



SHIFT WORK EFFECT ON OCCUPATIONAL HEALTH AND PERFORMANCE OF WORKERS IN THE MANUFACTURING SECTOR

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Abstract

Shift labour is the most widely used strategy for raising productivity. However, it has an effect on productivity either directly or indirectly through influencing employee health. The goal of this study is to identify the characteristics of shift work that have a negative effect on employee performance and health. Based on inclusion criteria, 52 articles published over the course of the previous 16 years in around 25 reputable journals were evaluated. There have been studies done on the effects of shift work on specific outcomes. A complete assessment, classification, and organization of the shift work literature has been done in a way that will make it simple to summarize and use in future studies. The review placed a strong emphasis on shift work's complexity in general. The study discovered a number of novel problems and challenges that need to be resolved. To lessen the negative consequences of shift work on employee health and performance, a standard, detailed, and ideal framework must be developed.

Keywords: *Shift work, fatigue, sleepiness, shift pattern, night shift, diseases, and disorders.*

1. INTRODUCTION

Shift work is believed to have started in old period when guards and watchmen of empires, as well as soldiers, worked at night. Shift work was implemented by iron foundries, steel plants, and textile factories in the late 1800s to boost productivity. The different kinds of production activities that run around-the-clock also include food and service industries. Shift workers currently make up 15% to 25% of the workforce [1]. Shift employment has become unavoidable due to the 24-hour operation of the manufacturing and service sectors in both developed and developing nations. The health and wellbeing of millions of people worldwide are adversely affected by shift work [2]. Any schedule that is not here between normal hours of 9.00 a.m. and 5.00 p.m. is termed as shift work. [3]. Shift labour is particularly prevalent in industrialized cultures. Sleep is significantly impacted by nighttime employment. Lack of sleep has a negative impact on a person's health, their performance, and there is risk of accidents [4].

2. LITERATURE REVIEW

The literature review process identified 500 relevant journal papers. Based on inclusion criteria 52 papers identified for review process. The inclusion criteria used for study selection is as under

- At least one shift attribute should be measured, along with how it affects outcome
- The research study should be conducted in industries from the manufacturing or production sector.

- The study should highlight the specific impact of shift work characteristics on health and performance.
- Research on the association between shift work variables and outcome measures should indicate statistical significance or a quantitative relationship.

The review procedure is shown in Figure 1, and studies were chosen based on study criteria for inclusion.

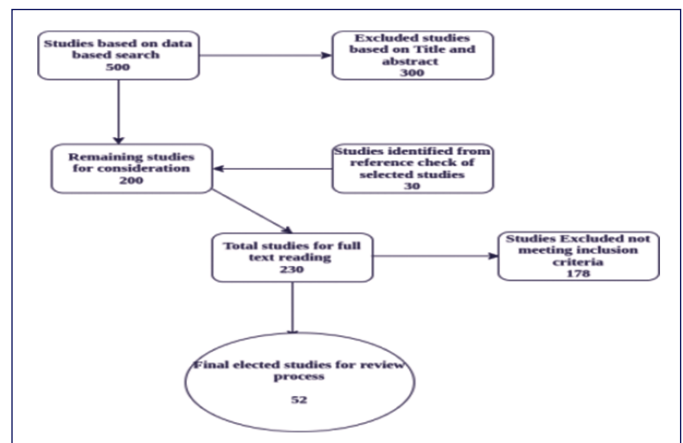


Figure 1. Study selection flowchart

2.1. Classification of Shift Work Factors

Literature is classified based on outcome of shift work and its ill effect on employees working in shift.

2.2.1 Shift Work and Physical Health

The 24 hour sleep-wake cycle is disrupted by shift work, which has been related in several studies to health issues. [1, 2, 4, 5].

According to Hooi et al. [5], employees who work shifts, such as night and morning shifts, may suffer substantial health impacts. A circadian rhythm is the term used to describe the typical 24-hour cycle of changes in human behavior, cognition, and physical functioning [6-7]. In an Indian sugar plant with 507 night shift workers, a survey found that 56% of the workers had gastrointestinal issues and 43% had cardiovascular issues [8]. A study on the effects of shift work on rapidly rotating shifts of male industrial workers in the mining and metals industry in India found that cardiovascular disorders were reported by 56.6% of shift workers, compared to 36.2% of regular workers, and 53.1% of shift workers reported gastrointestinal ailments [9]. A steel factory study in India found that shift workers had higher rates of hypertension (26% of shift workers reported it) and gastrointestinal issues (29.5%) compared to day workers [10]. Kubo et al. [11] found that a Japanese manufacturing company's daytime employees and three shift workers had hypertension as a result of their shift work. The findings show that working shifts significantly increases the chance of developing hypertension. A study in German automobile industry employees discovered that those who worked the night shift had the highest mean triglyceride and cholesterol levels, both of which are indicators of hypertension [12]. According to a study of workers in the German automobile industry, those who worked the night shift had the highest mean levels of triglycerides and cholesterol, both of which are signs of hypertension [12]. According to a study done in a steel company in Japan, working alternating shifts is a substantial independent risk factor for an increase in blood pressure among 3963 day workers and 2748 alternating shift workers [13]. A cohort research in a Japanese steel company found that alternating shift work is a significant independent risk factor for a rise in blood pressure among 3963 day workers (3963) and 2748 alternating shift workers [13]. Soeker et al [14] discovered that 56 percent of workers in a South African automobile industry were hypertensive in terms of systolic blood pressure and 50 percent were hypertensive in terms of diastolic blood pressure, showing hypertension prevalence. Li et al [15] investigated the link between shift work and metabolic syndrome in Japanese managers, technicians, service employees, skilled workers, and machine operators. The findings revealed that shift workers in the 40–49 age groups had the highest blood pressure and lipid levels. Heart disease, stroke, and type 2 diabetes are all increased by the metabolic syndrome. In a study of rotating shift employees and day workers at a petrochemical facility in France, Esquirol et al [16] looked at the link between shift work and metabolic syndrome. The prevalence of metabolic syndrome was reported in 22% of shift workers compared to 16% of day workers, according to the study. A similar study in an automobile manufacturing plant found that working two shifts is linked to the employees suffering from metabolic syndrome [17]. In a Malaysian manufacturing company, a significant difference in the prevalence of metabolic syndrome between

night-shift workers (45 %) and non-night-shift workers (33 %) reported [18]. All of the aforementioned research discovered a connection between shift work and health concerns among workers, including hypertension, cardiovascular and gastrointestinal difficulties, and metabolic abnormalities. All of this could lead to missed work days. According to the studies mentioned above, shift work is related to health problems such as hypertension, cardiovascular and gastrointestinal difficulties, and metabolic abnormalities in workers. It can all lead to missed work days.

2.2.2 Shift Work and Accident

Shift work disturbs the 24 hour human sleep wake cycle, resulting in mental and behavioral The 24-hour human sleep-wake cycle is disrupted by shift work, and the accompanying mental and behavioral alterations may increase the risk of workplace accidents and injuries due to impaired cognitive function while on the job or afterward [7]. In an Indian textile industry, shift workers reported occupational accidents at a rate of 27% compared to non-shift workers at a rate of 17%, according to [19]. In an Iranian mine, a study showed that 26.3 percent of shift workers and 16.2 percent of non-shift workers suffered occupational accidents [20]. When shift workers and regular employees in an Indian iron and steel company were compared for workplace injuries, 9.8% shift workers were hospitalized for injuries against 5% day workers [10].

Alali et al. ([21]) investigated the link between shift work and injuries among Belgian workers in the mining, manufacturing, and electrical industries. Workers working shifts had a higher risk of injury (OR 2.30, 95 percent CI 1.53–3.43), he concluded. Saha et al. [22] claimed for a higher number of injuries during the night shift (25) and evening shift(23) as compared to the day shift(18) based on the results of a study in the metal smelting industry in India. The US mining sector, which includes shifts of 10 to 12 hours, has risk factors for injuries, workers who started working between midnight and 6:59 a.m. were among the risk factors associated with injuries sustained during prolonged working hours, showing that the risk of injury is higher for those who work the morning and night shifts [23]. The relationship between shift employment and work-related injuries among shift workers in a South Korean electronics manufacturing was examined , study discovered that compared to non-shift workers, current and previous shift workers had a 2.7 and 1.7 times higher risk of work-related injuries, respectively [24]

2.2.3 Shift Work and Mental Health

Shift work disturbs the biological cycle, resulting in mental and cognitive changes in people [7]. In addition to having an effect on performance, poor mental health can result in errors or lapses in focus that can cause accidents at work and injuries. The research on the mental health of shift employees on the Indian railways discovered depression stress in 23.67 percent of employees, with younger age groups accounting for 84.62 percent of those suffering from anxiety stress (20- 40 years). This shows that the ability to tolerate shift work is age-neutral [25]. A study conducted among 14,226 employees February

2024 [22] at an electronics firm in South Korea found that the odds of shift employees experiencing insomnia, depression, or suicidal thoughts were 2.35, 1.23, and 1.17 times higher than those of daytime workers [26]. Ljosa et al. [27] looked at mental discomfort among Norwegian petroleum sector offshore shift workers and highlighted that men had higher degrees of emotional distress than women which was gender specific. Another study of 889 fixed- and rotating-shift underground coal miners in southern Brazil found that 13% of the employees had low prevalence of depression and moderate anxiousness [28]. In India, Srivastava et al [29] looked on the mental health of dairy workers. He concluded that shift workers reported significant disparities in mental health components anxiety, depression, and general mental health as compared to day employees. Rasoulzadeh et al [30] looked at the psychological discomfort of 400 shift workers at an Iranian petrochemical plant. Shift job tiredness was found to have a high positive relationship with psychological distress

2.2.4 Shift Work and Sleep

In order to fulfil a basic human need for rest and relaxation, a worker's occupation is important factor. Several studies found that sleep issues, excessive sleep, and fatigue may result from working on a non-traditional schedule [6, 20, 31]. Halvani [20] investigated the rate of fatigue in a mining firm in Iran. According to his data, 13.9 percent of shift employees reported feeling more exhausted than the 7.7% of non-shift workers.

When rotating shift workers at a pulp and paper factory in Brazil were surveyed, it was noted that whereas 60 percent of the female groups reported daily sleepiness on a regular basis, only 22.2% of the male groups reported feeling extremely sleepy during the day [31]. Shift workers in Canadian underground mines claimed to feel more sleepy finishing night shifts [32]. Another study looked at the sleeping patterns of 20 employees in an Australian lead smelting facility. According to findings, sleep is frequently accomplished less during the second shift of each kind. [33]. The sleepiness in 288 workers on 12-hour shifts in the Korean auto sector was examined, study found that compared to day shift workers, who had a 23.2 percent chance of being extremely sleepy and non-shift workers, who had a 9.5 percent chance, night shift workers had a 61.2 percent chance [34]. A survey of 373 textile industry employees in Portugal found that night shift workers had significantly more sleep disorders compared to morning or afternoon shift workers [35]. Two-shift, three-shift, and four-shift workers showed a greater frequency of sleep problems than non-shift workers, according to a subsequent cohort study of 2453 shift workers in the Chinese petroleum sector [36]. Omidi et al. [49] evaluated 155 shift workers and 104 day workers in an Iranian mining industry for sleep problems. As a result of the findings, 13% of shift workers utilize sleeping drugs to aid with daytime sleep. 71% of shift employees and 29% of day workers reported having sleep issues, respectively. Investigation into the prevalence of insomnia among Chinese shift workers in the steel industry revealed prevalence rates of 43.7, 40.3, and 51.7 percent, respectively. When compared to day and three system workers, those who worked other shift systems had

a higher prevalence of insomnia (52.9 percent) [37]. Kim et al. [38] used a national sample of 8,155 Korean manufacturing and industrial shift workers to study the relationship between factors connected to the workplace and insomnia. In the study, 43.5 percent of male three-shift workers and 28.7 percent of male non-shift workers reported having insomnia. A qualitative research with shift workers from four major manufacturing enterprises in the United States claimed that shift work causes sleep disorders and insufficient sleep by disrupting the body's natural rhythms [39]. Norwegian oil firm night shift workers, swing shift workers, and day offshore workers participated in a study, the results indicated that night and swing shift workers' sleep quality deteriorated on their first day off and persisted for the following 14 days [40]

2.2.5 Shift Work and Performance

Working at an irregular hour may cause physical or mental exhaustion [6, 31]. Worker performance and motivation are affected by poorly planned shift work arrangements [41-43]. Fatigue produces a loss of energy, which can result in poor focus, distraction, mood changes, and errors, all of which can lower worker productivity [44-47]. Muller et al [48] investigated occupational tiredness in Australian mineral industry day and night shift workers. According to the study, 80.4 percent of workers had sleepy or strained eyes, and 60.8 percent had trouble remembering or concentrating, indicating a decline in job function owing to exhaustion. These findings are supported by a study in the textile industry in India, which concluded shift workers had a greater fatigue score than general shift workers [14]. In the mining industry in Iran, Omidi et al. [49] evaluated fatigue in 155 shift workers and 104 day workers, results reported that Shift workers and day workers have significantly different levels of fatigue. 20 employees of an Australian lead smelting factory who worked 12-hour shifts in rotation were the subject of Baulk's [33] investigation into

Worker fatigue. He emphasized that night shift workers are more worn out than day shift ones. Lin et al. [50] examined the risk variables for work-related fatigue among daytime and rotating night and day workers at a Taiwanese semiconductor manufacturing company. The findings demonstrated that day and night rotating shift workers were four times more likely than day employees to experience occupational fatigue. Moradifar et al [51] investigated the fatigue symptoms of 300 gas transmission sector day and rotating night shift workers. He came to the conclusion that rotating-shift workers were more fatigued than fixed-shift ones. Bazazan et al. [52] studied tiredness in petrochemical industry rotating shift employees in Iran. The total mean fatigue score for the study population was 36.07. The data demonstrated a high frequency of general fatigue in the research population.

3. CATEGORIZATION OF STUDIES BASED ON INCLUSION CRITERIA

In order to achieve the goal of investigating many aspects of shift work research, the current study categorizes the literature review. The publications were divided into categories according to year, publishers, journals, industry sector, country, research design, data collection methods, and research results.

The descriptive analysis was carried out by categorizing and portraying the selected papers in charts and tables.

Figure 2. Distribution of studies based on year of publication

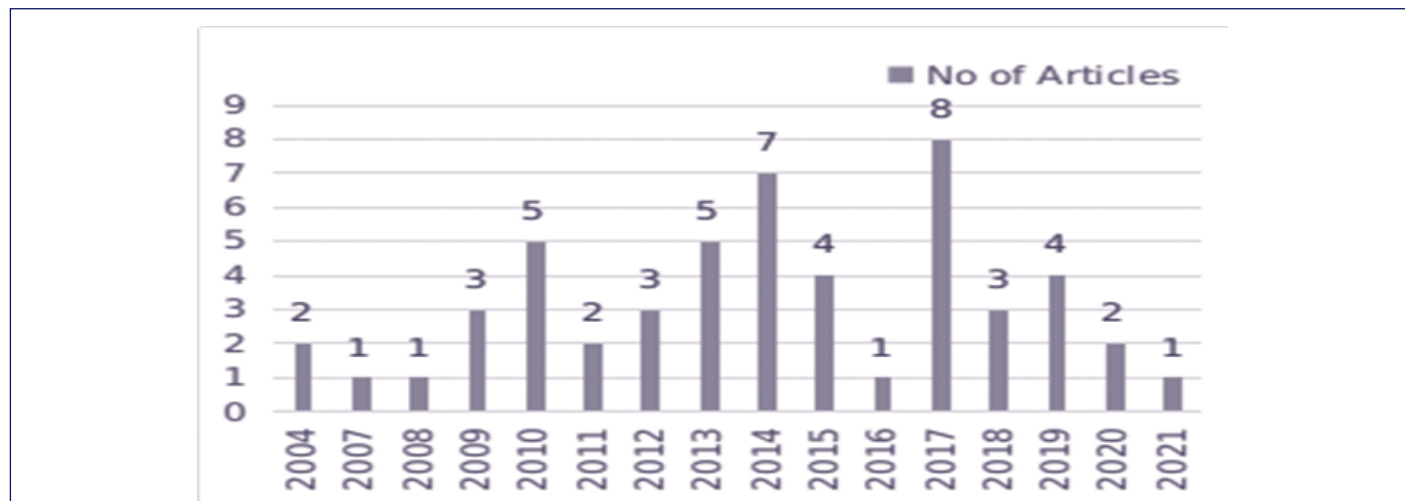


Figure 3. Distribution of studies based on publisher

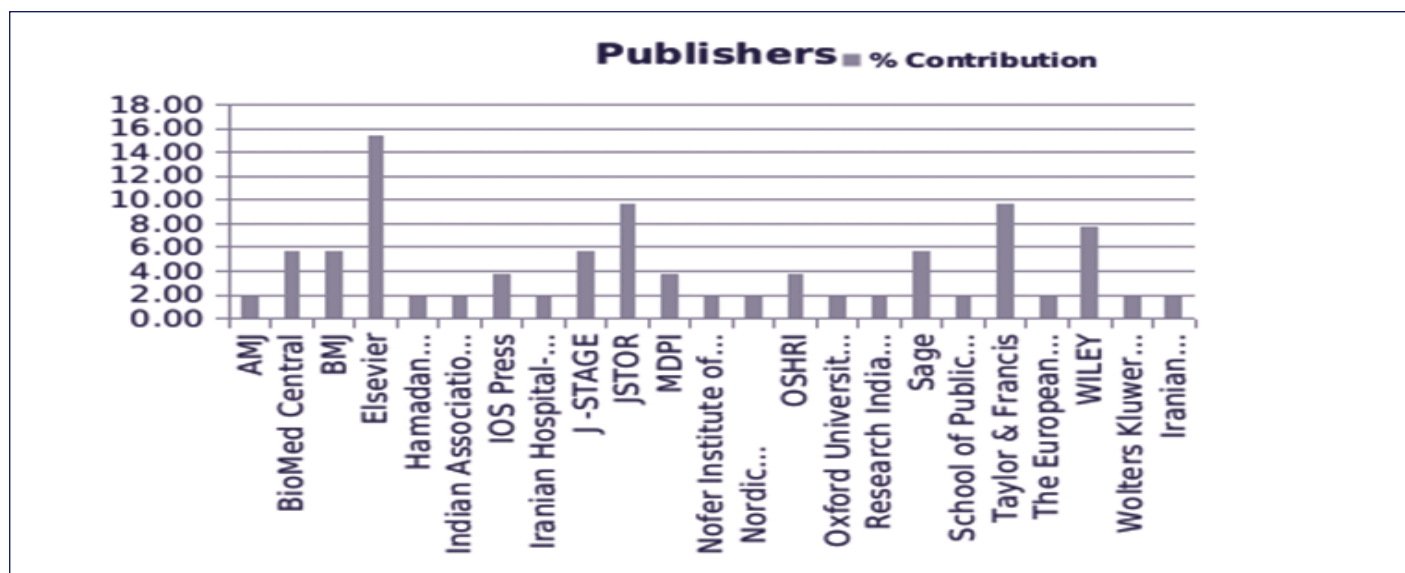


Figure 4. Distribution of studies based on Industry sector

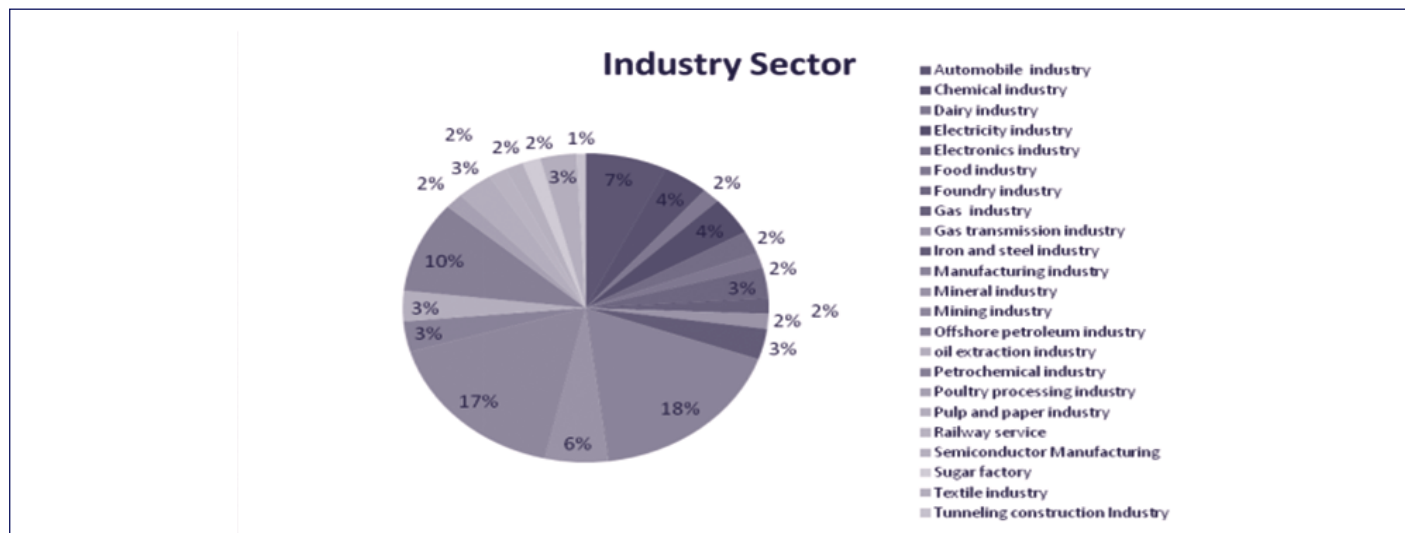


Figure 5. Distribution of studies based on country

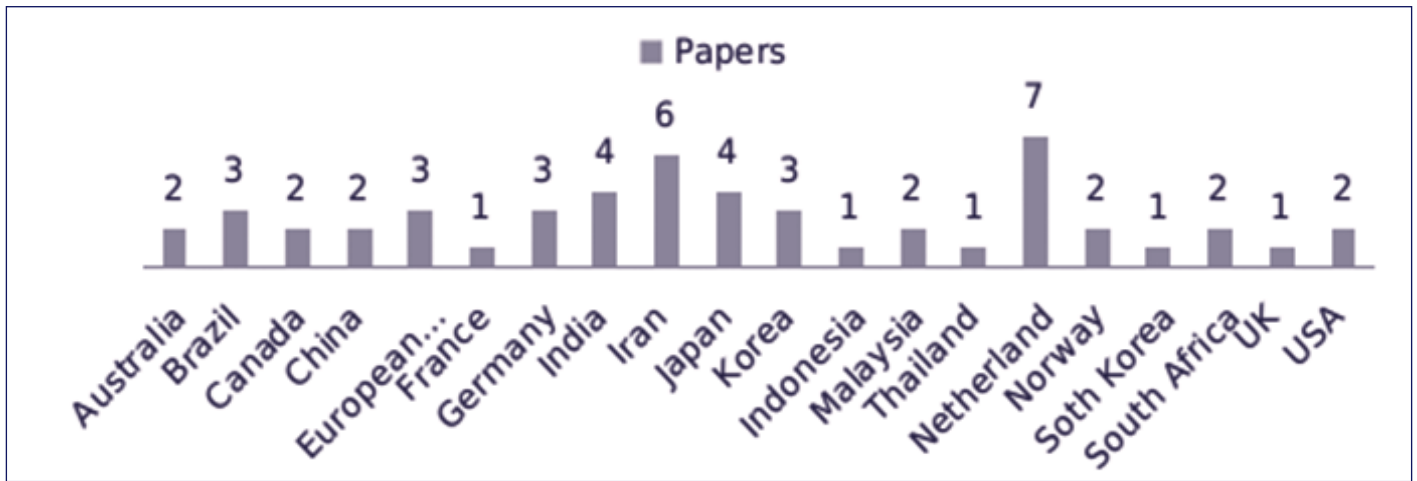


Figure 6. Distribution of studies based on outcome measurement

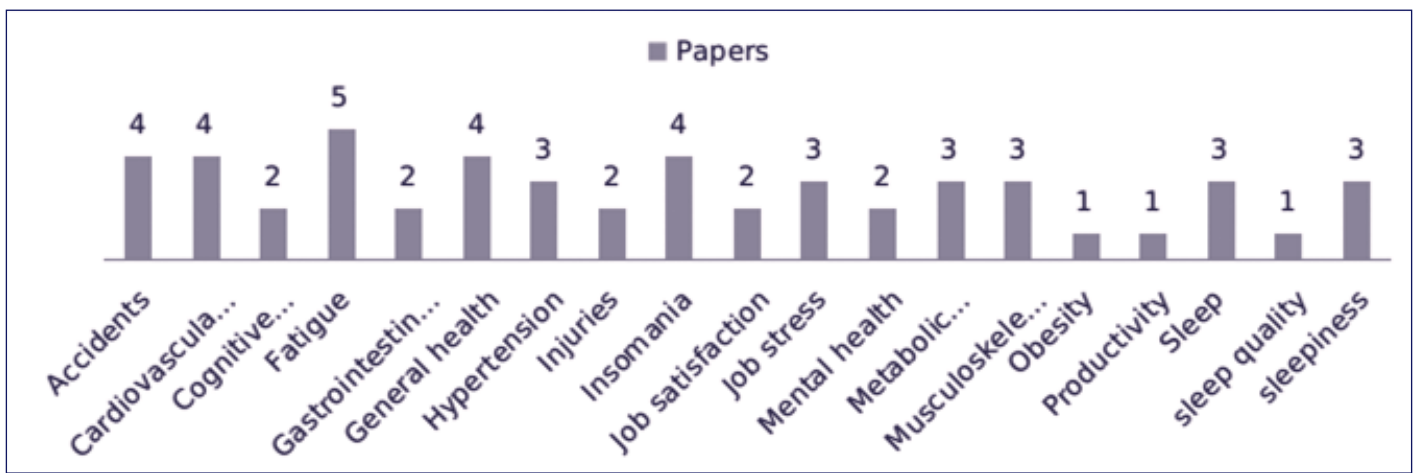


Figure 7. Distribution based on data collection tools

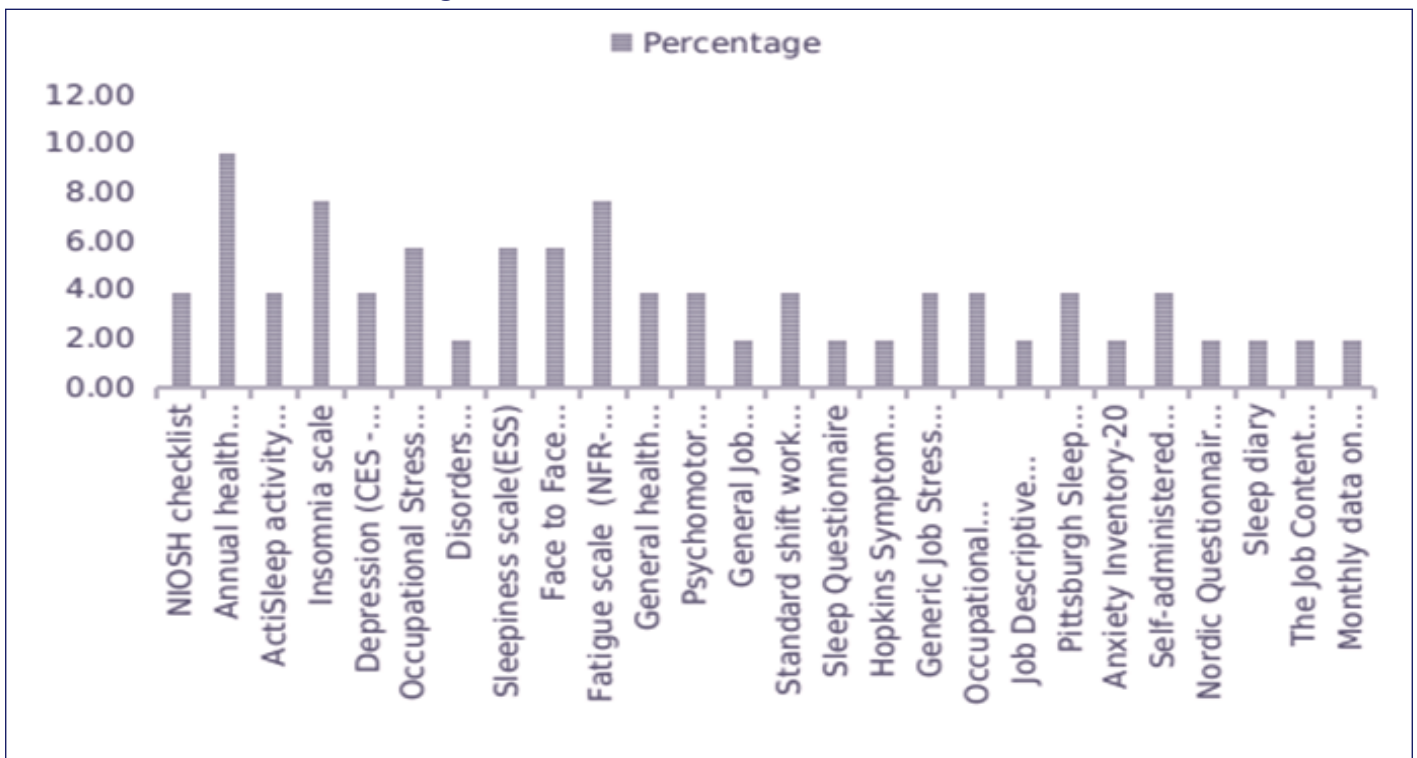
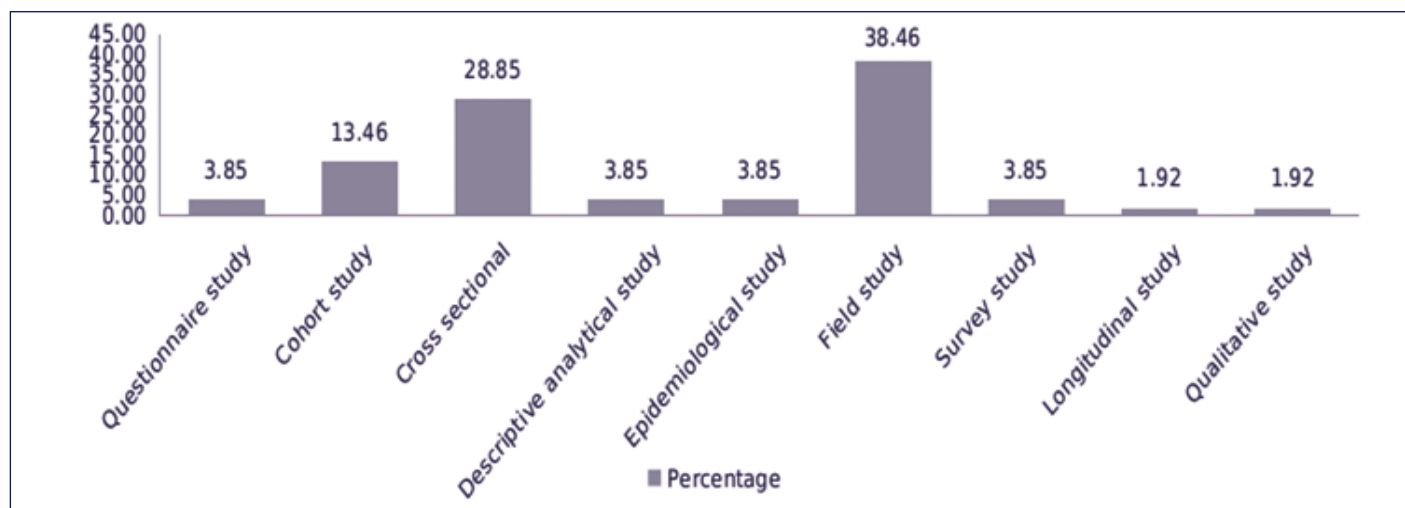


Figure 8. Distribution of studies based on research design



4. FINDINGS FROM DESCRIPTIVE ANALYSIS

- This category includes the frequency count of 52 articles according to their publication years (Figure 2). Between 2011 and 2014, there were more studies published than ever before, presumably as a result of growing public awareness of the negative effects shift work has on health and industrial productivity. A notable rise from 2016 to 2017. The gradual rise reflects the necessity for understanding the detrimental consequences of shift work on occupational health and productivity being acknowledged by academics and business leaders.
- The categorization based on publishers is done with the intention that future research will find these publications to be more relevant to their research (Figure 3). According to an examination of the publications we've chosen for review, Elsevier the publisher with the highest number of articles in the shift work field research (15.38%), followed by JSTOR (9.62%) and Taylor and Francis (9.62%) based on selected studies
- In order to map the requirement for shift work research in a particular industry, categories are created based on industry sectors. According to classification (Figure 4), the mining industry has the biggest percentage of studies (21%), followed by the manufacturing (15%), petrochemical (15%), and automobile (8%). There is greater room for future shift work study in other industry sectors because these four important industries represent approximately 50% of the shift work research in the selected articles.
- Although foundries and casting industries comprise only 6% of shift work study studies, they are an important and crucial sector in industrialized countries. In India, there are more than 4500 foundries and casting industries, of which 10% are large and medium-sized enterprises and 80% are smaller enterprises. The foundry industry is an important industrial sector, which provides numerous chances for shift work study for improvements.
- The number of studies performed in each country is shown in

Figure 5. The categorization indicates that more publications have been recorded in developing countries which indicates more opportunities for future shift work research in developing countries. Netherland leads with highest no of studies (13.46%) followed by Iran (11.53%), India (7.69%) and Japan (97.69%) out of selected studies.

- The classification based on research study results reveals the frequency of these associated outcome elements as shown in Figure 6. The effects of shift work that are most frequently investigated in included studies include exhaustion, insomnia, sleepiness, cardiovascular diseases, hypertension, accidents, and musculoskeletal problems. In order to mitigate their negative effects through intervention, future study should concentrate on these indicated outcomes.
- For researchers to choose the most popular instruments for data gathering in their next research, the categorization of data based on Figure 7 is useful. For qualitative data, questionnaires are also a preferred method, providing 25% as a data gathering instrument, and standardized scales provide 34%.

5. KEY ISSUES AND CHALLENGES IN SHIFT WORK RESEARCH

Following research findings and research gaps are reported from the literature review.

1. In shift work study, there are differences in the shift system design, research design, data collection tools and methodologies, work culture, and work practices, which limits the production of concrete results, decision-making, and potential interventions.
2. There is currently no suggested best shift system that can be advised for all sorts of shift work in industry. The existing research work compared several types of shift systems, shift patterns, and schedules.
3. The review found a major area of concern regarding the impact of shift work on health, wellness, and performance, which has an impact on productivity.
4. Research studies using a quantitative, ergonomic

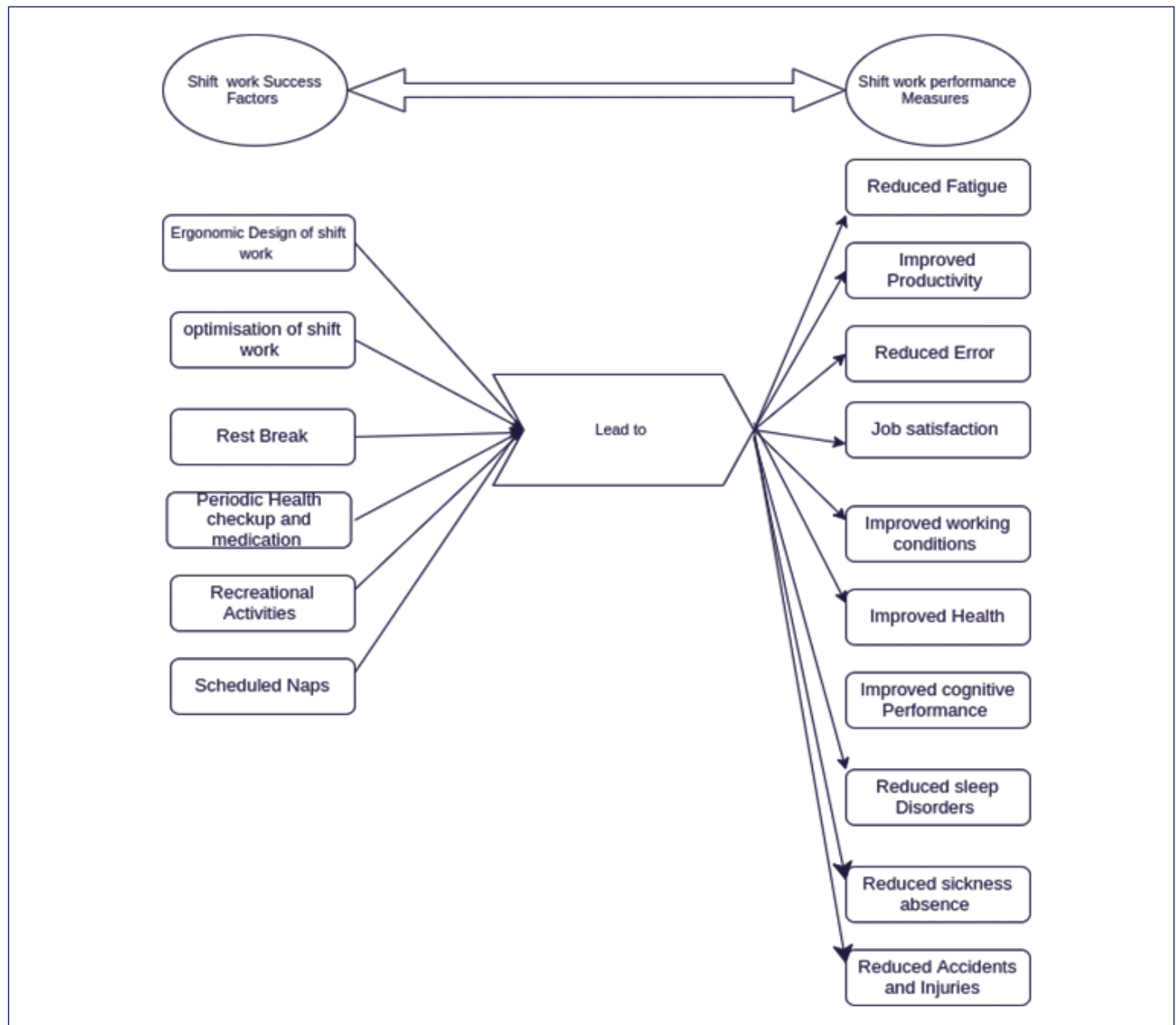
- methodology were necessary to show the effects of changes and make recommendations.
- Although foundry and casting are important industries, there are few research articles that highlight the effects of shift work in this field.
 - The results of shift work studies from industry and manufacturing field are few in number and too diverse in focus based on research design for definite conclusions to be drawn.

- Different aspects of shift design were not addressed by most of studies.

6. PROPOSED SHIFT WORK FRAMEWORK

Figure 9 depicts the conceptual framework for this investigation. This approach was developed in light of the numerous research that were reviewed and show how shift work affects employee health and performance.

Figure 9. Conceptual Framework for shift work



7. CONCLUSION

This review looked for shift work characteristics associated with worker performance and health as well as the difficulties of shift work studies. Academics, professionals, and researchers will benefit from these classifications by having a better grasp of shift work research and the opportunity for additional

studies. Varied industrial sectors have different levels of shift work research. Manufacturing businesses require extra attention because working conditions are unsuitable for these workers. Working in difficult conditions, as well as shift work, particularly night employment, puts workers at danger. The majority of the research focused on identifying outcomes and their relationship to shift work characteristics. A few

research focused on interventions based on an examination of shift work-related data gathered from various studies for improvement. This review looked for shift work characteristics associated with worker performance and health as well as the difficulties of shift work studies. Academics, professionals, and researchers will benefit from these classifications by having a better grasp of shift work research and the opportunity for additional studies. An optimal and ergonomic shift system design is necessary for industries, which requires thinking beyond the usual occupational health idea. Using multiple methodologies to investigate shift work study, further research and analysis is required. Furthermore, there are few studies that look at how many shift characteristics affect worker health and performance at the same time. In none of the research studies, all shift considerations are thoroughly investigated.

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