Shift Work: Physiological Effects on Railway Industry Workers

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ABSTRACT

Demanding work schedules are a fact of life in modern, 24-hour society where large numbers of human resources are involved in rotational task. The study was carried out in Railways to assess the psycho-physiological parameters, coping strategies of reservation counter workers. The purposive and random sampling design was used. Forty respondents were selected for descriptive and experimental data. The descriptive data was collected through interview schedule. The experimental data was gathered for different physiological parameters. The results reveal significant difference in physiological parameters i.e. blood pressure, heart rate due to rotational job demand. A manual entitled “Shift Workers Guide” was prepared. This suggests different guidelines to the individual and organization as how to cope better to the job demand. This would then enhance job satisfaction, health status and lifestyle of the employees at domestic level and official front.

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1. Introduction

Shift work is not new to Indian Industry. Shift work pattern was introduced in textile and jute mills, and coal mines right from the beginning of those industries. Not only were working in different shifts but women were also employed in round the clock production schedules. Shift work may be introduced for different purpose such as
maximum utilization of machinery, men and other resources, increased production, improving unemployment situation etc.

The term "rotational shift work" covers a wide variety of work schedules and implies that shifts rotate or change according to a set schedule. These shifts can be either continuous, running 24 hours per day, 7 days per week, or semi-continuous, running 2 or 3 shifts per day with or without weekends. Workers take turns working on all shifts that are part of a particular system.

Shift work can have many physiological, psychological and social effects on a person. Sindhu Panakal (1970) focused the attention on such human problems which arises due to rotating work shifts about the man who carries the burden of production. Railway is an important industry where large numbers of human resources are involved in rotational task. The purpose of combining human factor with railway industry workers is to reduce occupational health hazards of the workers.

Employees’ lives beyond work can greatly be influenced by rosters. The more shift work (particularly night work) and extended working hours that people are exposed to per day, per week and so on, the greater the effect on the quality of off-duty periods. According to Coffey et al (1998) rotating shift experience the most job related stress, followed in turn by the afternoon day and night shift. Similar study has been conducted on Indian context by Muhammad (2006) and He analyzed shift work pattern regarding to job attitudes, social participation and withdrawal behaviour of nurses and industrial workers.

To survive and remain healthy, the human body has to keep a balance between different processes within the organism (Anisman et al. 1996). This regulation involves many systems that interact on various levels (Besedovsky et al. 1999), and have evolved intricate processes to keep the different systems within certain boundaries. These are so called, “homeostatic systems” (homeostasis referring to “balance” or steady state) are vital and allows the individual to retain a physiological and behavioral stability despite environmental fluctuations (McEwen 1998). According to Ankevan et al (2006) Shift work bring about change in the circadian system and it has also been related to a number of other health disorders.

Humans and animals have precise and persistent rhythms in many behavioral, physiological, metabolic, cellular, and molecular parameters that, although influenced by the environment, are generated by an internal clock (Aschoff, 1967, 1978; Klein et al. 1991; Takahashi, 1993). This clock runs, even in the absence of external time cues such as light, with a period of approximately 24 hours, and has thus been named the “circadian clock” (circadian = around a day) (Czeisler et al. 1999). It is the reliable alterations of day and night of the earth that most living organisms, e.g. animals, plants and even bacteria, have adjusted their behavior and physiology function (Ishida et al. 1999; Panda et al. 2002; Hastings et al. 2003). Rotating shift work has well-known harmful effects on human health and well-being. It disturbs sleep, wakefulness, eating patterns, social life and in the long run, often results in gastrointestinal diseases. However, studying health problems in workers is difficult. If possible, workers will change jobs if they think the work is making them ill. A shift worker might change to a day job for that reason. This is called the “healthy worker” or the “survivor” effect. According to Lipkin et al,(1998), stated that stressful shift work that interfere with their biological rhythm.

The purpose of combining ergonomics with railway industry worker is to reduce occupational health hazards of the workers. Railway is an important industry where large numbers of human resources are involved in rotational task. A number of studies have demonstrated that Shift work/Rotational work disrupts the body’s circadian rhythms, that is, its daily cycle. It also affects the quality and quantity of sleep a person gets and disrupts family and social life. This impact on the health of the shift worker can potentially cause tiredness, mental stress, cardio-vascular diseases, gastro-intestinal disorders, menstrual disorders, poor performance and increased accidents. Quite a good number of studies have been conducted abroad on different areas of rotational work. But there is very little information available in the literature on rotational task in the railway industry in India. Therefore there is need to study the type of activities performed by the railways workers in the 24 hours of the day, to suggest remedial guidelines and management strategies to improve their work efficiency. Considering the above facts, the investigation was planned with the following objectives:

- To find physiological effect of work.
- To suggest possible guidelines to reduce the work load and increase work efficiency of the rotational workers.

2. Materials and methods
Experimental and descriptive research design was planned in order to achieve the objectives of the study. The study was conducted at northern railway headquarter (Gorakhpur) in the year 2010 on a total sample size of forty (40). The sample forty was selected on random sample basis. Under descriptive research design pre-coded interview schedule was used for the present study for collection of data related to shift work pattern and health related problems. Beside general information specific information was collected by framing statements on health related problems (Table 1) & collecting data pertaining to various physiological variable viz. heart rate, blood pressure, pulse pressure, and body temperature (Fig 1) and the readings were noted on a morning evening basis.

2.1. Physiological test

Blood Pressure: It was recorded with the help of sphygmomanometer through measurement of systolic and diastolic pressure. The average blood pressure was then calculated for the respondents of the experimental group. Blood pressure was recorded twice that is at the start and at the end of the respective shift schedule.

Average mean pressure = Diastolic pressure + 1/3rd of pulse pressure

Pulse Pressure: The pulse pressure is nothing but the difference of systolic and diastolic pressure. It was calculated with the help of following formula:

Pulse pressure = Systolic pressure - Diastolic pressure

2.2. Heart Rate

It was measured with the help of polar heart rate monitor. Five readings at an interval of 1 minute each were recorded and the average of all the five readings of the heart rate was calculated to get the average heart rate at a time. Heart rate was measured before and after the shift immediately.

Average heart rate = sum of all the five reading (1st+2nd+3rd+4th+5th) / 5

The change in the heart rate from morning to evening was calculated by the following formula:
Change in heart rate = Avg. HR in the morning - Avg. HR in the evening

2.3. Temperature

The body temperature of the respondent was recorded with the help of digital thermometer. Before recording the temperature it was made sure that the respondent does not eat anything at least 15 min. before the recordings. Temperature was recorded twice that is at the start and at the end of the respective shift schedule. The difference in the temperature from morning to evening was calculated by the following formula:
Change in Temperature = Temperature in the morning - Temperature in the evening

3. Results

Shift work exerts major influence on the physiological functions of the human body. These are primarily mediated by the disruption of circadian rhythms since most body functions are circadian rhythmic. Night shift is responsible for imbalance in the biological rhythm of the human being thus adding to tiredness in the body. Similar results have been reported by Monk (1996) that resynchronization of circadian system affects the mental and physical health, longevity of the worker as well as public safety.

3.1. Health related problem of shift workers

Responses related to health aspect of the respondents depict that approximately twenty seven point five percent of the total male respondents & least number of female reported that that their appetite almost never disturbed during the working period. One fourth of the total male and female said that their appetite was quite seldom disturbed and few reported that their appetite was quite often/almost always disturbed during work period.
Approximately half of the total respondents, male and female reported that they almost never felt nausea between their shifts systems and only two point five percent males & females felt quite seldom nausea during their shifts systems if there was too much suffocation or more pressure at work.

Forty five percent males and seventeen percent female responded that they almost never suffered from stomach problem and seven percent male and seventeen percent female respondents quite seldom had any such problems whereas seven percent males, five percent females quite often suffered from their stomach ache. The results are line with Anders Knutsson (2003) regarding health disorders of shift workers. He indicated that circadian rhythms for an association with peptic ulcer disease, coronary heart disease.

Thirty percent male and female respondents quite seldom suffered from digestion difficulties whereas twenty three percent male and ten percent female respondents quite often and only seven point five percent male almost always suffered from digestion difficulties. Similar results of Andlauer et al. (1979) reveals that gastrointestinal complaints of gastric upset, gas, constipation, poor eating etc. are strongly correlated with shift work. Scott et al. (1994) indicated strong link with gastrointestinal disorders being more common in shift workers than in day workers.

Data pertaining to constipation problems amongst sample population reveals that fifteen percent male and twenty percent female quite often suffer from this problem followed by eighteen percent male and eight percent female respondent almost always suffer from constipation. Less than one fourth respondents of the total quite seldom suffer from this problem. Sixty percent male and thirty seven percent female respondents were of opinion that they almost never suffered from aches and pains in their chest. Only one female responded that they felt quite seldom ache in her chest.

Forty five percent males and fifteen percent female respondents gave positive response to suffering from shortness of breath when climbing the stairs normally and fifteen percent male and twenty percent female quite seldom suffered from shortness of breath whereas five percent female respondents quite often suffered from shortness of breath when climbing the stairs normally. High blood pressure as an indicator of health related problem was reported by one fourth of the total respondents. Whereas thirty point five percent male and forty five percent female respondents had almost never suffered from high blood pressure. According to Anders Knutsson(2003) Shift workers have a 40% excess risk for CVD compared with day workers.

An irregular eating habit is one of the major reasons responsible for gain in weight amongst rotational workers Reeves et al. (2004). More than fifty percent of the total respondents, male as well as female have put on weight since beginning of shift work. Less than one fourth felt that they have not gained weight since beginning of job. Similar results have been reported by Yuichi et al. (2001). Sixty percent males and eleven percent female felt that they had not lost weight since beginning shift work and only ten percent female respondents felt quite seldom and 2.5 percent females quite often lost their weight. This finding also has been supported by Nakamura et al (1997) that more centrally disposed adipose tissue in shift workers.

Tabulating all the responses of the respondents, fifteen percent male responded that they almost never suffered from chronic back pain, forty point five percent male and seventeen point five percent female respondents quite seldom and two point five percent male and twenty percent quite often suffered from chronic back pain. Similar results have been reported in a study of human problems of shift work (SindhuPanakal (1970)

Most of the respondents in both the categories were of same opinion that gastric problem aggravated with shift work. Of all the selected respondents sixty percent male and forty percent female respondents responded that they almost never suffered from bronchial asthma. Approximately half of the total respondents almost never suffered from diabetes and twelve point five percent male, ten percent female quite seldom and two point five percent male suffered from diabetes. Sixty percent male and thirty eight percent female respondents responded that they almost never suffered from depression and only two point five percent female quite seldom suffered from depression. Fifty eight percent male, thirty five percent female respondents almost never suffered from arthritis and only two point five percent male, five percent female shift worker quite seldom suffered from arthritis problem. Responses related to anaemia reveal that sixty percent male, seven point five percent female responded that they almost never suffered from anaemia and seventeen point five percent female respondents quite seldom and seven point five percent per cent females quite often and seven point five percent females almost always suffered from anaemia.

Approximately forty eight percent males and seven point five percent females responded that they quite seldom suffered from headache and seven point five percent males, and ten percent females quite often and five percent male, twenty two point five percent female almost always suffered from headache. Lipkin et al (1998)
Shift workers are more likely to experience headaches, muscle pain respiratory infection and general malaise these in turn result in higher rates of absenteeism employee turnover.

3.2. Effect of rotational task on physiological parameters

3.2.1. Blood pressure

On the whole the average mean blood pressure in the morning of selected 40 respondents was found to be 102.54 mmHg and there was a rise in the average mean blood pressure in the evening i.e. 108.61 mmHg. It was observed that there was a rise in the average mean blood pressure of the selected respondents from morning to evening and the average difference was calculated to be 7.88 mmHg. The standard deviation values were calculated for the average mean blood pressure in the morning, evening as well as for the difference values were calculated, which came out to be 6.05, 7.16 and 3.04 respectively.

Payal (2006) studied the effects of work on blood pressure and changes in heart rate. There was a sharp rise in the systolic pressure during dynamic work and a considerable rise in the diastolic pressure in case of static work, thus lowering the pulse pressure to a considerable extent. Cumulative exposure to job strain among dual career women resulted in significant increase in systolic blood pressure especially those with low levels of social support at work. High blood pressure increases the risk of cardiovascular diseases (Payal, 2006). On the whole the average means blood pressure in the morning of selected 40 respondents was found to be 102.54 mmHg and there was a

3.2.2. Pulse pressure

The average pulse pressure of the respondents in the morning was reported to be 34.15 mmHg and in the evening the average pulse pressure was found to be 37.97 mmHg, with an average difference of 4.62 mmHg from to evening. A considerable difference of 4.62 ±2.67mmHg was noted in the pulse pressure from morning to evening.

3.3. Heart Rate

The heart rate was taken with the help of Polar Heart Rate Monitor and the readings for the average heart rate in the morning were found to be 78.77±4.56 beats/min, and the average heart rate in the evening was found to be 86.07±6.46beats/min. A significantly high difference of 7.32 ±5.74 beats/min was found on an average in the readings of morning and evening.

3.4. Temperature

The data gathered about the temperature of the respondents revealed that the average temperature in the morning for the experimental group respondents was 98.11±0.67°F and the average evening temperature was 98.54 ±0.59°F respectively. The difference in the morning evening readings was not very significant i.e.0.38±0.24°F.
### Table 1
**Health related problem amongst shift workers.**

<table>
<thead>
<tr>
<th>Statements</th>
<th>Almost never</th>
<th>Quite seldom</th>
<th>Quite often</th>
<th>Almost Always</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
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<tr>
<td>How often</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Appetite is disturbed</td>
<td>11</td>
<td>1</td>
<td>9</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>(27.5) (2.5)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Get a feeling of nausea</td>
<td>23</td>
<td>15</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>(57.5) (37.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suffer from stomach-ache</td>
<td>18</td>
<td>7</td>
<td>3</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>(45.0) (17.5)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Complain of digestion</td>
<td>12</td>
<td>12</td>
<td>9</td>
<td>4</td>
<td></td>
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<tr>
<td>(30.0) (15.0)</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Suffer from constipation</td>
<td>4</td>
<td></td>
<td>7</td>
<td>5</td>
<td>6</td>
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<tr>
<td>(10.0) (17.5)</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Suffer from aches and pains in chest</td>
<td>24</td>
<td>15</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>(60.0) (37.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Suffer from shortness of breath when climbing</td>
<td>18</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>stairs</td>
<td>(45.0) (15.0)</td>
<td>(15.0)</td>
<td>(15.0)</td>
<td>(20.0)</td>
<td>(5.0)</td>
</tr>
<tr>
<td>You have high blood pressure</td>
<td>13</td>
<td>14</td>
<td>6</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(32.5) (35)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain weight since beginning shift work</td>
<td>1</td>
<td>5</td>
<td>12</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>(2.5) (12.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>you lost weight</td>
<td>24</td>
<td>11</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(60.0) (27.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Have you suffered from any of the following</td>
<td></td>
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</tr>
<tr>
<td>Chronic back pain</td>
<td>6</td>
<td></td>
<td>17</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>(15.0) (42.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastric</td>
<td>2</td>
<td></td>
<td>13</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>(5.0) (32.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bronchial asthma</td>
<td>24</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(60.0) (40.0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>18</td>
<td>12</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>(45.0) (30.0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>24</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(60.0) (37.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthritis</td>
<td>23</td>
<td>14</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(57.5) (35.0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anaemia</td>
<td>24</td>
<td>3</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(60.0) (7.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td>19</td>
<td></td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(47.5) (7.5)</td>
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</table>

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4. Conclusion

Keeping in mind the general view, to suggest possible guidelines to reduce the work load and increase work efficiency of rotational workers. People who work shifts face many problems that others do not recognize. The difficulties stem from the change in eating, sleeping, and working patterns. The best solution to the problems of shift work would be to eliminate it but this is not often a practical possibility. Shift work is likely to continue to be a reality for a large percentage of rotational shift workers. There are two basic levels where improvements can be made: The organizational level - primarily through the design of shift schedules, education and better facilities. The individual level – helping workers to get better sleep, a healthier diet, and the reduction of stress. The manual was developed for shift workers/rotational workers which is both practicable and applicable for all the shift workers of the reservation counter. An overwhelming response was given to awareness campaign organized for the beneficiaries.

4.1. Health and social effects of shift work  workplace recommendations

After an exhaustive review of the possible shift work management techniques, a manual entitled Shift Workers Guide was prepared which included recommendations which are beneficial for the shift workers.

The best solution to the problems of shift work would be to eliminate it but this is not often a practical possibility. Shift work is likely to continue to be a reality for a large percentage of rotational shift workers.

There are two basic levels where improvements can be made:

The organizational level - primarily through the design of shift schedules, education and better facilities.

4.2. The organizational level

4.2.1. Following aspects can be considered at the organizational levels:

It is recommended that shifts rotate forward from day to afternoon to night because circadian rhythms adjust better when moving ahead than back. Avoid quick shift changes. Consider the time at which a shift starts and finishes. Early morning shifts are associated with shorter sleep and greater fatigue. Provide a rest period of at least 24 hours after each set of night shifts. The more consecutive nights worked, the more rest time should be allowed before the next rotation occurs.

Inform shift workers of their work schedules well ahead of time so they and their families and friends can plan activities. Allow as much flexibility as possible for shift changes. Keep schedules as simple and predictable as
possible. Provide good cafeteria services so a balanced diet can be maintained. The nutritional needs differ between day shifts and other shifts because of circadian rhythms.

4.2.2. The individual level

- Helping workers to get better sleep, a healthier diet, and the reduction of stress.

4.3. The individual level

4.3.1. Guidelines for diet and eating patterns

Maintain regular eating patterns as much as possible. Balanced, varied meals are very important. Keep family meal times the same even though the work routine constantly changes. Family meals may need to be altered in content to suit the shift worker.

Time meals carefully. Afternoon workers should have the main meal in the middle of the day instead of the middle of the work shift. Night workers should eat lightly throughout the shift and have a moderate breakfast. This way they should not get too hungry while sleeping during the day and digestive discomfort should be minimal.

Pay careful attention to the type of food eaten. Drink lots of water and eat the usual balance of vegetables, fruit, lean meat, poultry, fish, dairy products, grains and bread. Eat crackers and fruit instead of pop and candy bars during work breaks. Reduce the intake of salt, caffeine, and alcohol. Avoid greasy foods, particularly at night.

4.3.2. Other important considerations

Pay attention to general physical fitness and good health habits.

Find out and understand the potential health and safety effects of shift work.

Learn how to recognize and reduce stress through physical fitness, relaxation techniques and so on.

Take leisure seriously.

Avoid excessive use of antacids, tranquillizers and sleeping pills. It is healthier to watch what and when you eat, and use relaxation techniques to aid sleep.

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