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Prevalence of Fatigue Among Construction Workers in The United States

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Within dynamic and complex construction environments, fatal and non-fatal occupational records are alarming all over the world. Fatigue among workers is one of the key causes which affects their ability to operate safely. To improve safety management, the prevalence of fatigue among workers must be investigated to implement effective interventions for fatigue mitigation. However, the prevalence of fatigue among construction workers in the United States has not been studied. Therefore, this research explores this gap by recruiting 120 workers in the U.S. To achieve the research goals, the worker's level of fatigue (i.e., acute, chronic, and inteshift recovery) was measured using a validated OFER scale. Data analysis revealed (1) the prevalence of fatigue among construction workers is alarming (OFER Score=34.23), that acute fatigue, among all aspects of it, has the most profound impact on workers, and (2) there are no statistical correlations between measured fatigue levels and age and experience of construction workers. The findings of this study will be beneficial to practitioners and researchers in construction to implement effective safety measures to prevent accidents in workplaces.

Key Words: Fatigue, Construction Workers, Construction Safety, OFER Scale

Introduction

The construction industry is known for a dynamic and complex process with unique projects that have created various challenges for workers. These challenges have consistently led to a high rate of fatal and non-fatal injuries. In 2018, 20% of work-related mortalities were related to the construction industry in the European Union, the highest number of other industries (Namian et al. 2021). In the first three-quarters of that time, the construction accounts for 673 mortalities in 581 safety accidents that occurred in China (Xing et al. 2020). Similarly, in the United States, whereas only 4 % of the U.S. workforce is employed in construction, 20% of work-related mortalities are related to this industry (Al-Bayati 2022). Unfortunately, in 2019, approximately 15 workers died every day from catastrophic accidents, which shows an over 40% increase since 2007 in the United States (Ibrahim et al. 2022; Namian et al. 2022a).

It has been determined that the main factors of happening these accidents can be found human errors, unsafe behavior, a lack of knowledge and safety training, and poor and ineffective management at the sites (Abukhashabah et al. 2019; Bussier and Chong 2022; Namian et al. 2022b). One of the accident prevention methods is identifying, evaluating, and controlling potential dangers (Christian et al. 2009). This is because when accidents occur frequently, workers tend to ignore environmental hazards or believe they are not important enough to address, which prevents them from taking any corrective action to eliminate or control them.

Researchers have attempted to identify different variables that can exert an impact on workers' safety performance. For example, some demographic characteristics such as age, gender, training, experience, job role, and education have been determined to have a profound impact on workers' situational awareness (Ibrahim et al. 2022). More recently, some researchers have identified some variables like safety attitude (Kashmiri et al. 2020), safety climate (Pandit et al. 2019), safety training (Namian et al. 2016), distraction (Namian et al. 2018), and superstitious beliefs (Namian et al. 2020) that affect workers' safety performance.

One of the main factors identified globally as a harmful variable on safety performance is attributed to fatigue. A recent study has shown a strong negative correlation between fatigue and two essential components of safety (Hazard Recognition and Safety Risk Perception). In this study, Fewer hazards and lower safety risks were recognized and perceived by workers who have a higher fatigue level (Namian et al. 2021). Moreover, it has been identified as a main contributing factor to approximately 50% to work accidents (Sari et al. 2021). This illustrates how the fatigue factor is vital when it comes to managing Jobsite injuries. However, there is a dearth of research on the prevalence of fatigue among construction workers to help practitioners and researchers with fatigue mitigation. Therefore, this article aims to investigate this gap of knowledge in the United States.

Research Method

Fatigue is a pervasive and serious problem for workers around the world in different industries. For example, in the transportation industry is estimated that fatigue accounts for between 15 and 20 of all accidents (Bendak and Rashid 2020). In the construction industry, the impacts of worker fatigue can be more dangerous to occupational health and safety than in other industries caused of the temporary nature of construction sites (Xing et al. 2020). In the United States, work-related fatigue and overexertion are responsible for more than 30% of all occupational accidents (Yu et al. 2019). Moreover, it is estimated that the U. S. employers cost $136 billion annually for fatigue-related lost productivity in the world (Xu and Hall 2021).

Given the importance of fatigue on workers' safety, researchers have attempted to measure the prevalence of fatigue on job sites globally. Fatigue in some countries like Canada, Japan, the E.U., and Sweden has been reported to be a high prevalence (Lu et al. 2017). Generally, the prevalence of fatigue in the workplace between almost 10% and 40% has been reported (Bhuanantanondh et al. 2021). Understanding the prevalence of fatigue is known as the first step to taking effective actions for improving safety (Lu et al. 2017). Therefore, the present study aims to investigate the prevalence of fatigue among construction workers in the United States. To achieve the research goal, workers were selected randomly for active construction projects in the U. S. and asked to participate in the study. The details pertaining to the participants and fatigue level evaluation are explained in the following sections.

Participants

To measure the research objective, data were gathered from some active projects in the United States. Almost 50% of data was gathered from North Carolina State (32.50%) and Georgia State (11.67%). Over a period of one month in 2019, 120 construction workers were recruited randomly to answer the questions in person using a questionnaire. Workers' participation was voluntary, and the researchers assured that the information collected was confidential and would not be used for other purposes except for statistical use. Information will also not be given to employers or supervisors. On average, Participants' age and their job experience were from 18 to 67 (age average= 37.63) and 0 to 45 (experience average= 13.95), respectively. Only 7.5% (n=120) of the participants mentioned that they had had injuries in the past 12 months, and over 45% of workers have an OSHA 10 / OSHA 30 Certification.

Fatigue Level Evaluation

Work-related fatigue has an adverse effect on the productivity and performance of workers. Past research has demonstrated that fatigue can reduce the quality of work and productivity and increase safety problems and human errors in the workplace (Xu and Hall 2021). In the construction industry, heavy workload, awkward working posture, and prolonged working hours have been reported as contributing factors to workers' fatigue, leading to reduced decision-making ability, reduced motivation and attention, reduced response to changes or increased reaction time for thinking, and increased distraction (Xing et al. 2020; Zhang et al. 2015). In 2014, 40% of fall accidents were attributed to workers' fatigue (Parijat and Lockhart 2008).

To measure fatigue in construction, researchers have tried to utilize emerging technologies to detect the fatigue level of workers accurately. For example, surface electromyographic (sEMG) is attached directly to the skin of workers to measure muscle fatigue, and a wearable electroencephalogram (EEG) sensor can be used for psychosocial conditions to measure mental fatigue of workers (Li et al. 2019; Yu et al. 2019). Although these new technologies are promising, the inability of worker's normal work and cost issues are major hindrances. Therefore, fatigue monitoring in the construction industry has depended on self-report information.

Fatigue is divided into two acute and chronic types based on time (long-term and short-term). Acute fatigue is a common phenomenon related to short-time mental or physical heavy activities that usually are resolved by compensatory mechanisms (Aratake et al. 2007). Chronic fatigue is created if acute fatigue continues, and it reduces an individual's corporeal and physical abilities. Many researchers have stated that chronic fatigue is the reason for the most dangerous events in working (Rajaratnam and Arendt 2001). To accurately measure workers' fatigue levels in each project, information collected all week day's (except holidays) and workers' all efficient hours presently, using the Occupational Fatigue Exhaustion Recovery scale (OFER) (Winwood et al. 2005). OFER-15 questionnaire includes three dimensions: chronic fatigue (C.F.) (five items), acute fatigue (A.F.) (five items), and recovery between work shifts (5-items). The criterion of response in this questionnaire is a 7-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = neither agree nor disagree, 5 = somewhat agree, 6 = agree, 7 = strongly agree). Table 1 shows three questions of the OFER-15 scale, which was used to measure workers' fatigue levels. Accountable quantities for each item under the criterion are achieved between 0 to 35, and more distinction of each of these criteria will show more intensity of that. This questionnaire is the first instrument that can distinguish acute and chronic fatigue from each other.

Table 1

Three sample questions of the OFER Scale (Winwood et al. 2005)

Fatigue	Numbers	Questions
Chronic Fatigue	1	"I often feel I'm 'at the end of my rope' with my work"
Acute Fatigue	6	"After a work shift, I have little energy left"
Intershift Recovery	11	"I never have enough time between shifts to recover my energy completely"

Result and Discussion

The data collected from the 120 interviewed construction workers were gathered and statistically analyzed. Firstly, the descriptive statistics of the participants' fatigue levels and the frequency distribution of the subscale intensity of the OFER questionnaire are presented in Tables 2 and 3 and Figure.1.

Table 2

Descriptive statistics of fatigue levels

Scale	Minimum	Maximum	Mean	Median	SD
Occupational Fatigue Exhaustion Recovery (OFER)	3	81	34.23	33	18.23
Subscale					
Chronic	0	30	10.13	8	7.57
Acute	2	27	13.27	13	6.59
Intershift recovery	0	30	10.84	10	6.44

Table 3

The frequency distribution of the subscale intensity of the OFER questionnaire (n=120)

Subscale	**Intensity**			
	Low	Low/Moderate	Moderate/High	High
Chronic	44 (36.67%)	20 (16.67%)	27 (22.50%)	29 (24.17)
Acute	2 (1.67%)	33 (27.50%)	28 (23.33%)	57 (47.50%)
Intershift Recovery	3 (2.50%)	64 (53.33%)	25 (20.83%)	28 (23.33%)

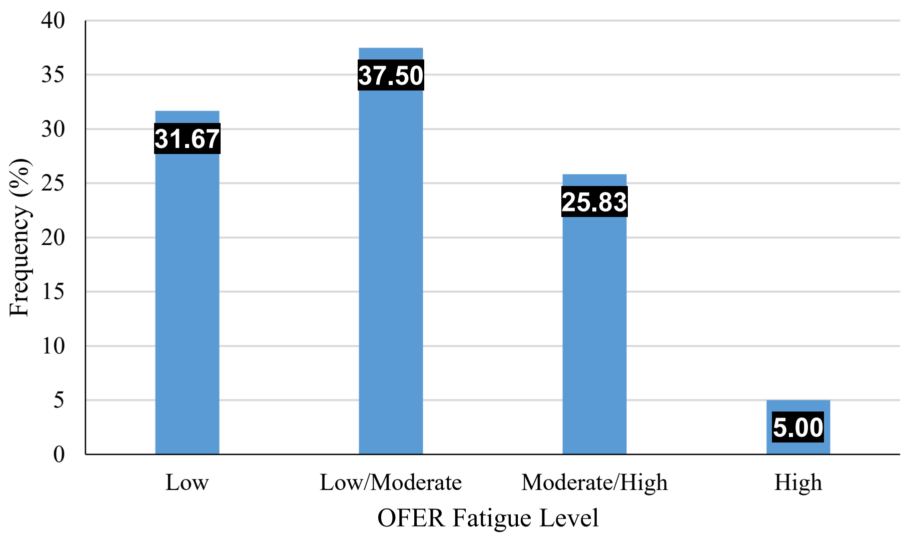

Figure.1. Measured fatigue level distribution (OFER Scale).

The second objective of the study was to evaluate the statistical correlation between demographic variables like age, construction experience, and fatigue level. The integrated data were statistically tested, and no statistical correlation (p-value=0.54) was supported by the data on age and fatigue level. Further, the data showed that there is no correlation between construction experience and fatigue level (p-value=0.20).

Research Implication

The current study attempt to investigate the prevalence of fatigue among construction workers in some active projects in the United States. The result reveals the prevalence of fatigue levels of moderate/high and high levels are above 30%, and most of the surveyed workers have reported that high and low/moderate intensity of acute and inter-shift recovery fatigue levels have experienced, respectively. This data's findings should serve as a warning to researchers and planners in the construction industry to put in place some interventions to lessen workers' acute exhaustion and speed up their recovery because chronic exhaustion can result from prolonged acute exhaustion and a rise in occupational accidents.

Conclusion

Perception of the prevalence of fatigue can improve the construction environment because workers are most prone to fatigue in construction projects due to doing physical and mental work every day. A large number of accidents are attributed to fatigue. However, the prevalence of it has not been studied as researchers have focused more on fatigue effect on other variables.

To address this knowledge gap, the current study explores the prevalence of fatigue among construction workers using a verified scale of fatigue measurement (OFER). The study data collection was conducted from 120 workers in various construction projects such as residential buildings and Institutional and Commercial buildings. The highest rates of the surveyed workers were on these types of projects.

A closer examination of the data revealed the prevalence of fatigue is approximately 34% and the fatigue level of most of the surveyed participants is low/moderate (37.50%). More specifically, workers have complained further from acute fatigue, among three dimensions of the OFER questionnaire, and a high level of acute fatigue was reported. In addition, the hypothesis that the mean age and construction experience of fatigued workers is statistically significantly higher than not-fatigued workers were tested. The survey found no correspondence among age, construction experience, and measured fatigue levels of workers.

This study provides an understanding of the prevalence of fatigue in construction as a contributing factor to accidents. The finding of this research is crucial for safety professionals to take effective mitigation strategies in order to implement better workplace practices the decrement the impact of fatigue. Perception of the causes, symptoms of fatigue, and ways to control fatigue in the workplace should be considered in future studies.

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