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Assessment of Sleep Quality Among Shift Workers in the Automobile Industry in Kanchipuram, Tamil Nadu

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ABSTRACT:

Introduction: Sleep disturbance is considered an important health problem among shift workers, which leads to impairment of social and recreational activities, a rise in the number of human errors, decreased efficiency at the workplace, and an increase in the number of industrial accidents which again has a counterproductive effect on workplace efficiency. This study aimed to determine the quality of sleep among automobile industry workers.

Methods: A cross-sectional study was conducted among 178 shift workers in the automobile industry in the district of Kanchipuram. The minimum sample size was calculated using the formula N = (Z1 -α/2)2 ×P×Q ÷ L2. The study participants were selected using a simple random sampling method. Socio-demographic details of the participants were collected using a pretested semi-structured questionnaire following which the Pittsburg Sleep Quality Index (PSQI) was used to assess the sleep quality. Data was entered in MS Excel and was analyzed using SPSS version 26.

Results: The majority of the study participants, 148 (83.2 %) belonged to the 18 – 25 years age group, 38.8% had 4-night shifts on an average in a week, 56.2% had scores greater than or equal to 5 which was interpreted as poor sleep quality which was significantly associated (p=0.021 and p=0.018) with history of waking at night to pass urine and systemic illnesses respectively.

Conclusion: Strategic planning on intervention should focus on reducing physical stressors, and workers' education on healthy sleeping. A variety of protective efforts should be undertaken and evaluated.

Introduction

Globally, automobile maintenance and associated companies generate well over 300 billion dollars annually [1]. Within the Indian economy, the automotive aftermarket accounts for 2.3% of India's gross domestic product [1]. Industrial and technological development with increasing competition between various industries and even countries increased the need for 24 hours per day of productivity and shift work. Shift work is defined by the International Labour Organization as a 'method of organization of working time in which workers succeed one another at the workplace so that the establishment can operate longer than the normal working hours of an individual'[2]. Shift work is a working system in which different groups of workers divide work across the 24 hours of the day to provide continuous service coverage by dividing working hours among two or more groups to cover the time needed for duty performance or for the

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production process [3]. Shift workers are those who perform duties outside the regular working hours before 7 am and after 6 pm [4]. In many countries, one in five workers work in shifts outside of the 9 am to 5 pm regular work hours. As shift work is essential especially in manufacturing sectors to optimize productivity and maintain business competitiveness, it is widely adopted around the world [5].

Shift work disrupts the sleep-wake cycle/circadian rhythm and its synchrony with other endogenous biological rhythms that can cause sleepiness when wakefulness is required and insomnia during the main sleep period [6]. The most common complaint is loss of subjective sleep quality. It has been seen that a subset of these shift workers develops shift work disorder (SWD), a health condition that is caused by circadian misalignment and causes insomnia or excessive sleepiness [7]. Shift work can result in insomnia, poor sleep quality, and daytime sleepiness. Studies have shown that due to shift work, the main sleep period at an unusual time is 1–4 hours shorter than night sleep. Poor sleep has important financial implications for shift workers, and evidence suggests associations with poor health, reduced productivity, poor QOL, increased accidents at work, and absenteeism [8].

Sleep disturbance is a common problem faced by night-shift workers which leads to impairment of social and recreational activities, a rise in the number of human errors, decreased efficiency at the workplace, and an increase in the number of industrial accidents which again has a counterproductive effect on workplace efficiency. Poor sleep quality increases the rate of accidents, work-related errors, and absenteeism and reduces overall work performance [9]. Additionally, poor sleep quality is associated with the decline of personal relationships and increases the overall rate of premature mortality. In addition, the National Health Interview Survey revealed that short sleep duration (less than 6 hours) increased the risk of injuries [10].

Poor sleep quality is likely to cause sleep deprivation, cardiovascular disorders, obesity, diabetes mellitus, anxiety, depression, lethargy and fatigue, and impairment of cognitive function [11]. It is also associated with diminished vigilance and work performance. Sleep quality is influenced by an array of factors ranging from demographic characteristics to personal lifestyle choices to type of work and condition of work environment. Advanced age, unmarried status, smoking habits, and alcohol consumption have been reported to compromise the quality of sleep. Among the workforce, work-related physical fatigue rotating shift work, and personal coping capacity have been reported to influence the quality of sleep [12]. Though the Indian Factories Act has mentioned certain notifiable diseases, the focus on those diseases comes up only as part of the periodic medical examination [13]. The organization of the shift cycle, the coping strategies of the individual, and the psychological demands make important contributions to both the social and health consequences of shift work.

There has been a considerable lack of awareness among the authorities about the problems that sleep deprivation can cause. Therefore, sleep-related issues are not given the importance they deserve [14]. Nowadays, there is more awareness about research related to occupational health and safety. However, most of the research focuses on the illness related to specific occupational diseases associated with certain exposures. There is a lack of organized literature on sleep quality among automotive industry workers despite the many physical, mental, social, and financial implications of poor sleep quality. There is not much Indian research carried out on the impact of shift work on sleep [15]. Given the scarcity of evidence and the high demand for shift work worldwide, more evidence is needed to improve our understanding of the impact of shift work on health. So, there is a need for research on sleep quality among industry workers [16]. This study aimed to determine the prevalence of and risk factors for poor quality of sleep and its impact on work-related injuries among automobile industry workers. Objectives of the study were to determine the quality of sleep among automobile industry workers, to assess the socio-demographic factors and work-related parameters associated with poor quality of sleep among automobile industry workers.

Methodology

This study was conducted as a population-based cross-sectional study among shift workers of the automobile industry in Kanchipuram district, Tamil Nadu. The data was collected over a period of 2 months extending from November 2021 to December 2021. The study

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population included all the shift workers in the automobile industry after obtaining their informed consent. Shift workers who are under treatment for psychiatric illness and those who are not chronic absentees have been excluded from the study. A simple random sampling method was adopted to select the study participants. Based on the anticipated prevalence of poor sleep quality among the automobile industry workers as 50% with an alpha error of 0.05, and the limit accuracy of 15%, the minimum sample size required for the study was 178 by using the formula.

$$N = (Z_{1-\alpha/2})^2 * P*Q, \text{ where } L = 15\% \text{ of } P = 7.5$$

$$L^2 = \frac{4*50*50}{[Q1-P]} = 178$$
$$(7.5)^2$$

Data was collected using a structured proforma which was tailor-made to capture the socio-demographic details of the study participants following which the Pittsburg Sleep Quality Index (PQSI) was administered to measure the quality of sleep in the current study.[6] A pretested semi-structured questionnaire was used to obtain basic details of the study participants which included socio-demographics, lifestyle behaviors, and occupational characteristics of the study participants. The PQSI proforma had questions about their sleep habits in the past 30 days and was based on 18 questions. Each component had a score ranging from zero (no difficulty) to three (severe difficulty). The components used were subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction. Scores for 7 components were calculated and the sum of the 7 component scores was the final PQSI score. So, the final score ranged between zero and twenty-one. Scores equal to and above five were considered poor sleep quality. The socio-economic status was calculated using the BG Prasad 2021 classification[7].

Since a time-tested, pre-validated proforma was used to measure the study outcomes, quality was ensured. Participant identity was always kept confidential, and the data was used only for research purposes. Data was entered into MS Excel and was analyzed using the Statistical Package for Social Sciences (SPSS) version 25. The final data was tabulated, and percentages were calculated for categorical variables, and mean, and standard deviation were calculated for measurable data. The associations were analyzed using the Chi-square ($\chi 2$) test for statistical significance. The study was approved by the Institutional Ethics Committee of a Tertiary care Hospital (SMC/IEC/2022/01/002) and the procedures were in accordance with the Helsinki Declaration in 1975 and as revised in 2000. Written informed consent in the native language (Tamil) was obtained from the study participants before getting the information from them.

Results

Table 1: The majority of the study participants, out of 178, 148 (83.2 %) and 75(42.1%) belonged to the 18 – 25 years age group, and had completed high school education respectively. Socio-economic status was calculated using the BG Prasad 2021 classification and 141 (79.2%) were from the upper middle class and 146 (82%) of the participants had no history of systemic illness.

Table 1: Socio-Demographic Profile of The Study Subjects

S.No	Variable	Category	Frequency (N = 178)	Percentage (%)
1	Age	≤25 years >25 years	148 30	83.2 16.8
2	Educational status	High School Higher Secondary Diploma	75 55 48	42.1 30.9 27.0

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3	Marital Status	Married Single	31 147	17.4 82.6
4	Socio-economic status[1]	Middle class Upper middle class Upper class	8 141 29	4.5 79.2 16.3
5	H/o Systemic illness	Diabetes Mellitus Hypertension Respiratory diseases Thyroid disorders Nil	4 10 17 1 146	2.2 5.6 9.6 0.6 82.0

[1]Based on Modified BD Prasad classification (October 2023)

Table 2 shows the work-related details of the study participants. Among the study participants, 103 (57.9 %) were contractual workers and 75 (42.1%) were operators. Those who had less than or equal to 1 year of work experience accounted for 113 (63.5%) and 65 (36.5%) had more than 1 year of experience. The majority of the study participants, 166 (93.3%) had 8 hours of work in a day and the rest worked for 7 hours a day. Of the study participants, 108 (60.7%) had less than equal to 30 minutes of travel time to work and the rest had more than 30 minutes of travel time to work. Of the study participants, 38.8% had 4-night shifts on average, 28.1% had 5-night shifts, 27.5% had 3-night shifts, 4.5% had 2-night shifts and 1.1% had 6-night shifts.

Table 2: Work-Related Details of The Study Subjects

S.No	Variable	Category	Frequency (N = 178)	Percentage (%)
1	Work position	Contractual workers Operators	103 75	57.9 42.1
2	Work experience in years	≤ 1 year > 1 year	113 65	63.5 36.5
3	Work hours per day	7 hours 8 hours	12 166	6.7 93.3
4	Travel time	≤ 30 minutes > 30 minutes	108 70	60.7 39.3
5	Average number of night shifts in a month	2 3 4 5 6	8 49 69 50 2	4.5 27.5 38.8 28.1 1.1

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Table 3 shows the personal history of the study participants. History of smoking, alcohol, and tobacco chewing was present in 107 (60.1%). History of coffee intake was present in 63(35.4%) and history of tea intake was present in 91(51.1%) of the study subjects and 26 (14.6%) had the habit of drinking beverages in the night-time. Among the study participants, 39.3% had daytime sleepiness and 53.4% had a history of waking up in the night to pass urine.

Table 3: Personal History of The Study Participants

S.No	Variable	Category	Frequency (N = 178)	Percentage (%)
1	Substance Use	H/O smoking/Alcoholism/ Tobacco Chewing	107	60.1
		No habits	71	39.9
2	H/o Coffee intake	Yes	63	35.4
		No	115	64.6
3	H/o Tea intake	Yes	91	51.1
		No	87	48.9
4	H/o intake of beverages at night	Yes	26	14.6
		No	152	85.4
5	Day time sleepiness	Yes	70	39.3
		No	108	60.7
6	H/o waking up to pass urine in the night-time	Yes	95	53.4
		No	83	46.6

Table 4 shows the component-wise PQSI scores of the study subjects. Overall score shows that 43.8% had good sleep quality with a score < 5 and 56.2% had scores greater than or equal to 5 which was interpreted as poor sleep quality.

Table 5 shows that the mean PQSI score of the study participants was 5.66 and the standard deviation was 2.87

Table 4: Sleep-Related Parameters of The Study Subjects

S.No	Variable	Category	Frequency (N = 178)	Percentage (%)
1	**Component 1** Subjective sleep quality	Very good	46	25.8
		Fairly good	66	37.1
		Fairly bad	53	29.8
		Very bad	13	7.3
2	**Component 2** Sleep latency	0	40	22.5
		1	105	59.0
		2	24	13.5
		3	9	5.0
3	**Component 3** Sleep duration	> 7 hours	40	22.5
		6-7 hours	127	71.3
		5-6 hours	11	6.2
		< 5 hours	0	0
4	**Component 4** Sleep efficiency	> 85%	178	100
		75-85%	0	0
		65-74%	0	0

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		< 65%	0	0
5	**Component 5** Sleep disturbance	Not during past month Less than once a week Once or twice a week Three or more times a week	0 139 39 0	0 78.1 21.9 0
6	**Component 6** Use of sleep medication	Not during the past month Less than once a week Once or twice a week Three or more times a week	144 32 2 0	80.9 18.0 1.1 0
7	**Component 7** Daytime dysfunction	0 1 2 3	42 70 54 12	23.6 39.3 30.3 6.8
8	**Global PQSI sleep score**	< 5 – Good sleep ≥ 5 – Poor sleep	78 100	43.8 56.2

Table 5: Global PQSI score of the study subjects

Name of the variable	Lower limit (LL)	Upper Limit (UL)	Mean	Standard deviation	Standard error	Range (UL – LL)
Global PQSI Score	1	15	5.66	2.87	0.21	14

Table 6 shows the association between sleep quality and socio-demographic variables. Poor sleep quality was 2 times more among those who woke up in the night to pass urine and the findings was statistically significant (p value = 0.021). Poor sleep quality was 2.8 times more among those who had one or other form of systemic illnesses and the findings were statistically significant, (p-value = 0.018). Poor sleep quality was more among subjects in the younger (18 – 25 years) age group, unmarried subjects, subjects belonging to the upper middle and middle class, subjects with a history of substance use, subjects with education below the college level, subjects with a history of coffee intake, and subjects with a history of tea intake. However, none of the other associations were statistically significant

Table 6: Association Between Sleep Quality and Selected Socio-Demographic Factors

Variable	Category N=178	Sleep Quality		Odds ratio (95% C.I of odds ratio)	Chi-square value	p-value
		Poor N=100 (Global PQSI ≥ 5)	Good N=78 (Global PQSI < 5)			
Age	18 -25 years (148)	85	63	1.4 (0.6 – 3.0)	0.6	0.46
	> 25 years (30)	15	15	1.00		
Marital status	Unmarried (147)	85	62	1.5 (0.7 – 3.2)	0.9	0.33
	Married (31)	15	16	1.00		

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Socio-economic status	Upper middle and middle class (149)	87	62	1.7 (0.8 – 3.9)	1.8	0.18
	Upper class (29)	13	16	1.00		
H/o waking to pass urine in the night	Yes (95)	61	34	2.0 (1.1 -3.7)	5.3	**0.021***
	No (83)	39	44	1.00		
H/o Alcoholism /Tobacco chewing /Smoking	Yes (107)	62	45	1.2 (0.7 – 2.2)	0.3	0.56
	No (71)	38	33	1.00		
Educational status	< College (130)	74	56	1.1 (0.6 – 2.2)	0.1	0.74
	≥ College (48)	26	22	1.00		
H/o Coffee intake	Yes (63)	36	27	1.1 (0.6 – 2.0)	0.04	0.85
	No (115)	64	51	1.00		
H/o Tea intake	Yes (91)	57	34	1.7 (0.9 – 3.1)	3.1	0.077
	No (87)	43	44	1.00		
H/o Systemic illness	Yes (32)	24	8	2.8 (1.2 – 6.6)	5.6	**0.018***
	No (146)	76	70	1.00		
(*p value ≤ 0.05)						

Table 7 shows the association between sleep quality and work-related factors. Poor sleep quality was 1.9 times more among those with work experience of more than 1 year and the findings were statistically significant (p-value = 0.043). Poor sleep quality was 6.6 times more among those with a history of day-time sleepiness and the findings were statistically significant, (p-value = 0.00000005). Poor sleep quality was more among those with travel time of more than 30 minutes and among those who worked as operators, however, the other associations were not statistically significant.

Table 7: Association Between Sleep Quality and Work-Related Factors

Variable	**Category N=178**	**Sleep Quality**		**Odds ratio (95% C.I of odds ratio)**	**Chi-square value**	**p-value**
		Poor N=100 (Global PQSI ≥ 5)	**Good N=78 (Global PQSI < 5)**			
Work experience	> 1 year (65)	43	22	1.9 (1.0 – 3.6)	4.1	**0.043***
	≤ 1 year (113)	57	56	1.00		
Travel timing	> 30 minutes (70)	44	26	1.6 (0.9 – 2.9)	2.1	0.15
	≤ 30 minutes (108)	56	52	1.00		
Day time sleepiness	Yes (70)	57	13	6.6 (3.2 – 13.6)	29.7	**0.0001***
	No (108)	43	65	1.00		
Work position	Operator (75)	48	27	1.7 (0.9 – 3.2)	3.2	0.074
	Contractual worker (103)	52	51	1.00		
(* p value < 0.05)						

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Discussion

This study was done among 178 shift workers of an automobile industry in Kanchipuram district in which all participants were males. 148 (83.2%) of the study population belonged to the 18 – 25 age group. 27% of the study population were diploma holders. The majority of the study population (82.6%) was single. This could be because the age group was a younger age group with a higher probability of being single. According to the Modified BG Prasad 2021 classification, 79.2% belonged to the upper middle class. 18% of the study population had one or the other form of systemic illness**.** The contract workers accounted for 57.9% of the study population whereas the operators accounted for 42.1% of the study population, and the majority of them had less than or equal to 1 year of work experience. 93.3% of the population worked 8-hours per day. The majority (38.8%) had three night shifts in a month.

Among the study participants, substance use in the form of smoking, alcoholism, and tobacco chewing was seen in 60.1%. (39.3%) complained of daytime sleepiness. 53.4% had a history of waking up in the night to pass urine. A meta-analysis done on 48 articles from PubMed, Web of Science, and Scopus published in the year 2021 concluded that daytime sleepiness was present in 10% and snoring was present in 22% respectively [17]. In the current study, daytime sleepiness was present in 39.3%. The higher rates in the current study could be because the current study was done only on shift workers whereas the other study was a meta-analysis done on all industrial workers.

In the current study, 56.2% of the participants had PQSI scores greater than or equal to five, which was indicative of poor sleep quality. A study done on 404 workers of industrial units of Kermanshah using the PQSI proforma concluded that 63.5% had sleeping problems, which was comparable to the results of the current study [18]. Use of sleep medication in the current study was seen in 18% of the study subjects in the past month. This was also comparable to the results of the Kermanshah study in which 24.3% of the workers were using sleep medication [18]. In this study, daytime sleepiness was present in 39.3% of the study subjects, which was slightly higher than the rates found in the Kermanshah study in which 23.7% of the workers had problems with daytime sleepiness [18]. The difference could be because of the difference in population types.

A study done on 1871 secondary school teachers in Malaysia using the PQSI scale to determine their sleep quality found that 61% of the teachers had poor sleep quality, which was comparable to the results of the current study [19]. The mean PQSI score of the study subjects was 5.66 and the standard deviation was 2.87. A meta-analysis and systematic review done on 936 articles among drivers in Iran concluded that more than half the drivers in Iran had sleep quality disorder (53.4%), which was comparable to the rates of the current study in which 56.2% had poor sleep quality [20]. Both drivers and night shift workers have night work in common. The current study has revealed a statistically significant association between sleep quality and the presence of systemic illness, waking up to pass urine in the night-time, and longer work experience (greater than one year). However, the other associations were not statistically significant.

In the current study, there was no association between sleep quality and age, socio-economic status, educational status, alcoholism, or smoking which were also similar to the findings of a study done on the manufacturing industry. A study done on 975 Bangladeshi residents using the PQSI scale also did not find any association between marital status, age, socio-economic status, alcoholism or smoking, and sleep quality which was similar to the findings of the current study [21]. The Bangladeshi study however found that there was a significant association between sleep quality, gender, and educational status. Since all the participants of the current study were male, the gender association could not be established. There were no degree holders or post-graduates in the current study, but the Bangladeshi study compared the university degree holders and post-graduates with diploma and below college level participants, which could explain the difference between the results found in both studies [21].

Our study also found a highly statistically significant association between poor sleep quality and daytime sleepiness, which could have dire consequences and has been an eye-opener in identifying the high levels of poor sleep quality amongst shift workers in the automobile industry and has necessitated the need to increase awareness among industries about the importance of

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sleep quality and the consequences of poor sleep. The limitation of this study was that it was done only in one industry and the results cannot be generalized to the shift workers of all industries and further research would be required to establish the results.

This paper addresses many of the conceptual and methodological challenges in the field of work hours and health research. The discussion sheds light on research on other types of work organization exposures as well. Some of the key points include: Studies of work schedules must provide clear and complete details of the total work hour measurement like extra jobs, overtime, paid work, start end times, consecutive work days, and rest days. Studies are needed that model the relationship between progressive work duty time and the moderating effects of age, sex, health status, job and organizational context and specific outcomes such as fatigue, performance and safety which leads to more long-term health outcomes such as cardiovascular disease, MSDs, and mental illness. The impact of long working hours on family well-being needs to be investigated. A variety of interventions should be tested to examine the effects of both workplace and broader societal strategies directed at work hours and job content.

Conclusion

The study has been an eye-opener in revealing how poor sleep quality is quite high and how it can affect the quality of life and cause daytime sleepiness which could be the reason behind industrial accidents and other dire consequences. This study has emphasized the need to create awareness of the importance of sleep quality among industrial workers in general and specifically the automobile industry shift workers by increasing the awareness of sleep quality among industry workers and the awareness on the consequences of poor sleep quality, sleep breaks should be given during night shifts to ensure that the sleep homeostatic mechanisms are not totally disrupted. Assessing the quality of sleep should be an essential component of the periodic medical examination that is done in industries.

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