

# Shift Work and Work Load Factors

Salma Ummul<sup>1</sup> and Kameswara Rao K<sup>2</sup>

<sup>1</sup>Post Doctoral Fellow, Department of Environmental Sciences, Andhra University, Visakhapatnam, India

<sup>2</sup>Department of Environmental Sciences, Andhra University, Visakhapatnam-530003, India

E-mail: <sup>1</sup>usalma7@yahoo.com

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**Abstract**—Ergonomics is the study of work (Latin: ergo = work; nomos = rules, laws). More specifically ergonomics is the science of designing the job to fit the worker, rather than physically forcing the worker's body to fit the job. The objectives of the present study are to understand the occupational health problems among shift staff and evaluate the present shift pattern to their impacts on health and to suggest an optimal pattern. The problems associated with shift work are most often attributed to the assumptions that employees are being required to do the opposite of what their sleep wake rhythm would predict i.e. to stay awake during the night and to sleep during the day. The homeostatic systems are regulated by several endogenous biological rhythms but under certain compelling circumstances, internally synchronized rhythms no longer exhibit comparable frequencies and this situation is referred as a state of internal desynchronization. Therefore, in order to minimize this entropy, the employees participated in the study were grouped under different categories of employees, and within each category different age-sex groups. There is an agreement that shift workers are a population at risk. This is due to the fact that, they are exposed to psychobiological desynchronization and reduced coping associated with shift work.

## 1. INTRODUCTION

The past few decades have witnessed a tremendous growth in the population of shift workers especially in developed and highly industrialized countries. Developing countries are also not free from experiencing this phenomenon. In USA, almost two decades ago over 27% of the male workers and 16% of the female workers were working in shifts. At the comparable time in Great Britain the proportion of employees in the manufacturing industry doing shift work increased from 12.5% in 1954 to 25% in 1968. (National Board for Prices and Incomes, 1970). In Netherlands and France the shift workers were estimated to be around 19% and 21%, respectively, in the seventies. In Canada, at present about 2 million people (23%) work in shifts. Surprisingly, similar types of statistics are not available for India.

Major problems of shift systems arise from the extension of business hours that result in phase displacement of the sleep period and therefore substantial changes in the daily life of shift workers. There are several concepts and mechanisms how the working hours and schedules could influence the workers health and well being (Smith et al, 1998 b). First biological disruption to physiological processes, including the sleep wake cycle (Akerstedt 1990; Harma et al, 1998), Second

the impairment of physical health and psychological well being (Bohle and Tilley, 1989) and Third the disruption of domestic and social life (Walker 1985; Monk and Folkard 1992).

Physiological disruptions are some of the major problems for the shift workers. Shift work has been shown to develop impaired metabolism and impaired tolerance or response to medications (Philips et al, 1995). Rutenfranz and co-workers have concluded that "Perhaps the most important physiological problem regarding shift work particularly, shift work which includes night work, is the problem of the resynchronization of physiological functions after a phase shift of working and sleeping times (Rutenfranz et al, 1977).

Several reports confirm that very often shift workers suffer from internal desynchronization in the circadian rhythm of oral temperature, heart rate, PEFr, axillary and wrist activity, right and left hand grip strength (Reinberg et al 1988, 1989; Pati and Saini, 1991; Gupta and Pati, 1993, 1994). Several other studies have shown that shift worker has an increased risk of cardio-vascular diseases (Knutsson et al, 1986; Kristensen 1989; Tenkanen et al, 1997; Boggild, Knutsson, 1999; and Van Amesvoort, 2000)

Work schedules can have a negative impact on the health and well being of shift workers (Costa, 1996) and even within day work (Martens et al, 1999). Thus, work schedules and work load factors need to be examined in combination to obtain a realistic picture of the effects of shift work on fatigue as was also reported by Rosa (2000). Fatigue and insomnia are considered as the primary symptoms for the disturbances in the biological clocks or the circadian rhythms. Brain and body functions slow down during the nighttime and early morning hours. The combination of sleep loss and working at the body's low point can cause excessive fatigue and sleepiness. This makes more difficult to perform well, which increases the risk of accidents (Madide, 2003).

Unfortunately, so far, a proper strategy could not be evolved. It is also surprising that a consensus has yet to be reached among workers in this field concerning the identification and use of proper chronobiologic index/indices to ascertain individual shift workers tolerance.

In view of the above, the present work entitled “Shift work and work load factors” has been contemplated with the following objectives:

1. To understand the occupational health problems among shift staff of different age groups with varying service experience;
2. To identify the different health disorders or diseases associated with the shift staff and the incidences of these health problems;
3. To assess the different types of stress associated with the shift work and understand the impacts on health;
4. To evaluate the present shift pattern with special reference to their impacts on health and to suggest the optimal pattern.

**2. METHODOLOGY**

The study followed “*Syndrome Approach*” to realize the objectives of the study, by adopting a combination of the methods of obtaining data on the study respondents. The focus of the study being the health problems associated with the shift work, sampling was carried out by selecting the employees.

Results obtained were analyzed statistically wherever necessary. The parameters involving representation of averages were subjected for analysis to estimate the Mean, along with their Standard Deviation, Standard Error and Interval Estimates at 95% confidence level. The selection of the employees for the study was random. Based on the proportional distribution of the 5 types of employees, and based on their distribution in the Visakhapatnam division, the proportion of the samples for each type was determined.

**3. RESULTS**

**Quantitative work load of the respondents:**

Of the total respondents interviewed the quantitative workload of the subjects working 8 hours or less per day is 34.66%, followed by subjects working 8-16 hours is 65.33% and the subjects working more than 16 hours per day are nil (**Table 1**).

**Table 1: Quantitative work load of the respondents**

S No.	Work schedule	No. of respondents	% of respondents
1	<8hrs	104	34.66
2	8-16 hrs	196	65.33
3	>16 hrs	0	0

The work load is also classified according to the different age groups and inferred that within the age group 41-50 more respondents are working less than or equal to 8 hours per day, and in contrary within the age group 51-60 more respondents were working 8-16 hours per day as shown in **Table 2**.

**Table 2: Quantitative work load of the respondents in different age-sex groups**

Age Code	Age Group	No. of Respondents		% of respondents	
		< 8 hrs/d	8 – 16 hrs/d	< 8 hrs/d	8 – 16 hrs/d
AG-1	21-30	47	73	39.16	60.83
AG-2	31-40	22	77	22.22	77.77
AG-3	41-50	32	24	57.14	42.85
AG-4	51-60	3	22	12.00	88.00

**4. SHIFT PATTERN:**

In the Indian Railways of Visakhapatnam Division, employees working on shift duties had broadly two types of Shift systems. (1) Those who are working on Rotation of Shifts (RS); (2) Those who are working only during night shift, i.e. Permanent Night Shift (PN).

Of the total 300 respondents, the number of workers within the age group 21-30 are 120. Amongst these number of workers who worked in rotational shift work with nights is 76.67%, rotational shift work without night is 8.33%, and permanent nights is 15%. Similarly within the age group 31-40, the number of respondents is 99. Amongst these the workers who worked in rotational shift work with nights is 85.86%, rotational shift work without night shift is 10.10% and those who worked permanent nights is 4.04%. Within the age group 41-50 the number of respondents is 56. The respondents who worked rotational shift work with nights are 67.86% those who worked rotational shift work without night is 21.43%. Those who were on permanent nights are 10.71%. Within the age group 51-60 the number of respondents are 25. The number of respondents who worked in rotational shift work with night are 72% and the workers who worked rotational shift work without night is 20% and those who worked permanent nights is 8% as shown in the given **Table 3**.

**Table 3: Shift Pattern of the respondents**

S. No.	Age Gr.	Respondents in Shift Types					
		RS with NS		RS without NS		PN	
		No.	%	No.	%	No.	%
1	AG-1	92	76.67	10	8.33	18	15.00
2	AG-2	85	85.86	10	10.10	4	4.04
3	AG-3	38	67.86	12	21.43	6	10.71
4	AG-4	18	72.00	5	20.00	2	8.00

**5. RESISTANTS**

The respondents, who were not having any general health complaints over the last two years are referred to as **Resistants**, were 55 (18.33%) in number. Of these, 42 (76.36%) were men and 13 (23.64%) were women.

Of the 42 men, a majority were in the age between 31 and 50 years. Of the total men resistants, 19.05% were in AG-1; 35.71% in AG-2; 42.86% in AG-3 and 2.38% in AG-4 groups. In case of Women resistants, a majority (76.92%) were in AG-

1, 15.38% were in AG-2 and 7.69% were in AG-4, while in AG-3 there were none. The distribution of the Resistant men and women in different age groups is illustrated in Fig. 1.

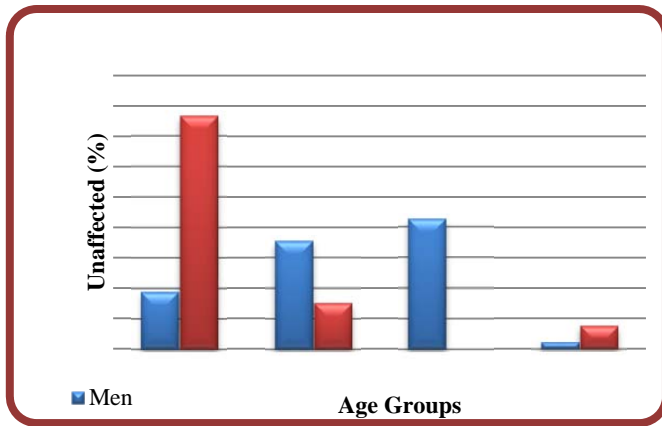


Fig. 1: Shift work resistant in Age-Sex Groups

The distribution of Resistant among different employee types is not varying widely and has a Mean percentage of  $20.24 \pm 4.85$ . Among LPs, 12.9% were Resistant; and among GDs, TTEs, Oss and TNs, the Resistant accounted for 23.81%, 20%, 19.12% and 25.37%, respectively (Fig. 6). Among the 27 respondents, who work on permanent night shifts, 5 were Resistant and all the five were in the AG-1, while two of them were women.

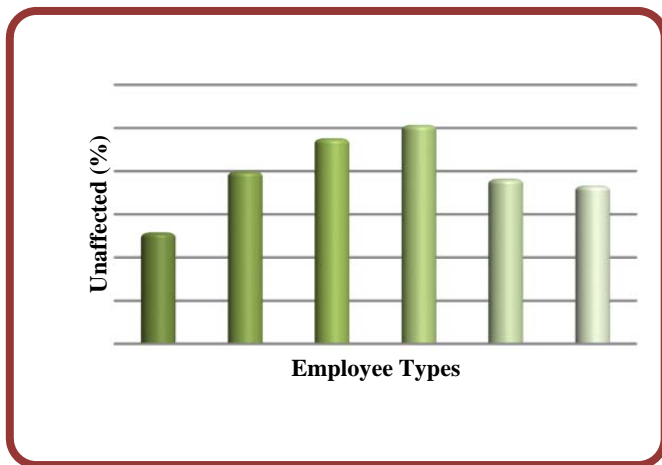


Fig. 2: Unaffected by Shift work (Resistant)

6. VULNERABLES:

The Underweight and Overweight individuals from the respondents, as was determined based on the Body Mass Index (BMI) are considered as the *Vulnerables*.

The Body mass Index of all the respondents together has a range from 16.12 to 39.22, with a mean of  $24.59 \pm 3.78$ . It varied slightly between the men and women, and also among the different age groups (Table 4).

Table 4: Body mass Index of the respondents

S. No.	Age Gr.	Body mass Index		
		Men	Women	Total
1	AG-1	24.51 ± 3.31	22.40 ± 3.71	23.58 ± 3.64
2	AG-2	25.50 ± 3.55	24.56 ± 3.42	25.58 ± 3.53
3	AG-3	25.50 ± 3.96	24.81 ± 2.95	25.47 ± 3.90
4	AG-4	24.34 ± 4.22	24.33 ± 3.94	24.34 ± 4.09
5	All	25.10 ± 3.66	22.97 ± 3.71	24.59 ± 3.78

The respondents were categorized in to four weight categories: (1) Underweight Category with BMI less than 20; (2) Acceptable weight category with BMI ranging from 20 – 24.9; (3) Excess weight category with BMI ranging from 25 – 27; and (4) Overweight Category with BMI > 27. The Underweight and Overweight categories are considered as Vulnerable by Underweight and Vulnerable by Overweight types, who are prone to get health disorders or diseases with greater probability.

Of the 300 respondents, 114 (38%) were found to be Vulnerables. Among them 73.68% were men and 26.32% were women. However, among the men, 36.84% were Vulnerables; while among women 41.67% were Vulnerables. Among the total Vulnerables, Underweight category accounts for 28.95% only, and of these, 54.54% were women. Among the Overweight category, 85.19% were men.

Of the Underweight Men respondents, 40.02% were in the AG-1, 26.68% in AG-2; 26.68% in AG-3; and 6.67% in AG-4. Of the Underweight Women respondents, 88.8% were in the AG-1, 5.55% in AG-2 and AG-4, while there were none in the AG-3.

Of the Overweight Men respondents, 23.2% were in the AG-1, 42.05% in AG-2; 30.45% in AG-3; and 4.35% in AG-4. Of the Overweight Women respondents, 58.31% were in the AG-1, 24.99% in AG-2; and 8.33% each in AG-3 and AG-4 (Fig. 3).

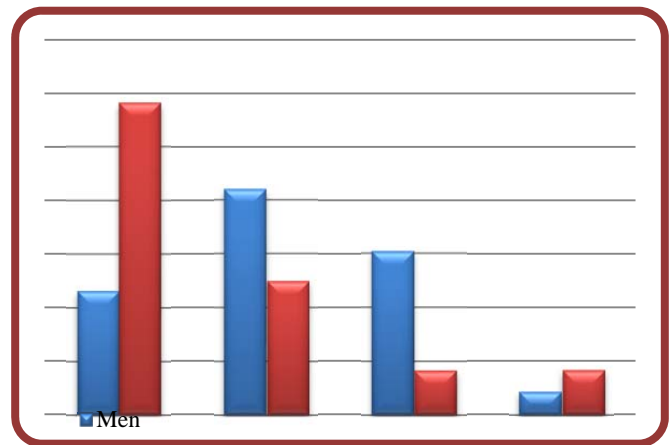


Fig. 3: Frequency of Overweight Vulnerable Men and Women in different Age Groups.

## 7. SPECIFIC HEALTH PROBLEMS:

Among the respondents, who complained with health problems and were taking medication or were under treatment, five types of health problems were identified to be most common. These included, (1) Gastric; (2) Asthma; (3) Diabetes; (4) Blood Pressure; and (5) Kidney Stones. Some of the respondents were suffering more than one of these five problems. Some of the respondents, who were not in these five categories, but were recorded with some other health problem, were discussed under miscellaneous health problems.

Symptoms of the health problems related to the disturbance of biological clock, were considered under health problem categories like (a) Sleeplessness; (b) Stress; (c) Anxiety; (d) Anger; (e) Depression; and (f) Mental perturbations. These were also discussed under stress problems.

## 8. CONCLUSION:

The disturbance of circadian rhythms can affect concentration, motivation, and reaction time, particularly at night. This combination can result in an increased risk of accidents and injury. Studies show that shift workers' accident rates are more than those by day workers. Koller 1996, states that shift work and night work have implications for the entire living sphere of mankind. Thus health hazards and stresses of work by itself, as well as intervening factors from outside the working life may influence and impair the state of health. There is an agreement that shift workers are a population at risk. This is due to the fact that, they are exposed to psychobiological desynchronization and reduced coping associated with shift work.

In the present study, an attempt has been made to trace the incidence of five specific health problems (related to Gastric, Diabetes, Respiratory, Blood Pressure, and Renal Salts accumulation) and six types of stress specific symptoms (Sleeplessness, Fatigue, Anxiety, Anger, Depression and Mental stress). All these physical, physiological, and psychological health problems are known to vary not only with the working hours, but also with the types of work they are associated with, work place conditions, load of responsibilities, socio-economic factors, and several other factors also. Therefore, in order to minimize this entropy, the employees participated in the study were grouped under different categories of employees, and within each category different age-sex groups as well the work load factors are given due consideration.

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