maintain a maximum working hours an employer works per day/per week/per month/per year. The respective shift work time has been reorganized from the 12 hour working system to 10 hours and now to 8 hours.

Shift work has been again categorized to fixed and rotating shift work. In fixed shift the working hours are constant i.e. they work on the same shift (day shift) and in rotating shift the shift pattern do get changed (either day or afternoon or night). Rotating shift, based on the length is classified into slow and fast rotating shift. Slow rotating shift compromised

\*Correspondence: john.mpharm@gmail.com, +917893277176,  
Department of Pharmacy Practice, GIET School of Pharmacy, Rajahmundry.  
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of longer duration in change of pattern(month) and fast rotating shift involves of pattern of shift over a week("Evaluate These Common 12-hour Shift Schedules – Workforce Magazine," 1997).

The research is done to evaluate the problems faced by shift workers. As shift plan has become quite common for each individual employee and certainly is different from one another. Shift plan is designed by the corresponding establishment and should be in accordance with the recommended standards. The shift plan is the central component of a shift schedule in shift work. The shift plan determines the sequence of work (W) and free (F) days within a shift system. The general plan considered is CC OFF AA BB. This plan enables to balance the disturbances an employee faces due to rotating shift. Here AA- Morning shift, BB- Afternoon shift, CC – Night shift and OFF represents the free time or week off for the worker. It is suggested that after night shifts, a worker gets an off. Few sectors follow 12 hours working hours. After 2 days working, can avail OFF. Again, sector to sector depend on their convenience they design their own shift plan.

If proper working timings and shift patterns are not followed, then it will damage balanced health of the individual and creates un healthy environment at workplace and at home("Public and Private Sector - Sectors of the Indian Economy - Everonn - CBSE Class 10th Course and NCERT Solutions," n.d.).This study aims to observe shift work related health effects and to improve awareness among the workforce and society.

As we work in shifts our food habits, sleeping pattern and lifestyle gets modified. For every shift these changes get transformed i.e. for every shift our body needs to adopt to these external changes. Before our body could adopt to the change induced by respecting shift, the other shift gets into the cycle ("Circadian Rhythms - National Institute of General Medical Sciences," 2017). This causes dreadful disruption of circadian rhythm which maintains all the biological responses including sleep-wake cycle, hormone induction-inhibition, hunger, growth and other cellular processes (David Salisbury, 2013). Correlative to the imbalance of circadian rhythm the following effects are observed:

**Obesity and Body Mass Index:** (Froy, 2012; Harrington, 2001). Circadian clock regulates activity of enzymes, hormones, and transport systems involved in cholesterol metabolism, amino acid regulation, drug and toxin metabolism, the citric acid cycle, and glycogen and glucose metabolism. Parallely, glucose uptake and adenosine triphosphate (ATP) concentrations exhibit circadian fluctuations in brain and peripheral tissues.

**Cardiovascular Effects:** (David Salisbury, 2013; Jain, Zhang, & Sabeh, 2014) Each cell involved in the cardiovascular system have their own molecular clocks which should be coordinated with the central clock for synchronized response of the body to diurnal variations in their environment.

**Insulin resistance:** (Yoshino & Klein, 2013) Melatonin involves in the synthesis, secretion, and action of insulin. The action of Melatonin also regulates the expression of transporter glucose type 4 (GLUT 4) or triggers phosphorylation of the insulin receptor. Therefore, a reduction in melatonin can be linked to an increase in insulin resistance.

**Diabetes and metabolic disturbances:** (Gale et al., 2011) sleep loss, or nocturnal lifestyle. However, the underlying mechanisms behind this association are largely unknown. To address this, the authors examined the metabolic and physiological consequences of experimentally controlled circadian rhythm disruption in wild-type (WT)Interactions between genetic predisposition and environmental triggers may leads to Type 2 Diabetes mellitus. Disturbance of circadian rhythms due to shift work, sleep loss, or nocturnal lifestyle predisposes type 2 DM. During clockwise shift rotation, the concentration of serum triglycerides, glucose and uric acid was decreased when compared with counter clockwise rotation. Furthermore, Beta cells in pancreas, have their own internal clock governing the proteins and genes involved in insulin secretion ("Regular bedtimes linked to better language, reading and math skills in preschool children -- ScienceDaily," 2010)

**Gastrointestinal disorder:** (Suwazono et al., 2008)

<b>Table 1:</b> General Analysis Among General and Shift Workers.			
<b>S.NO</b>	<b>PATTERN OF WORK</b>	<b>GENERAL</b>	<b>SHIFT</b>
<b>1</b>	<b>NUMBER OF WORKERS</b>	37%	63%
<b>2</b>	<b>AGE DISTRIBUTION</b>		
	18-28 years	4.46	15.8
	29-38 years	7.14	38.9
	39-48 years	37.5	30
	49-58 years	50.8	15.2
<b>3</b>	<b>EXERCISE HABITS</b>		
	Yes	21	26
	No	76	67
	Occasional	3	7
<b>4</b>	<b>ALCOHOL CONSUMPTION ANALYSIS</b>		
	Daily drinker	3	31
	Non drinker	84	62
	Occasional	13	7
<b>5</b>	<b>SMOKING HABIT ANALYSIS</b>	%	%
	Daily smoker	8	23
	Non smoker	82	74
	Occasional	10	3
<b>6</b>	<b>GIT DISTURBANCE ANALYSIS</b>		
	GERD	4.30	47.80
	Peptic ulcer	4.50	34.20
	IBD	0	4.50
	NO	81.20	13.60
<b>7</b>	<b>CHOLESTEROL LEVEL ANALYSIS</b>		
	Desirable level	91.90	87.90
	Borderline	3.60	4.20
	High level	4.45	7.90

As the food timings are altered there is an abnormal release of gastric secretions in the digestive tract which results in the formation of peptic ulcers, duodenal ulcers, heart burn and gastroesophageal reflux disease and thus resulting in various gastrointestinal disorders. All these above contribute to the complications in the shift workers.

### Materials and Methods

An observational prospective study was carried out in a Consumer health care company in Dowlaiswaram, Rajahmundry, Andhra Pradesh, India. It is a food processing company involves in the production of Nutritional supplement which comprehends both shift workers and general workers. In our study both shift workers (190) and general workers (112) were included. The aim was to compare the health effects of shift work among general workers and shift workers.

### Ethical Consideration

Approval from the Institutional Ethical Committee GSPRJY-IEC/Pharm.D/2016/04 (Department of Pharmacy Practice, GIET School of Pharmacy, Rajahmundry, Andhra Pradesh) was obtained before the commencement of data collection.

The study was carried from March 2017- May 2017. The inclusion criteria included in study was if both shift workers and general workers in the factory were enrolled in the study; people having working experience minimum 5years; People whose working duration is more than 6 hours per day. Workers were excluded if they were not willing to participate and who had the family history of disorders that were included in our study.

A standard questionnaire was designed to collect the data of the employees. The questionnaire included nature of work, years of experience, hazards of job, past and present medical histories, personal habits, symptoms endured by the workers. Initially the subject was explained about the type and need of the study and the details were collected as per the subject's will and the laboratory parameters like Blood Pressure, complete blood picture, lipid profile data, glucose levels and BMI, Total cholesterol level were collected from the Consumer health care company. All the data were identified by unique

employee code and patient's initial. Patient information and results obtained on the Laboratory parameters were kept confidential.

Blood reports of the workers were collected to compare the BMI index, cholesterol levels, glucose levels among shift workers and general workers to conclude the study.

### Analysis of Data

Data was analysed using statistical software SPSS version 24. The following tests were included: Mean and variance for all parameters,  $\chi^2$ -test to evaluate the differences (Diabetic status, Sleep disorders, Appetite and GERD disturbances) between the two groups and Z Test to calculate the unknown variance, mean and its significance.

### Results

Out of 302 workers, 112 were general workers and 190 were shift workers. Among 302 workers 6% (n=18) comes under 18-28 years of age, 15% (n=46) were of 29-38 years of age, 37% (n=111) were of 39-48 years of age and 42% (n=127) were of 49-58 years of age. The age categorisation among shift workers are 42%(n=47) were of age 39-48 and 58%(n=65) were of 49-58 years of age and from 190 general workers, 16% (n=30) were of age 18-28, 39% (n=74) were of age 29-38, 30% (n=57) were of age 39-48 and 15% (n=29) were of 49-58 years of age.

Table 1, represents the distribution pattern of Age, exercise habits, alcohol and smoking habits, GIT disturbances and Cholesterol level analysis among general and shift workers.

### Chi-Square Test

From the above test the chi square value for diabetic status, sleep disorders, appetite and GIT disturbances of the workers were found to be 62.11,40.97,20.38,and223.36 respectively( $P<0.001$ ).Therefore, this study shows that the diabetic status, sleep disorders, appetite and GERD disturbances of the workers are dependent on the shift pattern being followed by them.

### Z- Test Results

Out of 302 samples collected, 190 were shift workers and 112 were general workers. Random blood sugar levels of the shift workers(mean-179.0263)

**Table 2:** Comparing Means Among General and Shift Workers.

S.NO	CHARACTERISTICS	MEAN	KNOWN VARIANCE	OBSERVATIONS	Z -Value	P- Value
1.	RBS -SHIFT	179.0263	1633.444	190		
	RBS-GENERAL	153.3304	1191.719	112	5.8585	<0.001
2.	SYSTOLIC-SHIFT	126.9789	211.1636	190		
	SYSTOLIC-GENERAL	120.6786	116.9949	112	4.2908	<0.001
3.	DIASTOLIC-SHIFT	85.21053	76.30465	190		
	DIASTOLIC-GENERAL	81.83036	50.25024	112	3.6657	<0.001
4.	TGL-SHIFT	124.4263	5265.791	190		
	TGL-GENERAL	117.4018	3996.531	112	0.8822	0.1888
5.	BMI-SHIFT	25.99942	17.17873	190		
	BMI-GENERAL	25.87295	11.96712	112	0.2847	0.3879

and of general workers(mean-153.3304) and the Z value was found to be ( $Z= 5.85$ ). Systolic blood pressure of shift workers (mean-126.9789), general workers (mean-120.6786) and the Z-value was found to be ( $Z=4.29$ ). Diastolic blood pressure in shift workers (mean-85.21053), general workers (mean-81.83036) and Z value was found to be ( $Z=3.66$ ). These three parameters were found to be highly significant as the Z value had shown value

greater than 2.58 ( $Z>2.58$ ) whereas the triglycerides level and the BMI values were found to be insignificant ( $Z <1.95$ ), as depicted in table 2.

#### Discussion

In this 70 days' study, we examined whether the alternating shift work effects the metabolic functioning of the workers. This study was conducted in a consumer healthcare company. Shift work has long

been unrecognised as an occupational health hazard up until now. Current research includes most common design as cross-sectional which has shown limited evidence. (Antunes, Levandovski, Dantas, Caumo, & Hidalgo, 2010; Härmä, Tenkanen, Sjöblom, Alikoski, & Heinsalmi, 1998; Kim et al., 2013) The pattern has been declined from 12-hour shift pattern to 8-hour shift pattern (David Salisbury, 2013)

We have considered sample size of 303 where 37% were general workers and 63% were shift workers. The age distribution pattern of shift worker included was 42% in 39-48 age group and 58% in 49-58 age group and in general worker the pattern followed is 16% in 18-28 age group, 39% in 29-38 age group, 30% in 39-48 group and 15% in 49-58 group. Our findings suggested that when Gastrointestinal disturbances, Sleep and Hypertensive and Diabetic status was found to be much progressive in shift workers than general workers. Substantially to this, statistical test like chi-square and z-test have suggested association between shift workers and our preferred parameters (Ulhoa, Marqueze, Burgos, & Moreno, 2015). Amongst others, a cross sectional study by Harma. M, et al, found that the prevalence of insomnia, sleep deprivation, and daytime sleepiness depended significantly on the shift system. To overcome day sleepiness among shift workers, they tend to drink tea and/or coffee 3 times more than the general worker per day. This increased consumption of tea and/or coffee, which acts as CNS stimulant has added up as a factor of gastric disturbances and decreased appetite. In our studies, it was found that mean RBS value for shift worker and general were found to be 179.0263 and 153.3304 and p value was found to be <0.001, illustrating the impact of shift work on prevalence of the Diabetes. Apart from this chi-square test was done in terms of diabetic, sleep disorder, appetite and GIT disturbances where the p value was <0.001, which indicates high significance of the dependence of shift work on these metabolic disturbances. Equipping our study, Ulhoa.M.A, et al, endowed that changes in concentrations of melatonin, cortisol, ghrelin, and leptin are evident among shift workers and Melatonin has been implicated for its role in the synthesis and action of insulin which can be associated with an increase in insu-

lin resistance and a propensity for the development of diabetes (“Diabetes & Shift Work | Diabetes Canada,” n.d.).

In our studies, Body Mass Index and Total Glycerides were found to be of no significance among shift workers. The impetus behind this could be that our study was conducted for the stretch of short duration where there is likelihood that clinical manifestations could not be relayed and we had not gone for further Lipid profile test including LDL, HDL. A study conducted by Min-Ju Kim, et al, enumerated Shift work as a risk factor for obesity and an association between current shift work and body mass index (BMI) among female nurses in Korea was established (Kim et al., 2013). The International Labour Organisation have framed a shift plan which is ought to be adopted by each organisation. This shift plan balances all the disturbances caused by circadian rhythm. Moving to strengths of our study, in our study the workers were willing to collaborate with us and we have come up with few recommendations to the company which when implemented can solve the effect. Our study has handful of limitations which includes, firstly the study was conducted for short span and secondly, women were not included in the study.

### **Conclusion**

In conclusion, our study revealed that when the health of a general worker is compared with the shift worker who follows a routine of improper working schedule, keeping in pace the same working environmental conditions then it was found that those who are working in shifts tend to have higher risk of prevalence of disorders such as Hypertension (Blood Pressure compared), Diabetes (Random Blood Sugar compared), Sleep and GIT disturbances. Body Mass Index, Total cholesterol levels of both general and shift workers did not show any high significance when compared. More detailed studies on shift work related health effects should be conducted and shift work specific statistical data to be analysed by Government authorities to frame Guidelines, work place facilities and health awareness programmes. We conclude that the prevalence of the metabolic disorders were found higher among shift workers than

general workers.

To prevent prevalence of disorders we have recommended the following to the company:

- 15 minutes YOGA programme before each shift begins.
- Special consideration in mess food should be enabled for diabetic workers.
- Awareness programmes in local language regarding shift work ill effects and smoking cessation should be introduced.
- Shift work induced stress and psychological disturbances should be copied by arranging rehabilitation programmes and implementing policies towards it.
- Monitoring and limiting the intake of tea/ coffee to avoid gastric disturbances.
- To overcome sleep disturbances there should be periodic rest period during the shift work.

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#### Conflict of interest

The authors declare no conflict of interest.

#### Informed consent

Informed consent was obtained from all the participants included in the study.

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#### Author contribution

J. John Kirubakaran and M.D. Dhanaraju designed the methodology and guided in complying of the data. PalliUrvasi, Qudsia Fatima, M. Sri Rama Teja collected the data and was responsible for statistical analyses. Rabiya Ahamedi complied the study and revised the content of the paper. All authors contributed to the preparation of the article and approved the final submitted version.

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