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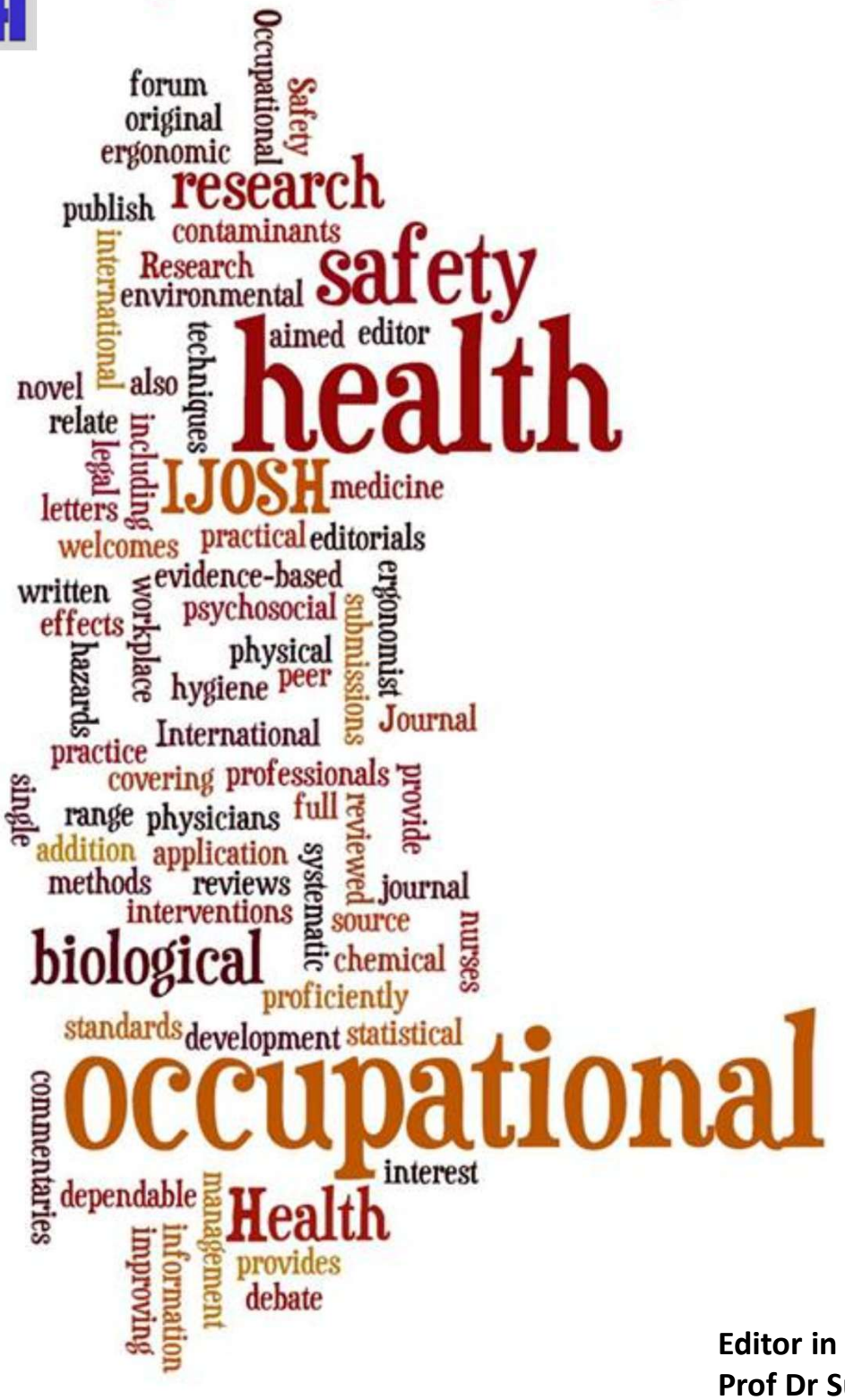

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Letter to the Editor

Addressing the Challenges in Medical Training for Occupational Health in India's Rapidly Industrializing Landscape

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I am writing this letter to address the gap in occupational health training among medical professionals in India. Although urbanization and industrialization are advancing at an extraordinary pace in India, the same momentum is not being reflected in the field of occupational health. As India now boasts over 250 million industrial units, the health and safety of millions of employees working in hazardous environments has become a critical issue.

Occupational health, which focuses on ensuring the physical, mental, and social well-being of workers, plays a crucial role in enhancing workforce productivity and promoting economic growth.[1] Workers spend a significant portion of their lives at work, and their work environment directly impacts their health. Poor occupational health practices lead to a variety of health issues such as respiratory diseases, musculoskeletal disorders, mental health conditions, and even fatal injuries. These problems not only impact individual workers but also result in significant economic losses through reduced productivity, absenteeism, and increased healthcare costs.

The Government of India has established legislation such as the Factories Act[2] and the Employees' State Insurance (ESI) Act, aimed at protecting employee rights and providing health benefits. Additionally, the Directorate General of Factory Advice Service &Labor Institutes (DGFASLI) also contributes its part by training medical professionals in occupational health through its various training modules. One of them is the Associate Fellow of Industrial Health (AFIH) program, a three-month comprehensive course that is a statutory requirement for doctors working in the industrial sector. This program offers a robust curriculum, covering occupational health practices, environmental health, and statutory provisions, supplemented with research methodology and industrial visits.[3].

We at ESIC Medical College and Hospital, Faridabad, were the first among our cohort to complete this course following approval from

DGFASLI. However, the preparedness of the medical community to address the complex issues of ergonomics, industrial safety, and hygiene remains a concern, and several challenges hinder its effectiveness.

One of the significant hurdles is the lack of practical training infrastructure in medical colleges. The institutions often lack the necessary labs, museums, or hands-on opportunities that would enable doctors to gain real-world experience in industrial health settings. Most of the present medical professionals are not themselves trained in the specialized and complex topics of industrial safety, industrial hygiene, occupational health, and environmental health. The AFIH program not only demands medical expertise but also requires professionals to work collaboratively with workers, management, and law enforcement agencies.

Another challenge is the complexity of adult learning, where students have to juggle work, family responsibilities, and coursework.[4] The additional financial burden of pursuing this course, staying in the hostel away from the family, combined with the struggle to stay motivated in acquiring new skills later in their careers, further complicates their ability to engage fully with the training.

Given ESIC's unique position to offer students a firsthand, world-class experience in managing occupational hazard-exposed individuals through its OPDs and industrial camps, we have worked to address these training gaps by providing hands-on, clinically focused instruction to our AFIH students.

Our curriculum was further enriched by incorporating lessons in research methodology and biostatistics from community medicine experts, while integrating our students into ESIC's healthcare system to ensure comprehensive learning.

To increase the momentum in occupational health training, the following measures are worth suggesting:

1) **Integrating Occupational Medicine into MBBS Curriculum:** Occupational Medicine should be recognized as a core subject rather than a peripheral component of medical education. Furthermore, in line with other medical specialties, a dedicated postgraduate (Master's) degree in Occupational Health should be introduced to provide in-depth, specialized training. This would not only enhance the competency of healthcare professionals in managing work-related health issues but also elevate the status and scope of occupational health as a distinct and essential medical discipline.
2) **Increasing CME on Occupational Health for Faculty:** Regular Continuing Medical Education (CME) sessions on occupational health should be conducted for faculty members. This will ensure they remain well-equipped with the latest knowledge and practices to train AFIH students effectively.
3) **Fostering Interdisciplinary Collaboration:** Medical professionals should work in tandem with interdisciplinary fields, recognizing the diverse skill sets required to address the complexities of occupational health. This promotes a holistic approach to the course.
4) **Ethical Considerations and Worker Rights:** The AFIH curriculum should emphasize the ethical responsibilities of occupational health professionals, including the importance of respecting worker rights and maintaining workplace safety standards.
5) **Mental and Social Health Sensitization:** Alongside physical health, AFIH students should be sensitized to the mental health and social environment of workers. This holistic approach ensures that all aspects of worker well-being are addressed.

A medical professional trained in occupational health has the power to significantly improve the quality of life for workers, potentially adding

years to their lives by addressing work-related health issues.

In conclusion, while efforts have been made to address occupational health through legislation and training programs, there is a pressing need to enhance the medical education and infrastructure related to occupational health. Collaboration between the medical and engineering fields, investment in training resources, and the development of more comprehensive educational programs are essential to meet the rising demand for occupational health services in India.

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Original Article

Assessing the consistency of two models of benzene neurotoxicity risk assessment to create and validate a health risk screening guideline among fuel service workers

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ABSTRACT

Introduction: This research and development study aimed to (1) evaluate the consistency of two models of benzene neurotoxicity risk assessment (NRA) and (2) create and validate a neurotoxicity risk screening manual among fuel service workers (FSW). Data were collected through interviews and urine collection. The neurotoxicity risk screening was divided into two models: qualitative neurotoxicity risk assessment (NRA-1) and quantitative neurotoxicity risk assessment (NRA-2). The two sample groups included inside- and outside the fuel dispenser area were 100 per group, and a neurotoxicity risk screening guide was created and validated using a panel of 15 experts.

Methods: NRA-1 used the following variables in health screening to assess exposure to benzene: frequency of exposure, duration of work (years), number of working hours, number of overtime hours per week, number of trucks providing refueling services per day, and reuse of clothes. NRA-2 used two variables to screen for frequency of exposure: frequency of work (hours per day) and trans,trans-muconic acid (t,t-MA) levels in urine.

Results: NRA-1 showed that 29.0% of the workers had a low risk level, 37.0% moderate, 13.0% high, and 2.0% very high. For NRA-2, 32.0% of the workers had a low risk level, 37.5% moderate, 11.5% high, and 6.0% very high. Both NRAs were statistically significantly consistent ($r = 0.409$, $p < 0.001$). The neurotoxicity risk screening guide was criticized by experts, and it can be concluded that it can be used as a pilot for neurotoxicity screening of FSWs.

Conclusion: The risk assessment was conducted using both qualitative (NRA-1 model) and quantitative (NRA-2 model) methods. The both methods can be applied to easily implement the assessment. The low-cost method can be used to perform the qualitative assessment without testing for metabolites in urine.

Keywords: Benzene, Fuel service workers, Neurotoxicity risk assessment, Medical and public health personnel

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Introduction

Chemicals in fuels have shown that benzene is a substance of particular concern because it is a known carcinogen.[1] There are reports of measurements of benzene in fuel stations that exceed the standards set by the American Conference of Governmental Industrial Hygienists, both in the environment and in the bodies of workers.[2-4] For example, a study of exposure to benzene, toluene, ethyl benzene, and xylene (BTEX) in the urine of fuel station workers

found that the workers had benzene (B) exposure exceeding the standard by as much as 29.0%, but toluene (T) was within the standard.[5] Accordingly, fuel station workers are at higher than acceptable health risks.[6]

Benzene can affect workers' health, which is a matter of great concern because 50% of the BTEX that humans inhale throughout their lives will be absorbed into the body.[7] Tunsaringkarn et al.[8] stated that only 14.6% of fuel service workers practice safe behavior while working. The health effects from this group of substances can occur both acutely and chronically in many systems. The main effects are on the nervous system.[7,9-11] Exposure to excessive amounts of benzene can damage the central nervous system (CNS), cause depression,[12] and affect memory, understanding, and behavior.[13] Even at low concentrations, long-term exposure to benzene increases the risk of anemia and leukemia in humans.[14-16]

Health care for risk groups exposed to benzene is usually done by assessing the biomarker of benzene exposure in urine in the form of trans,trans-muconic acid (t,t) MA;[17-18] evaluating changes in biochemical indicators, such as neurochemical biomarkers such as acetylcholinesterase;[19-20] evaluating symptoms in various systems using the modified EUROQUEST questionnaire;[21] and performing neurobehavioral tests and systems.[22]

However, there are still limitations in occupational health operations for informal workers at fuel stations, including a lack of personnel to assess health risks, relatively high prices for toxicology laboratory analysis, and insufficient resources to support occupational health.[23] In Thailand, over the past few years, seven agencies have been authorized to conduct independent laboratory analysis, with only two laboratories located in the eastern region. Importantly, the cost of toxicology laboratory testing based on risk factors is higher than the cost of general analysis; for example, the average cost of t,t-MA analysis is 391.4 baht per sample.[24] Therefore, one option is to use health risk assessment as a method to screen for neurological risks among fuel service workers exposed to benzene.

The assessment of benzene's health risks involves both qualitative and quantitative assessment models, which have been internationally recommended. In Thailand, guidelines for health risk assessment are based on the TIS 2012 standard.[26] Previous studies have assessed occupational health risk models of exposure to benzene, toluene, and xylene at low concentrations, which were semi-quantitative and quantitative assessments, in five manufacturing establishments in China,[27] the health risks of benzene inhalation among gas station workers using the model of the U.S. Environmental Protection Agency (EPA),[28] a biomatrix of health risk assessment of benzene-exposed workers at Thai gasoline stations,[6] and the health risks of volatile organic compounds in high-risk groups in Map Ta Phut Industrial Estate, Rayong Province.[29] For qualitative risk assessment, a health risk assessment model to screen for farmers exposed to pesticides.[30]

There is no study on the creation of a manual for screening the risks of benzene to the nervous system in a risk group. Gas stations contain a variety of chemicals that affect the nervous system, particularly aromatic hydrocarbons such as benzene, toluene, ethylbenzene, and xylene (BTEX group). Studies on several chemicals have found that 29.5% of gas station workers have t,t-MA levels (metabolites of benzene) exceeding the American Conference of Governmental Industrial Hygienists (ACGIH) and Thai standards (more than 500 μg/g Cr).[2,6] The gas station workers also reported 32.5% more neurological symptoms than those who did not previously work there. Toxicology has confirmed a link to the nervous system, which has led to the development of an assessment model. However, other chemicals may also have an effect, such as toluene, but its metabolite levels in urine have been found to be within standard limits.[5] Research studies have only been conducted on the benefits of health monitoring of professionals working at fuel

stations in Thailand, who do not have annual health check-ups for risk factors like those in the industrial sector.[3,28] Therefore, our study's objective was to assess the consistency of two models of benzene neurotoxicity risk assessment to create and validate a health risk screening guideline among fuel service workers. The benefits include creating innovations in neurotoxicity risk screening, and the screening manual can be efficiently utilized to reduce costs and mitigate the impact on the nervous system from benzene exposure in the risk group in the future.

Methods

This study used a research and development design. The research operation was divided into three phases: (1) studying personal information, work history, and metabolites of benzene exposure in urine (trans,trans-muconic acid, t,t-MA); (2) assessing the consistency of two models for assessing benzene risk to the nervous system; and (3) creating and validating a manual for screening health risks among fuel service workers (FSWs) for medical and public health personnel and assessing satisfaction with its use. This study was reviewed by the Human Research Committee at Burapha University, with research project code number HS 031/2020, prior to data collection.

The sample was divided into three groups according to the research phase as follows: In Phases 1 and 2, the sample group consisted of individuals who worked in the fuel station area. The sample size was calculated using the unknown population mean estimation formula by substituting the variance (σ) from Eze et al.[31] in the fuel station group, which was equal to 0.36; the 95% confidence (z) value was 1.96, and the error (e) value was 0.05. The sample size was 200 people, divided into the exposure group of 100 people, who worked in the fuel station (inside fuel dispenser areas: I-FDA) and were responsible for providing fuel, and the comparison group of 100 people, who worked in the fuel station but were not directly accountable for providing fuel (outside fuel dispenser areas: O-FDA). The inclusion criteria consisted of working in a fuel station (either I-FDA or O-FDA); being 18–60 years old; being able to read, listen to, and write Thai; and consenting to participate in the research. The exclusion criteria were being unable to work the whole 8 hours or participate in the research activities. The sample consisted of 200 workers in the area of 8 gas stations. This research assessed exposure using the dose of t,t-MA in urine. Therefore, the study selected gas stations of the same size, with a similar number of workers, and offering similar welfare benefits to workers, in an attempt to control for exposure consistency.

In Phase 3, the sample group consisted of 15 experts, including academics and users of NRA guidelines. Academics were university lecturers and doctors with expertise in related fields, including occupational health, industrial hygiene, community and family medicine, toxicology, public health, research statistics, engineering, the environment, and communication technology. Users included representatives from the occupational and environmental diseases division and representatives from occupational and environmental medicine groups of hospitals in the sample area.

Phase 1: Personal information, work history, and t,t-MA in urine. The research instruments and data collection in this study were divided into two parts: an interview form and a urine sample collection device, as follows:

1) The interview form was divided into four parts, totaling 30 questions. The scores were given by selecting the answer and filling in the blanks. The questionnaire consisted of the following: (a) Personal information data, 10 questions, such as gender, age, body mass index, income, marital status, education level, smoking, and alcohol history. (b) Personal hygiene, nine questions, divided into five positive questions, such as washing hands before eating, washing hands before drinking water, changing clothes after work, going out to rest in an area away from the fuel dispenser during breaks, and four negative questions, such as drinking water in the work area,

wearing the same clothes to work the next day, etc. The answer options are actions: yes or no. (c) Six questions about behavior in using personal protective equipment (PPE) and appropriate work clothes, such as safety glasses, face masks, gloves, boots or sneakers, long pants, and long sleeves. The answer options are actions: yes or no. (d) Work history, including five items: work experience (years), number of working hours per day, number of working days per week, overtime work (hours/week), and sleep time per night (hours), among others.

Fifteen symptoms of the nervous system were assessed using an interview form, including dizziness, headache, fatigue/easily tired, stress/irritability, lack of concentration/poor memory, more drowsiness than usual, nausea/vomiting, numbness in the hands/feet, weak arms and legs, hand tremors, loss of smell, or reduced sense of smell. If there was at least one symptom, it was considered abnormal.

To ensure the quality of the interview form, the researcher brought the developed instrument to three experts, consisting of one university lecturer specializing in occupational health and two occupational physicians. After the quality test, the item-objective congruence index (IOC) was calculated for each item. It was found that each question had an IOC value of more than 0.5 for all items. The reliability was checked by finding the Cronbach's alpha coefficient, which was 0.88.

Interview forms were collected per the following steps: (i) After receiving approval from the research ethics committee, the researcher recorded a message and initially coordinated with the fuel station's manager to request cooperation in the study, explain the study's objectives and details about data collection, and request permission to collect data. (ii) The researcher met with the fuel station's manager and FSWs to explain the objectives and request permission to collect data at the time, date, and location provided. (iii) The researcher went to the area to collect research data by interviewing. The researcher explained the questions to the research assistant so they would understand them in the same way. Later, the researcher met with the manager at each fuel station, as scheduled, to begin collecting research data by interviewing the sample at each location. The interview took 10–15 minutes for each person at the office of each fuel station. The interview form was received after the interview was completed.

2) Urine collection, with equipment including a 50-mL polyethylene container, for the purpose of assessing the levels of t,t-MA with data interpretation criteria according to the recommendations of the ACGIH.[2]

For urine sample collection, the researcher distributed urine sample containers to workers during work and instructed them to collect urine samples at the end of the shift; workers collected mid-stream urine samples in a plastic cup, poured half of the urine container into a polyethylene container, and immediately placed it in a cooler box at a temperature below 4°C. When the required amount was collected, it was sent to the laboratory each day for analysis of t,t-MA levels; the analytical laboratory was an ISO/IEC 17025 or ISO 15189 laboratory.

The quantity of the samples was analyzed by using column type C18, mobile phase, containing water/acetonitrile at a ratio of 50:50 v/v, the flow rate of 1.0 mL/min at 37.0 °C, sample solvent by methanol, and ultraviolet detection at 254 nm wavelength, and extracted using the method of Onchoi followed by analysis using High Performance Liquid Chromatography (HPLC). the interpretation of the results based on the ACGIH used a cut-off point (standard normal), which t,t-MA <500.00 μg/g Cr.[32]

Phase 2: Assessment of the consistency of the two models of benzene neurotoxicity risk assessments (NRA). The four steps of health risk assessment were as follows:

Step 1: Hazard identification. The researcher used data collected in Phase 1, including personal information, work history, and t,t-MA in the urine of operators working at fuel stations, including fuel filling, cashiering, and loading fuel (I-FDA),

and washing vehicles, repairing vehicles, selling in a convenience store, and selling beverages and food (O-FDA). The details of the chemical data (Safety Data Sheet) for benzene, including the amount of benzene exposure, exposure frequency (EF), and exposure duration (ED), were studied.

Step 2: Dose response. The results from the assessment of abnormal neurological symptoms in the Phase 1 study were grouped into 5 scores to classify health effect rating (HER) or severity rating (SR): 1 (0–2 symptoms), 2 (3–5 symptoms), 3 (6–8 symptoms), 4 (9–11 symptoms), and 5 (12–15 symptoms or more).[33]

Step 3: Exposure assessment, to assess benzene exposure in two models: qualitative exposure assessment using an interview and quantitative exposure assessment by assessing t,t-MA. After that, the exposure rating (ER) was classified by multiplying it with the exposure frequency (EF) as follows:

a) Qualitative exposure assessment. The exposure assessment was derived from the results of the relationship analysis between the independent variables (personal information, work history, personal hygiene, and PPE) and the dependent variable (neurological symptoms). The variables with a statistical relationship of $p < 0.05$ were selected to be used to predict the level of benzene exposure, including (A1) duration of work (years), (A2) overtime worked (hours per week), (A3) number of pickup trucks refueled per day, (B1) wearing short-sleeved shirts while working, and (B2) wearing the same clothes repeatedly or wearing the same clothes for more than 1 day. The above variables are identified as risk factors based on the statistical analysis.

The levels of qualitative ER were calculated as the exposure assessment score (EAS) from risk factors (RF) by summing the scores (A1+A2+A3+B1+B2) multiplied by the exposure frequency (EF) or A4, which is calculated as follows:

Qualitative exposure assessment:

$$EAS = RF \times EF = (A1+A2+A3+B1+B2) \times A4 \quad (1)$$

b) Quantitative exposure assessment uses the criteria according to the Thai Ministry of Industry's 2012 announcement on chemical risk assessment, using the results of the assessment of t,t-MA compared with the standard value of the biological exposure index (BEI) to obtain the chemical concentration rating (CR). CR was classified into five levels (10% lower than BEI, 10–49%, 50–74%, 75–100%, and >100%). The Biological Exposure Indices (BEIs), as recommended by ACGIH2, define t,t-MA as less than 500 μg/g Cr. Therefore, the range of t,t-MA exposure levels is divided into <50, 50–249, 250–374, 375–500, and >500 μg/g Cr, and was scored as 1, 2, 3, 4, and 5, respectively, then multiplied by the EF. The EF consists of Level 1 (exposure once a year), Level 2 (exposure 2–3 times a year), Level 3 (exposure 2–3 times a month), Level 4 (exposure for 2–4 hours continuously in one shift), and Level 5 (continuous exposure throughout the entire shift). Then, the exposure rating (ER) was obtained. Therefore, when calculating of CR and EF, it will be equal to 5 x 5, the total is equal to 25 points, divided into 5 levels of exposure again: 1–3, 4–6, 10–16, 17–20, 21–25, interpreting the exposure level as 1–5, which is acceptable, low, moderate, high, and very high,[26] to be used in the matrix with Health effect rating (HER).

Quantitative exposure assessment:

$$ER = CR \times EF \quad (2)$$

Step 4: Risk characterization (RC). This step involves identifying qualitative risk characteristics at five levels: acceptable or insignificant, low, moderate, high, and very high. It is obtained by multiplying the CR by EF to get ER, then multiplying ER by the health effect rating (HER) or the severity level from Step 2 (Levels 1–5), and then comparing the scores in Table 1 to rank the risk level according to the Thai Ministry of Industry's[26] announcement on chemical risk assessment.

$$RC = ER \times HER \quad (3)$$

Table 1: Levels of risk characterization (RC)

Health effect rating (HER)	Exposure rating (ER)					Exposure Assessment Score (EAS)		
	1	2	3	4	5	Score	Levels	Levels
1	1	2	3	4	5	1-3	Acceptable	0
2	2	4	6	8	10	4-6	Low	1
3	3	6	9	13	15	10-16	Moderate	2
4	4	8	12	16	20	17-20	High	3
5	5	10	15	20	25	21-25	Very high	4

Phase 3: Creating and validating a neurological risk assessment (NRA) manual among FSWs for medical and public health personnel and assessing satisfaction with its use.

To assess the consistency of the qualitative neurological risk assessment (NRA-1) and quantitative neurological risk assessment (NRA-2), the scores of the two models were analyzed for consistency using the kappa test. Then, details of the nervous system risk assessment of benzene were used to create and validate the manual, consisting of Part 1: Academic content of the manual: basic knowledge of occupational chemicals, the body's dose-response to chemicals, chemical toxicity, biomarkers, health surveillance, and principles of health risk assessment; and Part 2: Neurological risk screening and guidelines (NRA-1 and NRA-2).

Satisfaction with the implementation of the NRA screening among FSWs exposed to benzene was assessed for use in the field. The researcher organized a meeting to gather opinions from 15 experts, including academics and those who would use the manual, including university lecturers; workers in occupational health, industrial hygiene, community and family medicine, toxicology, public health, biostatistics, engineering, environment, communication technology; staff from the occupational and environmental diseases division and department of disease control; and representatives from the occupational and environmental medicine of local hospitals.

The manual was assessed using the satisfaction assessment form and focus group discussions as follows:

1) The satisfaction assessment form had 21 items with three options (appropriate, fair, and should be improved). The items assessed novelty, applicability, usability as a guideline for health screening in accordance with the objectives, being created from appropriate and consistent academic principles and concepts, having a reliable process for obtaining the manual, new knowledge in the manual, ease of understanding and usefulness to readers, usefulness to the occupational health sector, the ability of the knowledge in the manual to be exchanged or referenced or disseminated in the profession, usability in real-world health service organizations, completeness of important topics, up-to-date content, clear explanations appropriate for the user group, consistent writing style, appropriate content sequence, reliability, interesting colors or appearance, easy-to-read font size, appropriate illustrations that communicate with the content, easy access when needed or downloadability, organization or ease of reading, and emphasis of essential topics.

2) The focus group was a brainstorming session with set questions to gather opinions from experts, including the appropriateness of the academic content of the manual, the clarity of the language used, and the feasibility of using the manual as a guideline for officials and public health personnel in screening the risks of fuel station workers. The researcher analyzed the content, used consensus to summarize the meeting results, and made adjustments according to the recommendations.

The statistics used in this study were divided into descriptive and inferential statistics. Descriptive statistics included frequencies and percentages. For inferential statistics, the chi-square test was used to analyze the relationship of pairwise variables between 19 independent variables, found that 6 variables were found to have a statistically significant relationship (p <0.05) with health symptoms, namely, work history (4 items) (duration of employment, working hours, overtime work, number of trucks filled with fuel), and risk behavior (2 items) (wearing short-sleeved shirts while working and wearing the same clothes repeatedly or wearing the same outfit for more than 1 day). Therefore, the 6 variables were combined with the neurological symptoms (15 items) and selected variables with a statistically significant relationship (p <0.05) to be used to predict the level of benzene exposure (Exposure rating, ER), with the exposure frequency (EF). In addition, Cohen's kappa coefficient was used to test the consistency of the two NRA screening models. The kappa score range is 0.00, 0.01–0.20, 0.21–0.40, 0.41–0.60, 0.61–0.80, and 0.81–1.00, which can be interpreted as very little, little, fair, moderate, good and very good, respectively.[34]

Results

Phase 1: Personal information, work history, and t,t-MA in urine.

There was a total of 200 workers: 100 inside fuel dispenser areas (I-FDA) and 100 outside fuel dispenser areas (O-FDA). The number of males and females was similar (the ratio of males to females was 1.00:1.27). The mean age was 27.78 years (SD = 5.95). Approximately half (52.5%) were overweight or obese. Of the I-FDA and O-FDA, 53.0% and 74.0% did not smoke, respectively. Regarding the history of alcohol drinking, 49.0% of I-FDA and 42.0% of O-FDA were still drinking. Overall, the majority of the 200 workers at the gas stations did not smoke (63.5%). However, some people did not smoke but could smell cigarette smoke from others (13.0%).

Overall, the workers (n = 200) had an average work experience of 2.44 (S.D. = 4.06) years, average working hours of 9.09 (S.D. = 1.54) per day, an average working period of 6.31 (S.D. = 0.47) days per week, and average overtime work per week of 6.42 (S.D. = 4.87) hours. The workers slept an average of 7.49 (S.D. = 1.38) hours per day. However, 19.0% of them slept less than 5–6 hours. The results from the study of the I-FDA group (n = 100) showed that an average of 32.65 (S.D. = 24.80) refueled pickup trucks and 31.51 (S.D. = 30.43) motorcycles per day per worker.

The results of the relationships between 19 independent variables and neurological symptoms found that six variables (risk factors: RF) related to neurological symptoms were statistically significant ($p < 0.05$), including the years of work at this fuel station, overtime worked, number of pickup trucks filled per day, number of working hours per day, wearing short-sleeved shirts, and wearing the same clothes or uniforms to work. Therefore, the researcher used all six factors to create an NRA-1 model in the second phase.

Phase 2: Assessment of the consistency of the two models of benzene neurotoxicity risk assessment (NRA).

Two NRA benzene models were developed to find a screening guideline: (1) a qualitative neurological risk assessment (NRA-1) model and (2) a quantitative neurological risk assessment (NRA-2) model[32] (see Table 2).

The results found that the exposure rating (ER) of the workers was 100% continuously exposed to benzene throughout the shift (see Table 3).

The exposure level results according to NRA-1 were obtained by multiplying the ER with the EF according to the score level (score 1–5). The ER was calculated from the grouping results from the EAS or RF (A1+A2+A3+B1+B2), consisting of work history and health behaviors multiplied by the EF (see Table 4)

Table 2: Risk factors for qualitative and quantitative NRA model

NRA-1 model			NRA-2 model	
Part 1 Work history		**Score (points)**	**Part 1 Work history**	**Score (points)**
A1	Duration of working at this fuel station _____ years	< 1 year = 0 ≥ 1 year = 1	Not used	Not used
A2	Working overtime _____ hours per week	<6 hours per week = 0 ≥6 hours per week = 1	Not used	Not used
A3	Number of pickup trucks _____ filled per day	<10 trucks per day = 0 ≥10 trucks per day = 1	Not used	Not used
A4	Working frequency at fuel areas (hours per day) Notes: This section does not need to be combined with other sections.	Rarely 2-3 times a year 2-3 times a month 2-4 hours per shift >4 hours per shift	Use the same as NRA-1 model	Use the same as NRA-1 model
Part 2 Health behavior				
B1	Wearing short-sleeved shirts while working	No = 0 Yes = 1	Not used	Not used
B2	Wearing the same clothes repeatedly or wearing the same outfit for more than 1 day at work	No = 0 Yes = 1	Not used	Not used
	Not used	Not used	**t,t-MA levels compared with BEI values** <10% of BEI 10–49% of BEI 50–74% of BEI 75–100% of BEI >100% of BEI	 1 2 3 4 5
Part 3 Symptoms of the nervous system (Numbers of symptoms)				
C1	0–2 3–5 6–8 9–11 12–15	1 2 3 4 5	0–2 3–5 6–8 9–11 12–15	1 2 3 4 5

Table 3: Number, percentage, exposure frequency (EF) and exposure rating (ER) levels classified by 2 models of exposure levels

Levels	NRA-1 model		NRA-2 model	
	Exposure frequency (EF)	**n, % (Hours working per day)**	**Exposure frequency (EF)**	**n, % (Hours working per day)**
1	Rarely	0 (0.0)	Rarely	0 (0.0)
2	2–3 times a year	0 (0.0)	2–3 times a year	0 (0.0)
3	2–3 times a month	0 (0.0)	2–3 times a month	0 (0.0)
4	2–4 hours per shift	0 (0.0)	2–4 hours per shift	0 (0.0)
5	>4 hours per shift	200 (100.0)	>4 hours per shift	200 (100.0)
Levels	**Exposure rating (ER) of NRA-1 model**		**Exposure rating (ER) of NRA-2 model**	
	ER was obtained by multiplying the Exposure score (ES) or the sum of Risk factors		EF was calculated from ER x EF*	

Levels	NRA-1 model		NRA-2 model	
	Exposure frequency (EF)	n, % (Hours working per day)	Exposure frequency (EF)	n, % (Hours working per day)
	(A1+A2+A3+B1+B2) with the frequency (EF) as shown in Table 3.			
1	acceptable	0 (0.0)	acceptable	0 (0.0)
2	low	8 (4.0)	low	40 (20.0)
3	moderate	102 (51.0)	moderate	52 (26.0)
4	high	75 (37.5)	high	49 (24.5)
5	very high	15 (7.5)	very high	59 (29.5)

Notes: Exposure rating (ER) of Qualitative NRA-1 was obtained by multiplying the Exposure score (ES) or the sum of Risk factors (A1+A2+A3+B1+B2) with the frequency (EF) as shown in Table 3. *For Exposure rating (ER) of Quantitative NRA-2 was calculated from exposure rating, ER x EF follow with Thetkathuek et al.[33]

Table 4: Qualitative neurological risk assessment (NRA-1) model

Exposure rating, EF (A4)	Exposure assessment score (EAS) or Risk factor (RF) A1+A2+A3+B1+B2)					Exposure levels		
	≤1	2	3	4	5	Exposure assessment score (EAS)	levels	Exposure rating (ER)
Rarely	1	2	3	4	5	1–3	acceptable	1
2–3 times a year	2	4	6	8	10	4–6	low	2
2–3 times a month	3	6	9	13	15	10–16	moderate	3
2–4 hours per shift	4	8	12	16	20	17–20	high	4
>4 hours per shift	5	10	15	20	25	21–25	very high	5

The exposure level results according to NRA-2 were obtained by multiplying the ER according to the results of the comparison with the five BEI levels and the EF. Details are shown in Table 1 (column NRA-2 model).

The results of the study were obtained by combining scores for abnormal neurological symptoms. It was found that most cases had a Level 2 effect on the nervous system, totaling 49 cases (24.5%) (see Table 5).

The results of the RC study were obtained by multiplying the ER score by the HER score. The RC percentage was classified into five risk levels (RLs): acceptable, low, moderate, high, and very high. The study's results showed that in NRA-1, the largest group was at the moderate level (n = 74 cases; 37.0%), followed by the low level (n = 58 cases; 29%). In NRA-2, the largest group was at the moderate level (n = 75 cases; 37.5%), followed by the low level (n = 64 cases; 32%).

Table 5: Number and percentage of abnormal neurological symptoms

Levels	Neurological symptoms (Symptoms)	n	%
1	0–2	102	51.0
2	3–5	49	24.5
3	6–8	31	15.5
4	9–11	13	6.5
5	12–15	5	2.5

The consistency assessment showed a close consistency between the two NRA models. When the researcher tested the results statistically using Cohen's kappa coefficient, it was found that the two risk assessment formats were moderately consistent (kappa = 0.41, $p < 0.001$; see Table 6).

Table 6: Number and percentage of RC of NRA1 and NRA-2

Risk characterization (RC)			NRA-1		NRA-2		Kappa test	p-value
Score	levels	Levels	n	%	n	%		
1–3	acceptable	0	38	19.0	26	13.0	0.41	<0.001
4–9	low	1	58	29.0	64	32.0		
10–16	moderate	2	74	37.0	75	37.5		
17–20	high	3	26	13.0	23	11.5		
21–25	very high	4	4	2.0	12	6.0		

Phase 3: Creating and validating an NRA manual among FSWs for medical and public health personnel and assessing satisfaction with its use.

The researchers used the NRA-1 and NRA-2 models to create a screening manual for neurological risks, which consists of two parts: the screening manual and the steps of the screening process, as follows:

1. The NRA screening manual for medical and public health personnel (Figure 1) resulted from content quality checks from brainstorming in the form of focus groups of experts and users. The content consisted of two parts: (i) relevant academic content and (ii) a neurological risk screening manual obtained from research and recommendations for use in the assessment. The details are as follows:

Part 1: The manual's academic content includes basic knowledge about occupational chemicals, the body's dose-response to chemicals, chemical toxicity, biological indicators, health surveillance, and principles of health risk assessment.

Part 2: The neurological risk screening form and recommendations for use in health risk assessment consist of a qualitative NRA-1 and a quantitative NRA-2, including examples of assessments based on neurological risk levels.

2. NRA screening included the following steps:

1) The qualitative NRA-1 to screen health risks to the nervous system used a questionnaire consisting of work history, health behaviors, and abnormal neurological symptoms. Those factors entered the obtained data into the risk assessment classified according to the various steps mentioned above. The quantitative NRA-2 assessed the level of exposure using the EF data with the results of the assessment of the level of t,t-MA in urine. The level of effect on the nervous system (HER) was made according to the steps mentioned above.

Figure 1: NRA screening manual among workers at fuel service workers

2) The risk assessment results from Step 1 can screen workers into five risk groups: acceptable, low, moderate, high, and very high. If it is found that the FSWs are at high or very high risk, they should undergo a basic physical and laboratory examination, including advice on reducing exposure to risk factors or self-protection, assessing biochemical indicators, assessing biological indicators, etc.

3) From Step 2, workers who were tested for t,t-MA biomarkers were divided into two evaluation levels: t,t-MA < 500 µg/g Cr and t,t-MA ≥ 500 µg/g Cr, referring to the criteria of the ACGIH (2025) and the Department of Disease Control, Ministry of Public Health (2015). The following actions are recommended: (i) t,t-MA < 500 µg/g Cr: health monitoring should be conducted at least once a year; (ii) t,t-MA ≥ 500 µg/g Cr: advise on reducing exposure to benzene, proper personal hygiene, and proactive monitoring by inspecting the work area to find the source. In addition, after giving advice, t,t-MA exposure should be assessed again in 6 months (Figure 2).

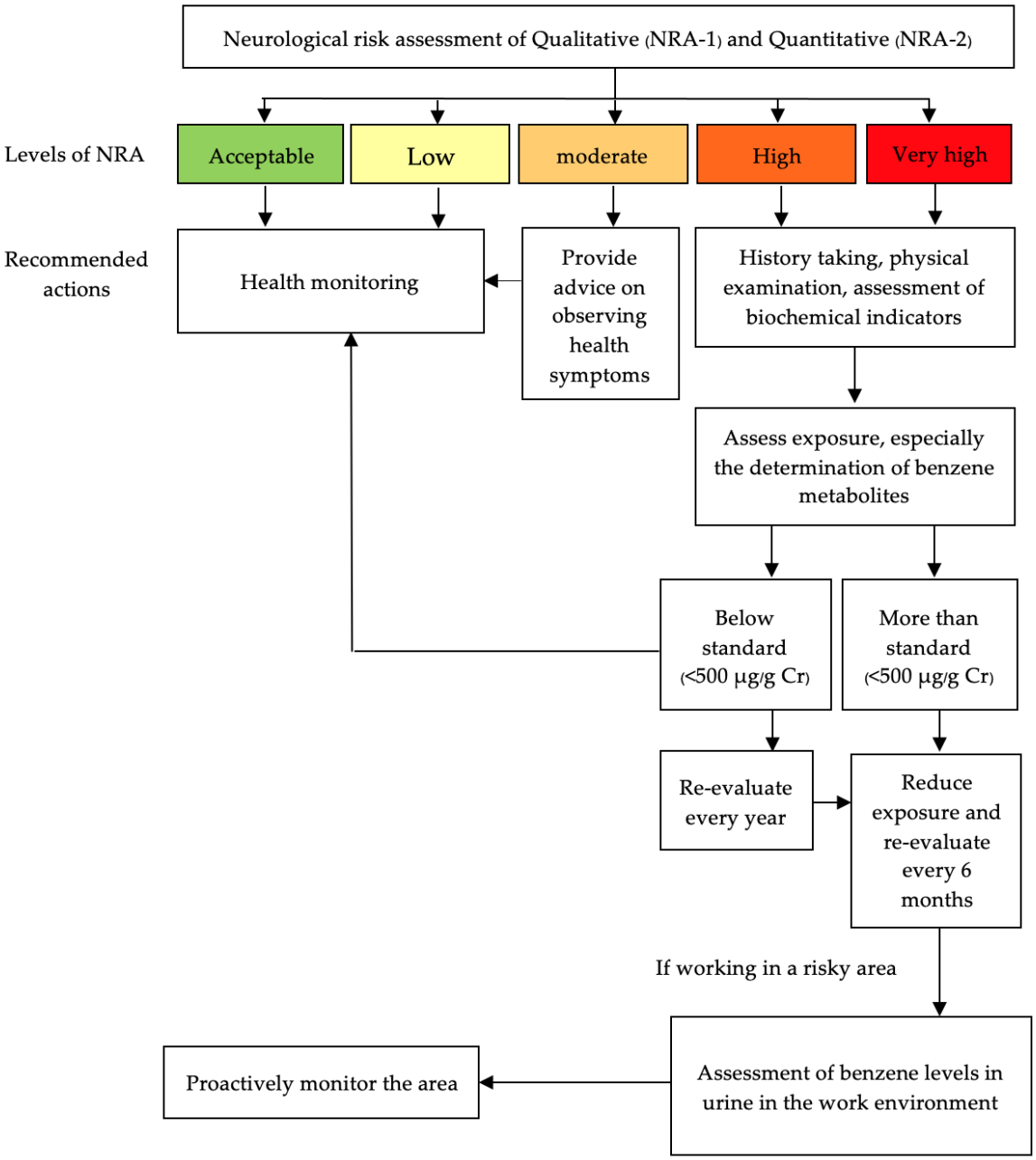

Figure 2: Guidelines for screening for health effects from exposure to benzene

The results on the manual's appropriateness based on the evaluation questionnaire from 15 experts found that all topics were at a good level of appropriateness. For example, they found that the NRA manual was clear and provided appropriate explanations for the user, had a consistent writing style, contained appropriate illustrations and content, was organized and easy to read, and emphasized important points, (see Table 7).

Table 7: Results of NRA of expert satisfaction assessment

Items	Issue	Results (n=15)		
		very appropriate	Enough	improved
1	The NRA manual is innovative.	14 (93.3%)	1 (6.7%)	-
2	The NRA manual can be used.	14 (93.3%)	1 (6.7%)	-
3	The NRA manual can be used as a guideline for health screening in accordance with its objectives.	14 (93.3%)	1 (6.7%)	-
4	The NRA manual is derived from appropriate and consistent academic principles and concepts.	13 (86.7%)	2 (13.3%)	-
5	The acquisition of the NRA manual has a reliable process.	13 (86.7%)	2 (13.3%)	-
6	There is new knowledge in the NRA manual.	11 (73.3%)	4 (26.7%)	-
7	The NRA manual is easy to understand and useful for readers.	12 (80.0%)	2 (13.3%)	1 (6.7%)
8	The NRA manual is useful for the occupational health sector.	14 (93.3%)	1 (6.7%)	-
9	The knowledge in the NRA manual can be exchanged, referenced or disseminated in the profession.	14 (93.3%)	1 (6.7%)	-
10	This NRA manual can be used in real-world health service agencies.	13 (86.7%)	2 (13.3%)	-
11	The NRA manual contains the completeness of important topics.	14 (93.3%)	1 (6.7%)	-
12	The NRA manual is up-to-date in content.	13 (86.7%)	2 (13.3%)	-
13	The NRA manual is clear and provides appropriate explanations for the user group.	15 (100.0%)	-	-
14	The NRA manual has a consistent writing style.	15 (100.0%)	-	-
15	The NRA manual has an appropriate content sequence.	13 (86.7%)	2 (13.3%)	-
16	The NRA manual is reliable.	13 (86.7%)	2 (13.3%)	-
17	The NRA manual is colorful and has an interesting appearance.	10 (66.7%)	5 (33.3%)	-
18	The NRA manual has a font size that is easy to read.	13 (86.7%)	2 (13.3%)	-
19	The NRA manual contains appropriate illustrations and content.	15 (100.0%)	-	-
20	The NRA manual is easily accessible when needed or can be downloaded.	10 (66.7%)	4 (26.6%)	1 (6.7%)
21	The NRA manual is organized, easy to read, or has important points emphasized.	15 (100.0%)	-	-

The researcher synthesized the content analysis of the focus group results to assess the model's potential use in screening risks in the area. The experts expressed their opinions and made suggestions for the NRA manual. The manual's content can be used as a guideline for medical and public health personnel to neurologically screen FSWs in accordance with their objectives. Additionally, it is an innovation that can be applied in the field. However, there was a suggestion that the researcher should create artwork to make the NRA manual more beautiful and enjoyable to read. In terms of benefits, the NRA manual was found to be beneficial to FSWs' health; however, the context of fuel service stations and the Eastern Economic Corridor should be added to make the NRA manual more comprehensive. In addition, the NRA manual should explain how it should be used easily, such as by providing examples of risk assessment

methods, and it should be tested before being used in the field and brought back to develop a more complete manual for practical use

Discussion

This study emphasized the importance of benzene on the nervous system. However, neurotoxic effects may be attributed to multiple chemicals in the fuel, such as BTEX.[5] Previously, attention has been paid to this group of compounds. However, benzene has received attention due to its toxicity to multiple systems and its carcinogenicity as well as its skin absorption due to its lipid solubility.[15]

This was a pilot study of the use of an NRA screening form for assessment of FSWs. The NRA screening form underwent a critique process from experts in various related fields, considering its content and the feasibility of its use. The important issues that experts recommended can be divided into academic content and format, such as taking into account the target group clearly when using the assessment form, sequencing the academic content before entering the neurological risk screening to create understanding before use, giving examples of step-by-step use, designing the NRA manual to be interesting to read, the methods because it studied other kinds of fuel station workers who were also exposed to benzene, such as those in food and beverage sales, convenience stores, etc., including variables used in risk assessment. The risk factors were derived from studies examining factors related to health, including work factors, health behaviors, and biological indicators, which encompassed both NRA-1 and NRA-2 models. Due to the variety of factors, it is necessary to use data that covers more exposure opportunities rather than any single factor.

This NRA screening has two recommended models: qualitative NRA-1 and quantitative NRA-2. When testing the consistency of both NRAs' screening, it was found that both NRAs were statistically significant (kappa test = 0.41, $p < 0.001$). Therefore, both NRA models can be used according to the appropriateness of the context in the fuel station. In addition to assessing exposure copyright of the images, etc. The NRA manual was revised based on the suggestions and critiques. Therefore, this NRA screening form is reliable for use and is a guideline that can be applied in practice.

The NRA form followed the Ministry of Thai Industry's guidelines, which included the following criteria: frequency of exposure and severity of neurological symptoms, the primary effects of benzene. Previous health risk assessments have been conducted on FSWs.[3,6,28] For example, Thongsanthia et al. assessed health risk by considering the risk probability based on measurements of BTEX in the work environment.[3] For health severity, symptoms were categorized into mild, moderate, and severe. The study's results showed that fuel workers had a moderate risk level of 7.5%, which was comparable to that of cashiers in fuel stations. However, even though the assessment criteria were the same (exposure opportunities multiplied by severity), this study had different sample groups and

with biological indicators, workers with high and very high risk are recommended to take proactive measures to prevent personal hazards and measure chemicals in the work environment to find their source so that workers can reduce their exposure. The screening form was evaluated by a committee of experts who gave recommendations. It is reliable, but for future development, a study should be conducted with a larger sample of workers to test the screening form's specificity and sensitivity again, including confirmatory factor analysis.

Conclusion

This study's strengths include the development of a screening form for neurological risks that did not previously exist. The risk assessment was conducted using both qualitative (NRA-1 model) and quantitative (NRA-2 model) methods. Both methods can be easily applied to implement the

evaluation. The low-cost method can be used to perform the qualitative assessment without testing for metabolites in urine.

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Original Article

Chronic respiratory morbidity, musculoskeletal discomfort and other self-reported illnesses among migrant brick kiln workers in rural South India

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ABSTRACT

Introduction: Brick kiln workers face a higher risk of respiratory issues like Chronic Bronchitis and Asthma due to exposure to fine particulate matter. This study aimed to assess the prevalence of these conditions, along with musculoskeletal discomfort and other self-reported morbidities, among workers in a rural health center's field practice area.

Methods: This cross-sectional study included all men and women above 18 years of age (n=650) working in the 12 brick kilns in the study area. Out of 650, 580 workers gave consent for study participation. A standardized and validated questionnaire (ICMR-INSEARCH) along with Peak Expiratory Flow Rate (PEFR) was used to assess the prevalence of respiratory morbidity. Other morbidities were assessed by history taking and clinical examination of the participants.

Results: There were 580 workers, with a mean age of 36.47(SD 11.45) years. Of them, 66% were engaged in molding, 25% in carriage, and 6% in baking work. There were 15.2% smokers and 8.4% tobacco users. Chronic bronchitis was present in 37 (6.4%) and asthma in 12 (2.1%) workers. Higher age (>50 years) was associated with chronic bronchitis ($p<0.05$). Males and those who smoke less than 10 beedis daily had a higher PEFR ($p<0.05$). Musculoskeletal problems, low back ache (37%), neck pain (10.5%), and knee pain (9.5%) were the most common self-reported morbidities, followed by hypertension (9%) and gastritis (6%).

Conclusion: The brick kiln workers had a high prevalence of chronic bronchitis and bronchial asthma. Musculoskeletal problems, especially low backache, were the most common morbidity reported.

Keywords: Brick kiln workers, Chronic Respiratory morbidity, Musculoskeletal discomfort, South India

Introduction

As per the WHO 2021 data, Chronic Obstructive Pulmonary Disease (COPD) kills 425 people every hour to become the fourth leading cause of death.[1] But in India, it is the second principal cause of morbidity, second only to ischemic heart disease,[2] and contributes close to one-third of total Disability Adjusted Life Years(DALYs) due to chronic respiratory diseases in the world.[3] Within India, in the last two decades, the total deaths and DALYs due to chronic respiratory diseases has increased significantly. Air pollution, tobacco use, and occupational risks are the leading risk factors for chronic respiratory diseases DALYs in India.[4]

All three risk factors are simultaneously present in a brick kiln, increasing the risk of respiratory illness in an already poor, malnourished migrant

worker to a greater level. The brick kilns emit tons of particulate matter, Sulphur dioxide, carbon monoxide, carbon dioxide, and oxides of nitrogen, polluting the environment.[5] The habit of smoking and smokeless tobacco use is high among the brick kiln workers.[6] Since COPD is typically diagnosed based on symptoms, and individuals with low awareness often seek medical care late in the disease's progression, the condition is frequently underdiagnosed.[7–9]

The brick kiln workers are at a higher risk for not only respiratory illness but also a lot of physical and physiological stress, leading to musculoskeletal problems owing to their prolonged, frequent, and repeated heavy physical work, manual handling of materials, and awkward back postures.[10]

India is the second-largest producer of bricks globally, employing around 15 million workers.[11] In Tamil Nadu, brick kilns primarily operate with seasonal migrant laborers from economically backward districts. These workers, often paid in advance for the work period, are typically young and physically fit, as the job requires long hours of strenuous labor over a period of four to six months. Once they begin working at the kilns, many return year after year. However, most of these workers are illiterate or have low levels of education, belong to marginalized communities, and have limited health awareness.[12] Upon arriving at the brick kilns—usually located in remote areas far from urban centers—they face high exposure to dust, harsh working conditions, and limited access to healthcare.[13]

Brick kiln workers are known to suffer from a variety of Musculoskeletal discomfort, skin conditions, anemia, digestive problems, etc.[14] Majority of them are involved in molding, and a smaller proportion of them are in the carriage section. Those engaged in molding have to work for long periods in a squatting pose, bending and moving side to side the whole night, and those in carriage have to carry 10-12 bricks every time on their head, which leads to a tremendous amount of pressure on the neck, shoulder, and back muscles. These compounds with their poor health-seeking behavior, low access, and their inability to take leave or permission frequently to rest or seek treatment.[9] Many of them are known to take painkillers by over-the-counter purchase.

Hence, the current study primarily aimed to assess the prevalence of chronic respiratory morbidity and other morbidities among migrant brick kiln workers in the rural health Centre field practice area of a medical college in South India.

Methods

A cross-sectional survey was conducted among migrant workers employed at 12 brick kilns in the field practice of the Rural Health Centre, which is part of the Community Medicine Department of a medical college. Approximately 50 workers were assigned to each kiln, and they remained there for half of the year. A study from Nepal[15] showed the prevalence of chronic bronchitis among brick kiln workers to be 19%. Taking this as prevalence and 20% relative precision and 95% Confidence interval, the minimum sample size required was calculated to be 409.

After permission from the Brick Kiln Association of the district and the owners of the brick kilns, the workers in each brick kiln were assembled at one place. Although it was resting time for most of the workers, especially those involved in molding, a door-to-door visit was done to contact each one of them in each of the kilns. All the employees of the brick kilns were migrants from villages in the backward districts of Tamilnadu. They stayed within dwellings in the kilns, which were kachcha houses with poor lighting and ventilation. There were a total of 650 workers across all twelve kilns combined. But after repeated persuasion and explaining the benefits of the study, 580 workers agreed to participate in the study (response rate of 89%). Brick kiln workers (both males and females) who were more than 18 years of age were included in the study.

A pretested questionnaire was used for data collection. It had questions on background characteristics, personal habits, duration of stay and work in the kilns, their respiratory and other symptoms at the time of interview. Additionally, to determine the prevalence of chronic respiratory illnesses, a standardized and validated questionnaire developed for the Indian study on Epidemiology of Asthma, Respiratory Symptoms, and Chronic Bronchitis (INSEARCH), sponsored by the Indian Council of Medical Research (ICMR), was utilized.[16] Height and weight were measured.

The peak expiratory flow rate (PEFR) of study participants was measured using Wright's peak flow meter, a standardized, reliable apparatus used to assess pulmonary function in a non-invasive, objective manner. The normal PEFR value should be between 400 and 600 L/min. The study participants were informed about the measurement procedure, and after obtaining their consent and a review of their pulmonary history, they were asked to take a deep, calm breath, and

their nostrils were closed using a simple clip. Then, the PEFR apparatus, using a detachable disposable mouthpiece, was sealed completely into the participants' mouths, and they were asked to perform a single forceful blow. Depending upon the velocity of the air blown by the participant, the pointer present on the graduated scale of the PEFR apparatus moves manually. The value was noted, and the procedure was repeated three times. The best among the three values was taken as the participant's PEFR.

Ethics committee approval was obtained from the Institutional Ethics Committee II (excluding the clinical evaluation of drugs, procedures, devices, diagnostics, vaccines, and herbal remedies) of the Sri Ramachandra Institute of Higher Education and Research (SRIHER) University. (Decision No: IEC-NI/16/AUG/55/66 and date: 18/01/2017). All participants were informed about the study before data collection, and written informed consent was obtained.

Descriptive statistics – proportions with 95% Confidence interval, mean with standard deviation were calculated for various parameters. For the association between two categorical variables, the Odds Ratio was calculated. Chi-square was used as a test of proportions, and the Student's t-test was used as a test of means. Statistical software used was SPSS Inc.16.0 and $p<0.05$ was taken for statistical significance.

Results

Among the 580 workers who participated in this study, there was an almost equal number of males and females (284 vs. 296). The mean age of the participants was 36.47 years, with a standard deviation of 11.45. About 299 (52%) of the workers were illiterate, and another 99 (17%) had studied up to the 5th standard. Two-thirds of them, 381(66%) were involved in molding. (Table1) Around 125 (21%) were smokers. Among males, 119 (42%) were smokers and tobacco consumers, whereas 4 (1.4%) of females smoked, and up to 36 (12.2%) consumed tobacco. This was mainly used at night to be awake during the molding of bricks, which they did from 9 pm till 5 am, usually. Most men, 114 (96%), used beedis for smoking. The prevalence of the different respiratory symptoms, as well as the chronic respiratory morbidities – Bronchial asthma and Chronic Bronchitis, as per the operational definition. Bronchial asthma was present among 12 people (2.1% with 95% CI 1.1-3.6) and Chronic bronchitis among 37 (6.4% with 95% CI 4.5-8.7) (Figure 1).

The prevalence of chronic respiratory illnesses against the background characteristics and the Odds Ratio for cross tabulation among the different categories and the p-values (Table 1).

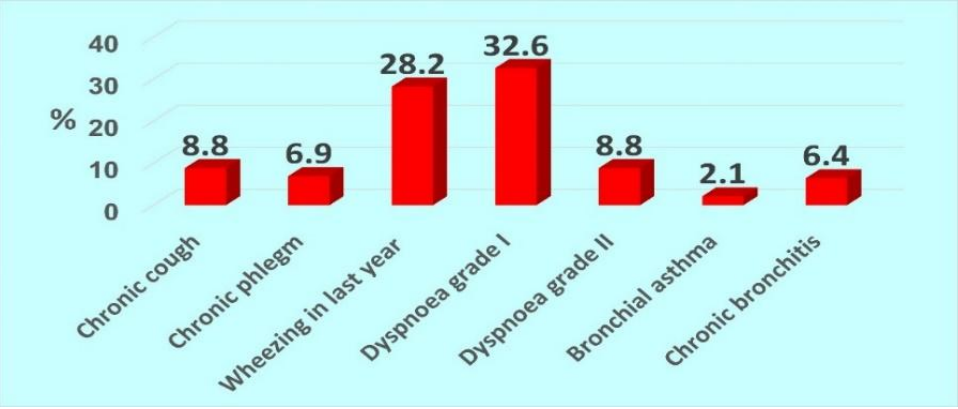

Figure 1: Prevalence of Respiratory Symptoms among brick kiln workers (n=580)

As shown in the table above, the prevalence of chronic bronchitis is higher among individuals over 50 years of age compared to the younger population, a statistically significant difference. Although smokers have a higher prevalence of chronic bronchitis than non-smokers, the difference is not statistically significant. However, among smokers, a longer duration of smoking, more than 15 years, has shown a higher proportion of people to be affected by chronic bronchitis compared to those with shorter durations ($p<0.05$). Apart from this, the difference in proportion of the two morbidities is not significant among the other categories.

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Table 1: Prevalence and association of Chronic Respiratory Morbidities among brick kiln workers with the background parameters (n=580)

Background Characteristics		Number (%)	Bronchial Asthma (n=12) N (%)	OR	P value	Chronic Bronchitis (n=37) N (%)	OR	P value
Age	Up to 50 years	514 (90.5)	10 (1.9)	1	0.505	29 (5.6)	1	0.028*
	>50 years	66 (9.5)	2 (3.2)	1.68		8 (12.9)	2.478	
Sex	Female	296 (51)	7 (2.4)	1	0.605	17 (5.8)	1	0.529
	Male	284 (49)	5 (1.8)	0.737		20 (7)	1.239	
Nature of work	Molding	380 (65.7)	7 (1.8)		0.071	28 (7.3)		0.473
	Carriage	144 (24.8)	3 (2.1)			7(4.9)		
	Baking	35 (6.0)	0 (0)			2 (5.7)		
	Others	20 (3.4)	2 (10)			0(0)		
Smoking	Non-smokers	455 (78.4)	10 (2.2)	1	0.675	25 (5.5)	1	0.098
	Smokers	125 (21.6)	2 (1.6)	0.722		12 (9.6)	1.822	
Smoking Duration (n=124)	≤ 15 years	52 (41.9)	1(1.4)	1	0.816	3(4.2)	1	0.015*
	>15 years	72 (58.1)	1 (1.9)	1.392		9 (17.3)	4.814	
Smoking Times/ day (n=119)	< 10	54 (41.9)	0(0)	1	0.316	4(9.8)	1.014	0.983
	≥ 10	65 (58.1)	2 (2.4)	1.025		8(9.6)	1	
BMI	Underweight	94 (16.2)	3(3.2)		0.421	9(9.6)		0.503
	Normal	371 (64.1)	5 (1.3)			20 (5.4)		
	Overweight	85 (14.7)	3 (3.5)			5 (5.9)		
	Obese	26 (4.5)	1 (3.8)			2 (7.7)		
Duration of work	<10 Years	294 (50.6)	6 (2.1)	1	0.793	19 (6.7)	1	0.626
	>10 Years	286 (49.4)	5 (1.8)	0.852		16 (5.8)	0.855	

The mean (SD) Peak Expiratory Flow Rate (PEFR) in L/min of the brick kiln workers with different characteristics is shown. The PEFR follows a normal distribution. It is seen that females had lower PEFR than males. ($p<0.05$) Smokers had higher PEFR values compared to non-smokers because non-smokers, who were predominantly females, had lower PEFR values, thereby pulling the mean value lower. Upon comparing the mean PEFR among males, smokers had a lower mean (325.86 with SD 83.54) compared to non-smokers (345.63 with SD 98.4); however, this difference was not statistically significant (not shown in the table). Smokers who smoked ten or more beedis per day had a significantly lower PEFR. Though there was no statistical significance, participants with bronchial asthma and COPD were found to have lower PEFR. (Table 2).

Musculoskeletal problems were the most common among the brick kiln workers, especially low back ache, which was the most prevalent (37%). All the anemics were women. Gastritis was reported equally among males and females. Body aches were common among women (Table 3).

MSDs, including LBA, knee pain, and neck pain, were higher among participants aged 35 years or older compared to younger individuals (52% vs

40%, p = 0.003). Low back ache was reported more frequently by males than females (41.5% vs 33%, p = 0.031). Musculoskeletal discomfort, especially LBA, was more common among workers in molding, followed by carriage and then baking (42.5 vs 29 vs 29% - p 0.005). The prevalence of MSDs almost doubled when the duration of work exceeded 8 hours (26 vs 51% - p 0.000). People who worked in brick kilns for 6 years or more reported MSDs less frequently compared to those who worked for 5 years or less (45 vs 77% - p 0.009*) (Table 4).

Table 2: Distribution of PEFR values among the brick kiln workers:

PEFR		Frequency	Mean (SD) L/min	P value
Population		580	296.2(91.26)	
Sex	Male	284	337.26 (92.78)	<0.001*
	Female	296	256.16 (69.47)	
Smoking	Yes	125	325.70(86.67)	<0.001*
	No	455	287.97 (90.90)	
Smoking duration (years)	< 15	52	323.55(84.09)	0.743
	≥ 15	72	328.79 (90.52)	
Smoking Times/day	<10	54	344.12 (100.48)	0.024*
	≥10	65	307.66 (70.44)	
Bronchial Asthma	Present	12	257.50 (58.8)	0.138
	Absent	568	297.05 (91.7)	
Chronic Bronchitis	Present	37	276.18 (109.49)	0.187
	Absent	543	297.5 (89.91)	

Table 3: Morbidity profile of the brick kiln workers (n=580)

Morbidity	No. (%)
Musculoskeletal problems	
Low back ache	215 (37.1)
Neck sprain	61 (10.5)
Knee Pain	55 (9.5)
Body ache	32 (5.5)
Headache	28 (4.8)
Shoulder ache	26 (4.5)
Other self-reported morbidities	
Gastritis/GERD	35 (6)
DM	5 (0.9)
White discharge	2 (0.3)
Urinary problems	2 (0.3)
Chest pain	2 (0.3)
Epilepsy	2 (0.3)
Clinical Examination:	
BP Systolic≥140 or Diastolic≥90 or known H/o Hypertension	53 (9.1)
Anemia	17 (2.9)
Pregnant	2 (0.3)

Table 4: Cross-tabulation of Musculo-skeletal Discomfort and Low Back Ache with background characteristics – Chi square test (n=580)

Background Characteristics		No.	MSD No.	%	p value	LBA No.	%	p value
Age	upto 35 yrs	300	119	40	0.003*	95	31.7	0.005*
	36 and above	280	145	52		120	43	
Sex	Male	284	131	46.1	0.801	118	41.5	0.031*
	Female	296	133	45.1		97	32.9	
Nature of work in brick kiln	Molding	381	190	49.9	0.005*	162	42.5	0.001*
	Carriage	143	58	43.6		41	28.7	
	Baking	35	13	37.1		10	28.6	
	Others	20	3	15		2	10.0	
Duration of work in brick kiln	>5 years	563	251	44.7	0.009*	202	35.9	0.001*
	< 5 years	17	13	76.5		13	76.5	
Work Hours daily	Up to 8 hours	119	31	26.1	0.000*	21	17.6	0.000*
	> 8 hours	455	232	51		194	42.6	

Discussion

Occupations in certain sectors are associated with specific health hazards, commonly referred to as occupational health hazards. Brick kiln workers are exposed to various particulate matter, environmental stressors, and gases, which compromise their health status. Thus, the current study aimed to assess chronic respiratory morbidity, musculoskeletal discomfort, and other morbidities among brick kiln workers (n = 580).

The current study reveals that nearly all the study participants (brick kiln workers) were from rural backgrounds, and the majority of them (52%) were illiterate, indicating that a lack of education may lead individuals to choose occupations in poor work environments with prolonged working hours.[17] As brick kiln work demands extreme manual work, a higher proportion of them were found in their young or middle adulthood phase of life.

A higher percentage of males were found to be involved in smoking, and due to poor socioeconomic status, they seem to have chosen beedi over cigarettes, considering the cost factor. Even a minimal percentage of females were found to chew tobacco, and the participants justified this by demanding that night shifts require them to be awake and alert.

Workers above 50 years of age had 2.478 times higher chances of developing chronic bronchitis than those less than 50 years and it was also found to be statistically significant. Also, those who had been smoking for more than 15 years were found to have almost five times higher chances of developing chronic bronchitis than their counterparts.[18,19]

Peak Expiratory Flow Rate (PEFR) is the maximum volume of air expelled forcefully in one single expiration and is a reliable objective marker for Pulmonary ventilation. A marked reduction in PEFR indicates airway obstruction, a key indicator of Obstructive Lung disease. In the current study, females were found to have lower PEFR than males and those who smoked more than 10 times per day were found to have higher PEFR.[20]

Brickkiln exposes individuals to workplace particulate matter, smokes, and gases that arise from combustible materials used during the brick-making process. These make an individual more prone to COPD, compromising lung function and hygiene.[21] The prevalence of chronic cough and phlegm in this study was 9% and 7% respectively and that of chronic bronchitis was 6.4%. A similar study conducted among 692 brickkiln workers in Jammu showed that chronic cough was the most frequent symptom present in 23.5% of the workers, followed by phlegm in 23% and chronic bronchitis was present in 21% which are much higher compared to the present study. The prevalence of chronic bronchitis was significantly associated with the sex of the participants in that study, but in this study, the difference was not significant.[21]

PEFR was found to be higher in males due to physiological factors, such as increased lung volumes and greater respiratory muscle endurance. Also, those who smoked more than 10 times per day were found to have lower PEFR in this study. This finding was similar to the finding in a survey among brick kiln workers in Wardha district.[22]

Brick kiln involves manual labor, and a very high percentage of participants have reported low backache, followed by neckache, and knee pain. A brick kiln is a process where coarse soil is subjected to various methods and transformed into solid bricks. This involves handling, molding, and transferring the materials to different places. Additionally, brick kiln workers experience prolonged work hours, leading to excessive exertion and depletion of skeletal muscle tissues and nutrients. A study from West Bengal reveals that the prevalence of low backache and neck pain among brick kiln workers is nearly 90%.[23,24] Also, the findings that males had a higher prevalence of low back ache and those with less than 5 years' work experience had a lower reporting of MSDs were similar to the study done in Rajasthan.[24,25]

Brick kiln particulates, smoking, tobacco chewing, loss of sleep, stress, and advancing age trigger inflammation within the host, leading to hypertension as seen in 1/10th of the study participants. However, brick kiln workers are reported to have a lower prevalence of hypertension compared to the general population, which is consistent with our study findings.[26,27]

The strength of this study lies in its cross-sectional design, which encompasses all workers from 12 brickkilns, comprising nearly 600 subjects and thereby representing the morbidity profile and respiratory health of brickkiln workers in South India. The usage of a standardized questionnaire to estimate the prevalence of chronic respiratory conditions and measuring PEFR adds strength to the study.

Limitations

The limitation of this study is that we could not use a standardized scale for measuring MSDs, as the time available for each worker to spare during any day was limited.

Conclusion

The brick kiln workers in South India have a high prevalence of chronic respiratory morbidities, especially chronic bronchitis. Also, the prevalence of musculoskeletal discomfort, especially low back ache and neck pain, anemia, and GERD is high among these workers, which affects their quality of life. Hence, adequate use of PPE, regulations for work hours, and periodic health checkups could help improve the health of brick kiln workers.

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Original Article

Effectiveness of specific muscle group stretching in reducing regional musculoskeletal disorders among textile workers

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ABSTRACT

Introduction: Regional musculoskeletal disorders (MSDs) are prevalent in the textile industry, primarily due to repetitive or static work postures. This study aimed to assess whether specific muscle group stretching exercises could reduce MSDs complaints among workers in the textile industry.

Methods: A quasi-experimental design with a pretest–posttest approach without a control group, which limits causal inference, was employed. Thirty textile workers participated in a structured stretching program twice daily for 8 weeks. Complaints of MSDs were assessed using the Nordic Body Map (NBM) questionnaire at baseline, Week 4, and Week 8. The data were analyzed using Repeated Measure ANCOVA to control for age, gender, length of employment, and BMI, with effect sizes calculated using Cohen's d.

Results: Significant reductions in MSDs complaints were observed across seven body regions ($p<0.05$). The largest improvement was in the upper neck region (mean score reduction = 0.83; Cohen's d = 1.116), indicating a very large effect size. Covariates (age, gender, length of employment, and BMI) did not significantly influence outcomes ($p > 0.05$).

Conclusion: While targeted stretching of specific muscle groups appeared to reduce regional MSDs among textile workers, the absence of a control group limits the ability to draw definitive causal conclusions. Future studies should employ randomized controlled trials with larger sample sizes to confirm these preliminary findings.

Keywords: Musculoskeletal Pain, Nordic Body Map, Quasi-Experimental Study, Textile Workers, Workplace Stretching

Introduction

The issue of musculoskeletal disorders (MSDs) has persistently been an occupational health issue in various industries around the world, with a specific participation of labor-intensive industries like the textile industry.[1] The causes of these disorders include repetitive motion, awkward postures, and extended static work, resulting in physical discomfort and significant productivity loss. Most of the tasks in the textile industry require prolonged sitting postures, repetitive upper limb actions, and pain in the neck, shoulders, lower back, and lower limbs.[2,3]

The Textile industry is the largest labor-intensive industry in Indonesia, employing millions of workers. Still, the country does not have much information about the prevalence of MSDs in this sector. There are a few interventions that have been noted to avert the risk of MSDs, which include ergonomic workstation design, postural modification, and stretch-exercise programs in the workplace.[4,5] It has been observed that such programs positively affect the posture, improve flexibility, and lower pain complaints of industrial workers.[6] Research in the Indonesian industrial setting, like the case of the aluminum plant, indicated that an intervention in worksite stretching had reduced MSDs pain scores in 19 compared to 13, indicating the possible sustainability of the method in the textile industry.[7]

However, there has been little to no research on the effects of ergonomic interventions, especially stretching exercises, on the clustering of the textile industry in Indonesia. It is in this gap that context-specific programs will address the ergonomic needs of those workers. Consequently, the study aims to determine the effectiveness of selected muscle group stretching exercises in reducing regional MSD complaints among a sample of textile workers based on an evidence-based ergonomic intervention.

It has also been established globally that workplace stretching regimens actually contribute significantly toward the reduction of MSDs complaints and improvement in musculoskeletal function over time.[8] Nonetheless, even though Indonesia has a high number of textile workers and ergonomic hazards like repetitive and static work are well-documented, there have not been systematic reviews of these types of interventions in the industry. This study fills that gap through a combination of an ergonomically tailored stretching program that specifically focuses on the various parts of the body that are most often affected in the case of a textile worker, including the knees, thighs, calves, lower back, upper back, and overall body discomfort. A quasi-experimental design was used to measure MSD complaints three times (week 0, week 4, and week 8) to determine the effectiveness of the program in a real-world occupational context.

Most previous studies of ergonomic interventions were conducted in office working conditions or industries other than textiles. Workplace stretching exercise interventions within the textile industry in Indonesia remain relatively understudied, with no studies being conducted to quantify the specific impacts on textile workers in Surakarta. Textile factory workers have definite job characteristics like repetitive movements and static working posture, particularly in the weaving unit, which raises the risk for MSDs. This study aims to address the gap in the literature on the effectiveness of workplace stretching exercises in reducing complaints of MSDs among textile plant workers with standing workstations.

This study aims to examine the effectiveness of the Specific Muscle Group Stretching Exercise program, one component of the Workplace Stretching Exercise intervention, in reducing complaints of MSDs in workers' neck, back, waist, thighs, knees, and calves at PT. Iskandar Indah Printing Textile, Surakarta, Indonesia. It was chosen as the trial site because it is one of the largest textile manufacturers in the area, where most workers are employed in repetitive static jobs, awkward working postures, and prolonged standing, which predisposes them to MSD development. Primary ergonomic evaluations, as well as company health records, suggested that complaints of MSDs were especially high in the neck, back, and lower extremities. The results of this study are expected to provide guidelines for an effective and focused specific muscle group stretching program in an effort to minimize the risk of musculoskeletal disorders in the textile industry.

Methods

This study employed a quasi-experimental pretest-posttest design without a control group. The absence of a control group was due to company policy and ethical considerations, which required that all eligible workers receive the

intervention to prevent potential health disadvantages. The study aimed to evaluate the effectiveness of specific muscle group stretching exercise in reducing localized musculoskeletal symptoms among textile workers over an eight-week period. The study was conducted at PT Iskandar Indah Printing Textile, Surakarta, Indonesia, a workplace with high ergonomic risk, over an eight-week period encompassing preparation, intervention, and post-intervention data collection.

The duration of intervention was eight weeks and was realized through specific muscle group stretching exercises applied twice a day (after two hours of morning work and in the afternoon). The movements were repeated thrice during each session, and the selected muscle groups were those that were vulnerable to musculoskeletal disorders related to performing repetitive and static work, such as the neck, shoulders, upper back, lower back, and lower limbs. Before the intervention, participants were subjected to the organized simulation and training to adhere to proper and safe performance. A standardized, written protocol was used by trained instructors to guide all the sessions throughout in an attempt to ensure the consistency of the program.

The required sample size for this single-group intervention study was determined using the following formula:

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2 x\, \sigma^2}{d^2}$$

where: α = 0.05, resulting in $Z_{1-\alpha/2}$ = 1.96; β = 0.20, resulting in $Z_{1-\beta}$ = 0.84; σ = 5 (Standard Deviation); d = 2.56 (Effect Size). Based on this calculation, the minimum required number of participants was 30.

The Specific Muscle Group Stretching Exercise is based on static stretching protocols and targets key tension-prone areas commonly affected by prolonged standing postures in textile workers. As illustrated in Figure 1, the program includes structured movements for the neck, shoulders, back, waist, and legs, which are the most commonly reported regions for musculoskeletal discomfort in this population. The movements are meant not only to increase flexibility but also to reduce the stiffness of the muscles, boost circulation, and prevent strain at a specified point in repetitive activities. Figure 1 can anchor the actual application of the intervention in the workplace and support its consistent implementation in the routine workplace-based stretching.

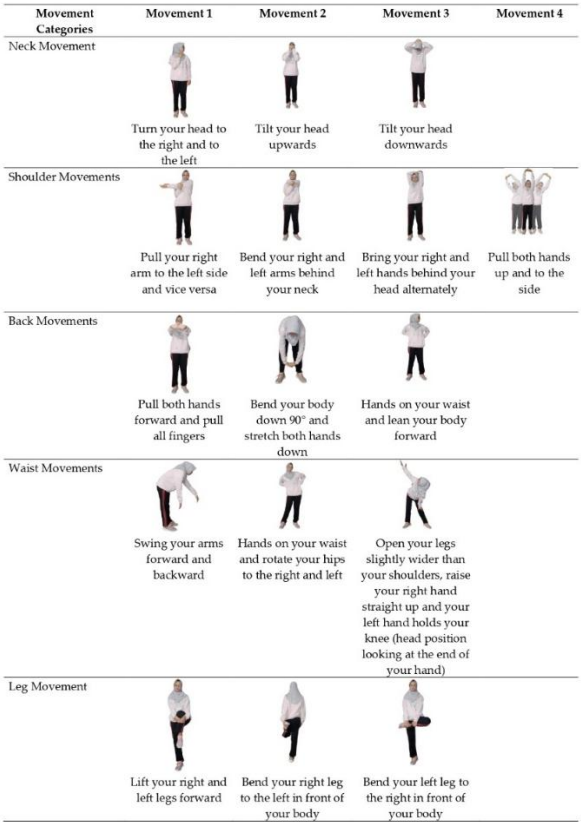

Figure 1: Categories and sequences of workplace-specific stretching exercises used in the intervention

Participants were recruited in line with the CONSORT guidelines. As shown in in Figure 1, a total of 104 textile workers were screened for eligibility based on predefined inclusion criteria (employed in production for ≥1 year, free from acute injury, and willing to participate) and exclusion criteria (undergoing treatment for severe MSDs, recent surgery, or pregnancy) (Figure 1). Of these, 46 participants were excluded for various reasons (e.g., not meeting the inclusion criteria, declining to participate), and 58 participants were allocated to the intervention. Just 38 people underwent the intervention, with dropout also occurring because of loss of follow-up (n=3) and termination (n=5). In total, 30

participants took part in the entire intervention and were part of the final analysis. Figure 1 is the participant flow diagram, which shows important dropout points and the reason for including the final analyzed sample. Reproducibility of the study is facilitated by the figure, which also ensures transparency in the management of the participants.

The study was approved by the Health Research Ethics Committee of RSUD Dr. Moewardi Surakarta (Number: 932/IV/HREC/2024). All participants provided written informed consent to participate in the study. Ethical standards in accordance with research guidelines were followed during the study.

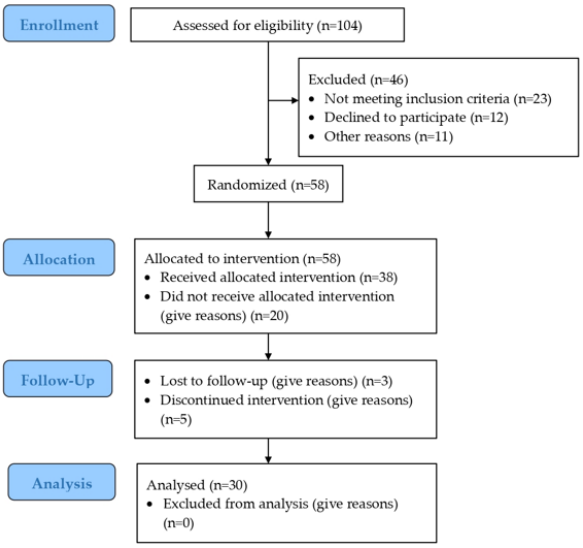

Figure 2: CONSORT Flow Diagram

The primary variable measurement in this study, regional musculoskeletal complaints, was conducted using the Nordic Body Map (NBM) questionnaire. The NBM questionnaire is a questionnaire that asks respondents to mark areas of pain or discomfort in the body, which has been found to be effective for identifying pain locations in workers, including the neck, shoulders, and upper back, and reflecting various levels of MSDs risk.[9] The NBM questionnaire demonstrated effectiveness because it receives extensive application throughout different industrial sectors to determine ergonomic risks.[10] The Nordic Body Map successfully assesses MSDs among blue-collar workers because its reliability and validity are confirmed through multiple assessments that show consistent results with high Cronbach's alpha scores.[11] The questionnaire presents a human body diagram as a visualization tool to direct respondents towards identifying particular pain areas. The Nordic Body Map guards 28 distinct pain points in the human body that span from the neck to shoulders and upper back and lower back and elbows to wrists/hands to hips to knees and ankles.[12]

The questionnaire contained a 4-point Likert scale ranging from 1 = no pain through 2 = slightly painful and 3 = painful to 4 = very painful, which respondents used to rate their discomfort in each noted area. The survey was distributed three times before intervention implementation and at 4 weeks and 8 weeks after intervention completion. The research collected demographic data along with risk factor data by age, gender, length of employment, and body mass index (BMI) measurements for control purposes. The researchers recorded both specific muscle group stretching exercise frequency and duration along with participant compliance data for subsequent analysis.

Musculoskeletal symptoms were compared using Repeated Measures ANCOVA before and after intervention, adjusting for age, length of employment, and BMI. Before analysis, statistical assumptions were checked: normality of residuals (Shapiro–Wilk test), sphericity (Mauchly's test), and homogeneity of variance and covariance (Levene's test and Box's M test). Effect sizes were calculated using Cohen's d. All statistical computations were performed using SPSS software, with a significance level set at $\alpha = 0.05$.

Results

The research included 30 textile workers as subjects. Their average age was 48.2 ± 8.1 years, with a range of 39 to 62 years, and their average length of employment was 22.6 ± 5.9 years, with a range from 12 to 32 years. The average body mass index (BMI) was 22.6 ± 5.9 kg/m², with a range of

18.1 to 32.8 kg/m². In terms of gender distribution, the participants consisted of 43.3% males (n = 13) and 56.7% females (n = 17). The demographic breakdown of the participants is presented in Table 1.

Table 1: Demographic Profile of Study Participants (N=30)

Variable	N	Range (Min - Max)	Mean ± SD	Frequency	%
Age (years)	30	39 - 62	48.2 ± 8.1	-	-
Length of employment (years)	30	12 - 32	22.6 ± 5.9	-	-
BMI (kg/m²)	30	18.1 - 32.8	24.6 ± 4.4	-	-
Gender					
Male	-	-	-	13	43.3
Female	-	-	-	17	56.7
Total	30	-	-	30	100.0

In the normality test of standardized residuals using the Shapiro-Wilk method, the results were Pre (p = 0.291), Post1 (p = 0.072), and Post2 (p = 0.061). Since the p-values are greater than 0.05, the data distribution is categorized as normal. A test of sphericity performed by Mauchly was smaller than the 0.05; it means that the assumption of sphericity was not met, while the Greenhouse-Geisser correction, 0.659, was still within the recommended range. The Test of Equality of Covariance Matrices by Box (p = 0.667) and the Test of Pre (p = 0.912), Post1 (p = 0.598), and Post2 (p = 0.438) all indicated p = 0.667, 0.912, 0.612, and 0.438, respectively, as larger than 0.05; this indicates that the assumptions of identical covariances and variance were valid. Thus, assumptions on further analyses were fulfilled.

Specific muscle group stretching exercise intervention was measured for efficacy by comparing musculoskeletal complaint scores before the intervention (Pre), at 4 weeks (Post1), and at 8 weeks (Post2). The results demonstrated statistically significant reduction in complaints across all body regions measured. Estimated effect sizes based on Cohen's d ranged from moderate to large; the greatest improvement occurred in the upper neck (d = 0.991), while the smallest was in the left calf (d = 0.702). For example, the upper neck complaint score decreased from 3.00 ± 0.79 at pre-intervention to 2.23 ± 0.57 at week 8 (average difference = 0.77, 95% CI: 0.48 to 1.06, p = 0.001, d = 0.991), indicating a large effect size. Similar trends were observed across other body regions, with effect sizes ranging from medium to large. The results are presented in Table 2.

Table 2: Mean Differences in Musculoskeletal Complaints and Effect Size (Cohen's d)

Body Part	Pre (Mean ± SD)	Post1 (Mean ± SD)	Post2 (Mean ± SD)	Mean Difference (Pre–Post2, 95% CI)	*p-value (Pre vs. Post2)	Cohen's d (Effect Size Pre vs. Post2)	**Effect Size Interpretation
Upper Neck	3.00 ± 0.79	2.40 ± 0.56	2.23 ± 0.57	0.77 (0.48 to 1.06)	0.001	0.991	Large
Lower Neck	2.77 ± 0.73	2.23 ± 0.57	2.20 ± 0.55	0.57 (0.33 to 0.80)	0.001	0.905	Large
Left Shoulder	3.07 ± 0.83	2.73 ± 0.52	2.47 ± 0.51	0.60 (0.31 to 0.89)	0.001	0.779	Medium
Right Shoulder	2.90 ± 0.80	2.67 ± 0.55	2.47 ± 0.51	0.43 (0.18 to 0.69)	0.002	0.683	Medium
Upper Back	2.23 ± 0.63	1.83 ± 0.38	1.73 ± 0.64	0.50 (0.25 to 0.75)	0.001	0.733	Medium
Lower Back	3.50 ± 0.51	3.33 ± 0.48	3.00 ± 0.58	0.50 (0.27 to 0.74)	0.001	0.794	Medium
Left Thigh	3.37 ± 0.49	3.23 ± 0.43	2.93 ± 0.36	0.43 (0.18 to 0.69)	0.002	0.638	Medium
Right Thigh	3.57 ± 0.50	3.30 ± 0.47	3.10 ± 0.48	0.45 (0.23 to 0.70)	0.002	0.735	Medium
Left Knee	3.70 ± 0.47	3.30 ± 0.54	3.30 ± 0.53	0.40 (0.19 to 0.61)	0.001	0.710	Medium
Right Knee	3.50 ± 0.51	3.37 ± 0.49	3.20 ± 0.48	0.30 (0.10 to 0.50)	0.005	0.535	Medium
Left Calf	3.50 ± 0.51	3.33 ± 0.48	3.23 ± 0.50	0.27 (0.07 to 0.46)	0.009	0.512	Medium
Right Calf	3.63 ± 0.49	3.40 ± 0.49	3.13 ± 0.57	0.50 (0.25 to 0.76)	0.001	0.733	Medium

Notes:*p < 0.05 was considered statistically significant. **Cohen's d interpretation: 0.20 – 0.49 = Small; 0.50 – 0.79 = Medium; ≥ 0.80 = Large.

Figure 3 shows the trend of estimated marginal means of MSDs complaints in the two areas of the body where they occurred (upper neck and left calf) at three points: at pre-intervention, during the mid-intervention period (Week 4), and during the post-intervention period (Week 8). The upper neck region (Figure 3a) had the highest effect size value of Cohen's d = 0.991 (large). The mean complaint scores also reduced significantly, as the scores obtained at post-intervention (2.23 ± 0.57) were lower than the ones obtained at the pre-intervention (3.00 ± 0.79). This difference can be explained by the fact that the level of complaints in the upper neck was higher among the participants, which led to increased sensitivity of the region in the upper neck to specific stretching. Instead, in the left calf region (Figure 3b), the effect size was lower (Cohen's d = 0.512, medium). The decrease in the number of complaints was not as significant (Pre = 3.50 ± 0.51; Post2 = 3.23 ± 0.50), which may be attributed to lower strain in the pre-existing condition or biomechanical inactivity of the calf associated with the textile-related tasks. These pattern-based statistics confirm that an intervention effect can be different, depending on the anatomical area, the severity at the pre-intervention, and the functional demands of a particular group of muscles.

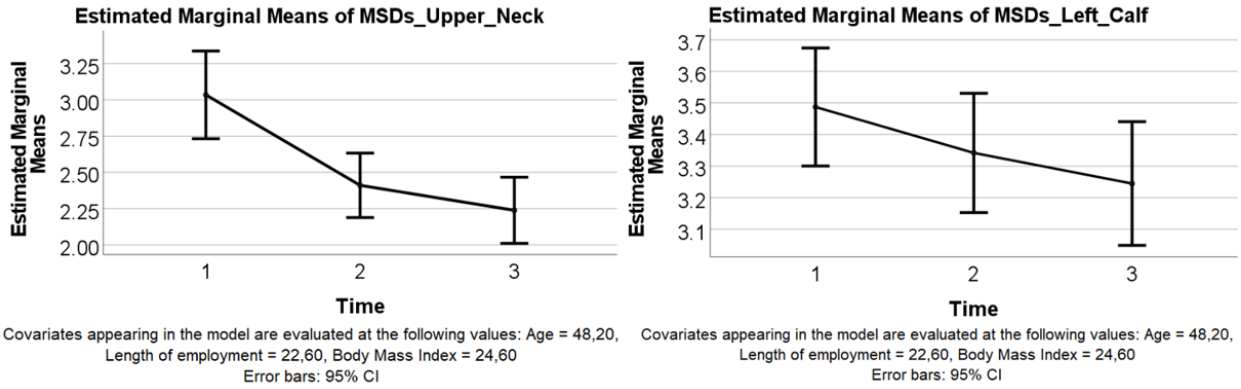

Figure 3: Profile Plots of MSDs Complaints in Upper Neck and Left Calf Across Time

(a) MSDs Upper Neck (b) MSDs Left Calf

The effects of covariates like age, gender, length of employment, and BMI on the reduction of musculoskeletal symptoms were analyzed using Repeated Measures ANCOVA. The analysis showed that none of these covariates had a significant effect on the reduction in symptoms ($p > 0.05$), meaning that the observed improvements were largely attributable to the Specific Muscle Group Stretching Exercise intervention. The full results of this analysis are shown in in Table 3.

Table 3: Covariate Impact on Musculoskeletal Symptoms (Repeated Measures ANCOVA)

Body Region	Gender	Age	Length of employment	BMI
Upper Neck	0.803	0.908	0.603	0.843
Lower Neck	0.147	0.607	0.500	0.956
Left Shoulder	0.303	0.547	0.884	0.487
Right Shoulder	0.200	0.632	0.940	0.119
Upper Back	0.885	0.744	0.842	0.185
Lower Back	0.332	0.767	0.785	0.818
Left Thigh	0.106	0.900	0.532	0.385
Right Thigh	0.420	0.789	0.542	0.675
Left Knee	0.579	0.906	0.963	0.512
Right Knee	0.677	0.574	0.959	0.524
Left Calf	0.688	0.884	0.368	0.457
Right Calf	0.923	0.853	0.735	0.457

Discussion

The aim of this study was to determine the effectiveness of specific muscle group stretching exercises in reducing regional musculoskeletal symptoms among textile workers. Our findings are consistent with those from diverse occupational settings internationally. For example, stretching interventions conducted among electronics factory workers in South Korea [13] and meat processing workers in Denmark [14] similarly reported significant reductions in MSDs symptoms, particularly in the neck and shoulder areas. These studies, like ours, implemented on-site, scheduled stretching routines guided by ergonomic principles. Consistent with reports from manufacturing workers in Nigeria [15] and garment workers in India [16], we also found that complaints decreased after the intervention across most body regions in question. Nevertheless, the degree of decrease in our sample was higher, especially in the upper neck, lower back, and right calf, especially in the upper neck and lower back, than that among healthcare workers in Thailand [17] and office workers in Germany [18], which was probably because of the selection of muscles in the stretching program, as well as the inclusion of muscle stretching practices in work shifts throughout the working day. The presented positive changes are consistent with biomechanical concepts interpreted as the increase in muscle-tendon unit flexibility, excessive passive tension decrease, and proprioceptive awareness enhancement, which alleviate the discomfort in areas exposed to a stationary load [19]. Unlike the creeping gains seen in sedentary worker groups, our cohort could not only gain benefit rapidly but could, therefore, realize the benefit to a greater degree to an extent that generated noticeable symptom reduction post-intervention.

The average age of the participants (49.9 + 6.9 years) shows that the targeted population has an increased baseline risk of MSDs because of lower tissue elasticity [20,21]. Age was a non-significant covariate in our analysis, as it is in nurses in Brazil,[22] which shows the potential of the intervention working equally well across the middle to late working age. The same cross-sector consistency supports the view that the targeted stretching program may have wide applicability.

The average length of employment of the respondents was 27.1 ± 5.9 years (range: 10-34 years). Long length of employment can lead to an increased risk of MSDs, particularly due to repetitive work and physical overloading [23,24]. Although long length of employment is a predictor of more complaints, from the analysis, length of employment did not affect the intervention effectiveness, which suggests the benefit of stretching in employees with long length of employment.

The respondents' mean BMI was 25.4 ± 3.8, which was overweight or preobese. Elevated BMI can increase musculoskeletal loading [25–27]. Contrary to expectations of high BMI for MSDs risk, stretching intervention was effective in reducing complaints, demonstrating its effectiveness with various physical status.

This research showed a notable reduction in MSDs symptoms in nearly all body regions. The highest reduction was found in the upper neck (Cohen's d = 1.116). The magnitude of change of upper neck symptoms (Cohen d = 0.991) compared to that reported by Buranruk & Wongwilairat (d = 0.85) in office workers may have been this way because the symptoms were relatively severe in our participants. Compared to prior research, we found greater mean effect sizes in the upper neck and lower back. This is an indication that the efficacy of stretching would be increased in a population that would deal with physically demanding tasks. These results further suggest why it is crucial to prescribe the intervention to address the particular biomechanical risks in individual occupational settings, since the interventions did not affect worker samples with low or no exposure to hazardous biomechanical postures.[28,29] The lower back and calf had effect sizes similar to those reported by King et al. among manufacturing workers, which suggested

that the intervention could have a similar effect in various work-related environments [17,30].

However, unlike studies in sedentary populations such as call-center employees in the UK,[31] where only marginal improvement was observed, our intervention led to large effect sizes. This divergence might be due to differences in baseline activity levels, targeted muscle groups, and occupational demands. The rest of the body, such as the shoulders, lower back, and calf, also showed a significant reduction consistent with previous studies on the effectiveness of stretching on those areas [32].

Repeated measures ANCOVA analysis indicated that covariates such as gender, age, length of employment, and BMI had no significant effect on the reduction of MSDs complaints. This suggests that the stretching intervention was the contributing factor responsible for reducing complaints, agreeing with the previously cited studies on the effectiveness of stretching without affecting demographic aspects.[18,33–35]

Overall, this study provides strong evidence that specific muscle group stretching exercises are effective in reducing MSDs complaints among textile workers. This supports the theory that stretching enhances flexibility and posture and also reduces muscle tension.[36–38] This simple-to-implement workplace program can improve worker health and productivity and reduce MSDs-related costs.

Limitations

The following are some of the limitations to be noted in this research. Quasi-experimental design lacking a control group lowers the internal validity and the capability to attribute the observed effects to the intervention only since the changes might also reflect the effects of other factors. Another example is those cases where there is workload fluctuation within a season (seasonal high-production requirements or overtime over an export deadline). The more intense workload during a specific period might worsen the symptoms temporarily or decrease the effectiveness of stretching exercises due to the culmination of fatigue, and the lower workload may reduce the physical strain of the task being performed with or without the intervention.

On the same note, psychosocial factors like job stresses, monotonous work, absence of supervisor support, or perceived high workload were also not captured in this study. All these factors have been known to interact with the physical load and may contribute to the development and magnitude of musculoskeletal symptoms to a substantial extent. Lack of control of these effects prevents isolation of the pure effect of stretching intervention. There is also the lack of randomization that puts a risk of selection bias, which can also affect the representativeness of the sample. Also, the possible confounding factors were not captured (psychosocial stressors, ergonomic work practices, and the workplace and environmental conditions) even though they directly influence the nature and severity of musculoskeletal disorders.[39,40] To enhance the generalizability and strengthen the causal interpretation, randomized controlled trial (RCT) designs are encouraged to be used in the future with a sizeable and a diverse sample and include measurements of psychosocial and ergonomic factors.

In summary, the present study supports the implementation of specific muscle group stretching exercises as an effective method for the prevention of MSDs complaints in textile workers. It would be necessary to design stronger and larger samples in future studies to validate the aforementioned findings and elucidate the mechanism behind the reduction of MSDs symptoms.

Conclusion

Combined with stretching-specific muscle areas, the content of this study shows that regional musculoskeletal disorder (MSDs) complaints among textile workers can be minimized considerably through focus on special muscle groups. These are exercises that could be utilized as a cost-effective and simple health promotion

program at the workplace. The interventions can be effective in enhancing the comfort of workers and productivity and minimizing the number of absent days linked to MSDs. However, the limited range of the quasi-experimental design and the lack of the control group hinder the possibility of establishing causality. Moreover, it cannot be ruled out that unmeasured reasons (i.e., psychosocial stressors and ergonomic work habits) have a potential impact. It is necessary to conduct future studies with larger and more varied populations through randomized controlled trials to see the jointly combined effects of stretching programs and ergonomic interventions and to isolate best practice strategies to prevent MSDs.

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Original Article

Evaluating occupational health and safety conditions among security guards in a Ghanaian Public University

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ABSTRACT

Introduction: The occupational health and safety (OHS) issues at academic institutions have received little attention, especially regarding the security staff who face specific job-related risks. This study examines the safety climate, risk exposures, and occupational health and safety (OHS) policies among security guards at the University of Cape Coast, Ghana.

Methods: A cross-sectional study was conducted from July to October 2023, employing both quantitative and qualitative approaches. Structured questionnaires, including the validated NOSACQ-50 tool, observational checklists, and expert-led risk assessments, were used in data collection. The study comprised 162 security guards with a minimum of one year of experience. The relationship between knowledge, attitudes, and safety outcomes was evaluated using descriptive statistics, chi-square tests, and correlation analyses.

Results: With a mean score of 2.25 ± 0.17, the general safety climate was judged to be low; management's safety commitment and communication received especially low ratings. Among the main occupational hazards were psychological risks (67.8%), environmental exposures (76.2%), and ergonomic stresses (87.7%). Among the frequently mentioned health issues were occupational stress (86.4%) and low back pain (74.0%). Only 23.5% of participants regularly reported exposures; hence, reporting of occupational injuries was less than ideal. High-risk areas identified by risk assessments as needing immediate mitigation included musculoskeletal injuries, stress, and insect bites.

Conclusion: Overall, the study reveals notable shortcomings in the OHS infrastructure and security environment for Ghanaian university staff. To ensure a safer workplace for security personnel, effective training, managerial commitment, policy implementation, and risk-reduction techniques are urgently needed.

Keywords: risk assessment, safety climate, security guards, university campus

Introduction

Occupational health and safety (OHS) is a vital concern across various industries globally, focusing on safeguarding employees' health, safety, and welfare. In Ghana, the importance of OHS has increased due to a heightened awareness of the risks associated with different professions and the necessity for safe working environments. While much of the research in Ghana has centered on sectors like mining, manufacturing, and healthcare, there has been limited focus on the occupational health and safety of security guards, especially in academic institutions. Security guards play a crucial role in ensuring the safety and functionality of university campuses. Yet, they encounter unique occupational hazards that can impact both their physical health and mental well-being. Prior studies that have involved security personnel highlight musculoskeletal

diseases,[1,2] fatigue, depression, and sleep disorders,[3] as the leading health problems among them. In research on security guards in Serbia, work-related stress was found to be associated with several medical conditions, including high blood pressure, diabetes, and syndrome X.[4] Limited research has been undertaken on the health and safety of security personnel within colleges and universities. A review of the available literature revealed a few such studies. A study from South Africa indicated that the rotational shifts impacted some aspects of the lives of campus security officers.[5] The respondents reported disrupted family relationships and insomnia. A different study with campus safety officers in Brazil found that the work capacity index had significantly high levels of association between social support in the work environment and depression levels.[6] In university settings, security guards often face high-risk situations, such as dealing with physical confrontations, enduring long working hours, working night shifts, and adapting to varying environmental conditions. These factors can contribute to stress, fatigue, and health issues, affecting their job performance and overall health. Despite their essential role in maintaining campus safety, there is frequently a lack of comprehensive OHS measures designed to meet their specific needs, leaving them at risk for occupational injuries and illnesses. As student populations grow and campuses expand in Ghanaian universities, the demand for security personnel has also increased.[7] However, limited resources and the lack of standardized OHS policies for university security staff mean that many guards operate without sufficient protection or support.[7] This highlights the urgent need for focused research on the health and safety conditions experienced by security guards in these environments. Even though a few studies have been conducted in Ghana to explore safety on campuses,[7,8] none have investigated the knowledge, practices, and attitudes of campus security guards on occupational health and safety (OHS). Such research is crucial for informing policymakers and university administrators about the specific OHS requirements of security guards, which can help shape effective interventions to enhance their safety and well-being. Understanding people's perceptions of safety and the identification of areas for improvement in the workplace depend on an awareness of the safety atmosphere that exists at the workplace. Different tools have been developed and used in many different fields to evaluate the safety situation. These cover the Psychosocial Safety Climate (PSC) Scale, Safety Climate Assessment Tool (S-CAT), Safety Climate Tool (SCT), and the General Health Questionnaire (GHQ-12).[9–12] Utilizing organizational and safety climate theories, psychological theories, past empirical research, global empirical findings, and a continuous development process, a collaboration of Nordic Occupational Safety Experts created the Nordic Safety Climate Questionnaire (NOSACQ-50) in 2011.[13] The NOSACQ-50 evaluates seven important aspects of safety environment including collective safety standards, safety communication, and management's dedication to safety. This all-encompassing approach helps one to fully understand the elements influencing safety behaviors, which is necessary to identify areas for improvement in the security service on university campuses.

This study, therefore, employed the NOSACQ-50 tool among other tools to assess the safety climate among security guards at the University of Cape Coast, a Ghanaian public university, exploring the nature and extent of the hazards they face, the adequacy of existing safety measures, and the impact of these factors on their health and job performance. By focusing on this under-researched group, the study seeks to contribute to the knowledge on OHS in Ghana by evaluating the occupational health and safety (OHS) conditions, risk exposures, and safety climate among security guards at the University of Cape Coast, Ghana.

Methods

The survey was conducted among the security personnel of the University of Cape Coast, a public university in Cape Coast, Ghana. This cross-sectional study used triangulation of methodologies. Its hazard identification was carried out using an observational checklist to inspect the workplace and a questionnaire to gather the opinions of security personnel on what constituted risks in the workplace. The NOSACQ-50 tool was used to assess the safety climate among the security guards. The study was carried out from July 2023 to October 2023. The study population consisted of all security staff who had worked at the University of Cape Coast for a minimum of one year. The total count of security personnel was 200, per records acquired from the Human Resource Directorate of the University. Per the eligibility criteria, 182 qualified to be included in the study, with 18 disqualified because they had worked with the University for less than one year. Using the census technique, all those who qualified were invited to join the study. The means and standard deviations were utilized to summarize continuous variables. The t-test was employed to conduct a comparative analysis between the groups. The categorical variables were summarized using their frequencies and percentages. The relationship between the independent and dependent variables was estimated using chi-square analysis. Data processing was conducted using software programs compatible with SPSS version 22. Statistical significance was determined at 5% and within the 95% Confidence Intervals. This research employed a structured self-administered questionnaire, and a pilot study was performed with ten security staff members from Cape Coast Technical University to verify its validity. This facilitated essential modifications to the questionnaire; also, the insights of specialists in occupational health were solicited during the development of the questionnaire and observational checklist. The reliability was improved by comparing the evaluation scores of three independent experts for identical hazards.

The survey comprised six sections: Section A collected data on the sociodemographic characteristics of respondents, while Section B gathered information on their awareness, knowledge, and practices related to occupational health and safety. The participants' perceptions of risks and the implementation of workplace health and safety were evaluated in Section C. Section D assessed the employees' self-reported exposure to occupational hazards. Section F examined the impact of occupational hazards on staff in the preceding year, whereas Section E was utilized to collect data on accessible workplace hazard mitigation strategies.

After examining earlier comparable research, [7,8,14] an observational checklist was created. It had eight parts. Sections on first aid, OHS rules, PPE use by employees, electrical safety, fire safety, general security, and availability of PPEs were among those covered. The study used the NOSACQ-50 tool to assess the safety climate among security workers at the University of Cape Coast. The findings were interpreted according to the author's guidelines as follows: a score of more than 3.30 (good level), 3.00 -3.3. (fairly good), 2.70-2.99 (fairly low), and less than 2.70 (low level). [15] A validated risk assessment matrix from a prior investigations[16,17] was used and modified to account for the risks found. Three experts utilized the form to assess the risks associated with the hazards identified during the risk identification procedures.

The Risk score (R) was determined by multiplying the probability of the event (P) by the severity of the event (S). The risk scores were defined as follows: inconsequential risk (1), tolerable/low risk (2, 3, 4, 5, and 6), moderate/medium risk (8, 9, 10, and 12), significant/high risk (15, 16, and 20), and intolerable risk (25). The University of Cape Coast Ethical Review Board approved the study protocol and issued an ethical clearance ID (UCC/IRB/EXT/2023/13).

Informed consent in writing was obtained from every participant. To maintain anonymity, no

names were included in the information gathered. To protect data, it was stored on a password-protected computer. The value of confidentiality was taught to every member of the research team during their training.

Results

The study participants comprised 162 individuals, representing an overall response rate of 89.0%. Of the respondents, 70 (43.2%) were in the 30-to-39-year-old age bracket. The majority of respondents, 132 (81.5%), were men. Most participants, 96 (59.3%), have worked in the university as security staff for at least 11 years. (Table 1).

Table 1: Socio-demographic characteristics of respondents

Characteristic	Frequency (%)
Age (years)	
⩽ 19	2 (1.2)
20 – 29	24 (14.8)
30 – 39	70 (43.2)
40 – 49	56 (34.6)
50 – 59	10 (6.2)
Gender	
Male	132 (81.5)
Female	30 (18.5)
Number of years at UCC (years)	
<5	40 (24.7)
5-10	26 (16.0)
11-15	52 (32.1)
>15	44 (27.2)
Education	
Senior High School Certificate	84 (51.9)
Diploma	50 (30.9)
Bachelor's degree	20 (12.3)
Masters' degree	6 (3.7)
Others	2 (1.2)

The respondents exhibited inadequate knowledge of occupational health, achieving an aggregate mean score of 2.93 ± 1.77 (maximum score of 7). Knowledge was significantly associated with attitude scores ($p < 0.001$) (CI: 0.032 – 0.083) and the availability of PPEs ($p < 0.018$) (CI: 0.014 – 0.143). There was no significant association between knowledge and age group ($p = 0.23$). A weak, positive, and significant association was found between knowledge scores and awareness of safety precautions ($r = 0.186$, $p = 0.018$). Although all participants, 162 (100%), indicated awareness of occupational health, only 60 (37.0%) comprehended it as pertaining to the well-being of employees, employers, and clients. The respondent demonstrated a good understanding of the necessary safety precautions, achieving an overall score of 6.13 ± 1.6 (maximum score of 7). The polled security staff demonstrated commendable occupational safety practices, achieving an overall mean score of 11.53 ± 2.90 (with a maximum possible score of 14).

A significant proportion of respondents, 126 (77.8%), were unaware of the processes established at the workplace to mitigate occupational dangers. In the event of an occupational health issue, the majority of participants, 104 (64.2%), were uninformed about any designated office or person responsible for addressing it. Only 18 (11.1%) indicated that they were to report an occupational injury. In the year preceding the research, only 96 of 162 respondents (59.3%) indicated that they had received any Occupational Health and Safety (OHS) training. Merely twelve individuals (7.4%)

of those polled participated in pre-employment training for occupational health and safety. Almost all respondents, 160 (98.8%), surveyed, perceived their employment as high risk. The attitude of respondents towards occupational health and safety was found to be very high, with a mean score of 39.01 ± 7.02 (maximum score of 50). Reasons for perceiving their job as risky were danger of being physically abused, 61 out of 162 (37.6%), fear of being verbally abused, 42 (25.9%), developing musculoskeletal disorders, 31 (19.1%), and working for long hours, 28 (17.4%). Respondents reported any health difficulties they experienced in the year preceding the poll that could be linked to their profession. Respondents identified low back pain,120 of 162(74.07%), and neck discomfort, 84 (51.9%), as the two predominant health concerns. Most of the security staff interviewed,140 of 162 (86.4%), reported experiencing stress due to their work.

Participants indicated exposure to three main hazards: environmental,494 responses (76.2%), ergonomic,284 responses (87.7%), and psychosexual, 76 responses (69.9%).

As illustrated in Table 2, the predominant environmental concerns observed were elevated noise levels, 132 (81.5%) and exposure to extreme weather conditions 152 (93.8%).

Table 2: Exposure to occupational hazards among respondents

Type of hazard	Exposed Frequency (%)
Environmental	
Exposure to extreme weather	152 (93.8)
High noise	132 (81.5)
Lack of privacy	112 (69.1)
Exposure to mosquitoes	98 (60.5)
Ergonomic	
Standing for long hours	146 (90.1)
Walking for long hours	138 (85.2)
Psychosocial	
Verbal assaults from students	76 (46.9)
Physical assaults from co-workers and students	56 (34.6)
Working for long hours	162 (100)
Time pressures, skipping meals and medications	159 (98.1)
Sleep disorders	96 (59.3)
Sexual harassment	0

Only 54 (60.0%) respondents were aware of the existence of the workers' compensation law in Ghana. No incidents of sexual harassment were reported. All respondents complained of extended working hours, whilst 159 (98.1%) were worried about having to skip meals and drugs due to work. When asked if they report any occupational exposures at work, 38 (23.5%) reported always doing so, 80 (49.4%) indicated that they sometimes do, and 44 (27.2%) never do. The reasons given by respondents who do not always report their occupational exposures, 124 (76.5%) included delay in response, 21 (17.3%), no action will be taken, 25 (20.4%), being blamed for the incident, 28 (22.2%), and not knowing who to report to, 43 (34.6%).

Respondents reported a high availability of PPEs, with a mean score of 14.36 ± 6.62 (maximum score: 32). Regarding their use of PPEs, respondents scored high, with a mean of 14.21 ± 6.00 (maximum score: 32). A strong positive correlation was found between the availability and use of PPEs ($r = 0.895$, $p < 0.001$).

The research team visited the various security posts on campus and made the following observations:

General Safety: The lighting in the various offices inspected was adequate. However, all the guard

posts visited were poorly lit and did not provide adequate protection against rain and heat. There were also no mosquito nets in place. Even though surveillance cameras were available in many parts of campus, some key areas did not have cameras installed.

When duty rosters were inspected, it was noticed that each personnel worked for 12 hours every day for 5 days a week. They run shift duties that include night shifts. It was also observed that they stood for about 7 hours during each duty period. There were no incident registers to record occupational exposures, so no records of occupational injuries were available for review.

The following PPEs were available for inspection: boots, gloves, high-visibility vests, and lone worker alarms. All staff on night duties were equipped with flashlights and a baton for defense. At the time of observation, none of the participants on duty wore stab-resistant vests, protective shields, or arm guards, and had no tear gas or stun devices for riot control if the need arose.

Table 3 reveals the findings of the decision matrix risk assessment conducted at the guard posts of security workers at the University of Cape Coast (UCC). This procedure assessed and identified common risks in the workplace. To ensure consistency in risk assessments, three independent occupational health experts evaluated workplace hazards using a standardized risk matrix. Inter-rater reliability was assessed using Fleiss' Kappa, yielding a value of 0.78, indicating substantial agreement among raters. Discrepancies were resolved through consensus discussions.

Staff were found to be most at risk of musculoskeletal injuries (Risk Score 20), stress (Risk Score 20), and mosquito bites (Risk score 16).

Table 3: Risk Assessment Matrix evaluating common hazards identified at the University of Cape Coast among security staff.

Risk/ Activity	Hazards	Probability of Occurrence (P)	Severity (S)	Risk Score (P x S)	Outcome	Control Measures
Musculoskeletal injuries	Standing for long hours	5	4	20	HIGH RISK	There is an urgent need to reduce working hours
Stress	Heavy workload, long working hours, inability to take annual leave	4	5	20	HIGH RISK	Need to increase staff strength to reduce workload, and ensure leave periods
Mosquito and other insect bites	Poor protection against insect bites	4	4	16	HIGH RISK	Guard posts should have nets to prevent the insects from entering. Staff should be given insect repellents

Injuries from physical assault	There are inadequate stab-resistant vests and some anti-riot tools like pepper spray, tear gas, protective shields, and arm guards.	2	5	10	LOW	Provision of non-lethal anti-riot tools and PPEs with proper training in their usage

A safety climate score of 2.25±0.17 reflects a low or inadequate safety climate as perceived by the workers. The low score was primarily influenced by inadequate scores in management safety commitment (1.61±0.013), management safety justice (1.70±0.18), management safety empowerment (1.65±1.16), and the workers' own safety commitment (2.52±0.12). Table 4 presents the safety climate perception scores of the respondents

Table 4: Respondents' safety climate perception scores distribution for the seven safety climate dimensions

	Dimension	Item	Mean	SD	Interpretation
1.	Management safety priority, commitment, and competence	9	1.61	0.13	Low
2.	Management safety empowerment	7	1.65	0.16	Low
3.	Management safety justice	6	1.70	0.18	Low
4.	Workers' safety commitment	6	3.07	0.23	Fairly low
5.	Workers' safety priority and risk non-acceptance	7	1.41	0.18	Low
6.	Safety communication, learning, and trust in co-workers' safety competence	8	2.88	0.16	Fairly low
7.	Trust in the efficacy of safety systems	7	3.44	0.15	Good
Total		**50**	**2.25**	**0.17**	**Low**

Discussion

This study highlights both systematic and organizational shortcomings influencing safety climate, risk exposure, and worker well-being by offering important insights into the occupational health and safety (OHS) circumstances and attitudes of security staff at the University of Cape Coast.

The mean safety climate score of 2.25 (±0.17) points to a generally poor safety environment that fits well with past research pointing to low managerial commitment and inadequate institutional safety culture as main obstacles in developing environments.[18,19] Particularly low were aspects like management safety priority, justice, and empowerment, a reflection of results

consistent with those of Dejoy et al.[20], who contend that employee confidence in management's safety justice is a major determinant of safety behavior and compliance.

Although every participant showed awareness of OHS ideas, only 37% of them accurately grasped its extent, therefore highlighting a surface level of awareness. This could probably be due to the low educational level of respondents, with a majority of them having a Senior High School certificate as their highest educational attainment. A similar finding was made in a study conducted among security guards in Nepal, revealing that about 65% of participants had attained only secondary education.[14] The fact that just 59.3% of respondents had any official OHS training and just 7.4% pre-employment highlights even more systematic neglect of capacity-building programs necessary to create a proactive safety culture.

The data confirm alarmingly high exposure to ergonomic hazards (87.7%), especially long hours of standing and walking, risk factors associated with musculoskeletal disorders (MSDs). This study reports a high prevalence of low back (74.0%) and neck pain (51.9%). This mirrors findings by Karande et al.[1] who identified a 96.6% prevalence of MSD among security workers in India. Another Indian study, among security workers, also identified a significant occurrence of low back pain, with about 47.69% reporting moderate disability due to prolonged standing and insufficient ergonomic support. [21] Working under such stress without organizational protections not only affects morale but also increases the risk of chronic illness and absenteeism.

Psychosocial hazards were reported by 67.8% of respondents. These included excessive hours, stress, and sleep difficulties. Security guards in this study worked 12 hours a day, five days a week, and were required to stand for more than half of that time. Bazana et al.[5] found that excessive work can harm social life, family relationships, and sleep. Night shifts may cause sleep difficulties. An observational study of 100 Delhi security officers indicated that 74.0% experienced sleep quality concerns and 48.0% had insomnia.[22]

Additionally, the reported psychosocial stress (86.4%), including verbal assaults and pressure to skip meals or medications, fits the broader literature on emotional labor in security roles. A Finnish study reported monthly prevalence rates of security guards experiencing verbal aggression at 39%, threats of assault at 19%, and physical acts at 15%.[23] Another study that was conducted among French security guards revealed a 40% exposure rate to physical and verbal violence. [24]

Only 23.5% of participants always reported occupational exposures, citing reasons like fear of blame (22.2%) and lack of knowledge on whom to report to (34.6%). These results correspond with previous Ghanaian campus studies[7,8] that highlight organizational inertia and fear of retaliation as significant barriers to incident reporting. Such conditions perpetuate a dangerous feedback loop where unreported hazards remain unaddressed, increasing cumulative risk.

In the risk assessment conducted, the most significant risk identified was musculoskeletal injury, primarily due to prolonged standing and walking, with 90.1% and 85.2% of respondents, respectively, reporting such exposures. These findings are consistent with previous literature indicating that static postures and extended shifts contribute heavily to lower back pain, neck strain, and joint discomfort among security guards.[1,6] The elevated risk score reflects both the frequency of exposure and the high severity of its impact, resulting in chronic pain, reduced productivity, and increased absenteeism. This underscores the need for ergonomic interventions such as task rotation, anti-fatigue mats, and flexible scheduling to mitigate risk.

Workplace stress was equally classified as high risk, with 86.4% of security personnel reporting job-related stress. Contributing factors include excessive workload, lack of leave periods, extended working hours, and psychosocial

stressors such as verbal abuse and insufficient organizational support. Studies from Serbia and Brazil also associate stress among security workers with hypertension, diabetes, and sleep disorders.[3,4] This high-risk score calls for urgent organizational restructuring, including increased staff recruitment, mandatory rest periods, and psychological support services, to alleviate stress and prevent burnout.

Environmental exposure to insect bites, particularly from mosquitoes, was another major concern. Nearly 94% of participants reported working in areas exposed to extreme weather conditions, with inadequate shelter and no mosquito nets in guard posts. While often overlooked in institutional OHS plans, frequent insect bites present real risks, including the transmission of vector-borne diseases such as malaria and dengue, especially in tropical settings like Ghana. The provision of mosquito nets, insect repellents, and structural upgrades to guard posts are, therefore, essential to lowering this risk.

Though not ranked as high as other hazards, the risk of physical assault remains significant due to inadequate protective gear. The absence of stab-resistant vests, riot shields, and non-lethal deterrents such as pepper spray increases workers' vulnerability, especially during campus conflicts or emergencies. This gap in protective resources aligns with global findings that frontline security staff in non-policing roles are often under-equipped to deal with high-risk confrontations. [25] Implementing modern PPE and tactical training would reduce both the probability and severity of such incidents.

This study underscores the urgent need for universities to develop tailored occupational health and safety (OHS) policies for campus security personnel. Key recommendations include strengthening managerial commitment to safety, implementing regular OHS training, improving ergonomic conditions and shift schedules, and establishing non-punitive injury reporting systems. Enhancing the availability and consistent use of personal protective equipment (PPE), upgrading guard posts to mitigate environmental hazards, and integrating mental health support into staff wellness programs are also essential. These interventions can significantly improve the safety, health, and job satisfaction of security staff within academic institutions.

Limitations

This study is subject to several limitations. First, the reliance on self-reported data introduces the possibility of social desirability bias, where respondents may provide answers they perceive as favorable rather than truthful. To mitigate this, the study incorporated observational checklists and expert-led workplace assessments to validate participants' responses.

Second, the qualitative nature of expert risk evaluations may introduce subjectivity. This issue was addressed by engaging three independent occupational health specialists, who conducted separate assessments before reaching a consensus, thereby enhancing objectivity and reliability.

Finally, the cross-sectional design limits the ability to infer causality between safety climate factors and health outcomes. However, the triangulation of methods and tools, such as the NOSACQ-50 and structured questionnaires, helped to strengthen the internal validity and contextual depth of the findings.

Conclusion

This study provides critical insights into the occupational health and safety (OHS) landscape for security personnel in Ghanaian higher education institutions, focusing on the University of Cape Coast. While there is universal awareness of OHS, the research reveals a significant disconnect between this awareness and practical competence, with insufficient knowledge and inconsistent safety practices. Systemic issues such as inadequate managerial commitment, a weak safety climate, inconsistent training, and a lack of incident reporting mechanisms contribute to high exposure rates to ergonomic, environmental, and psychosocial hazards, negatively affecting the

well-being, productivity, and morale of security staff. Employing the validated NOSACQ-50 tool, triangulated data sources, and expert-led risk assessments, the study ensures methodological rigor and a comprehensive evaluation of the safety climate. The findings underscore the urgent need for university administrations and policymakers to implement robust interventions, including structured training programs, ergonomic improvements, reliable injury reporting systems, and a redefined safety management culture that prioritizes transparency and worker empowerment.

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Original Article

Knowledge on lead exposure among Paint workers in Kirtipur Municipality, Nepal

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ABSTRACT

Introduction: Lead exposure is a serious threat to public health. Among various occupational groups, paint workers are at increased risk of lead exposure. This study aims to assess the knowledge on lead exposure, identify symptoms of lead toxicity and to estimate the blood hemoglobin level among paint workers in Kirtipur Municipality.

Methods: A cross-sectional study design was used among 108 paint workers having at least 2 years of exposure. The data collection period was from June to August 2024. Data were collected using convenient sampling through interviews. Semi-structured questionnaires were used as a tool for data collection. The study has been approved by ethics committee. Data entry and analysis was done in SPSS. Chi-square test and multivariate logistic regression analysis was done to find the association between lead exposure and age, level of education, number of years of exposure, duration of working hours, took formal training on safety measures etc.

Results: The mean age ± SD of the participants was 37.61 ±9.75 years. The mean years of exposure was 15.27 ±8.87 years, and mean duration of working was 9.39 ±2.07 hours/day. Headache was the most common symptoms of lead toxicity. Only 10 (9.3%) of the paint workers had good knowledge on lead exposure. Those who have taken formal training on hazards and safety measures have good knowledge on lead exposure and the association was also statistically significant (P≤0.001). However, age, work duration, work experience, and education did not show any significant association. Among the participants, 28 (25.9%) were diagnosed as anemic based on hemoglobin levels.

Conclusion: Study shows that only 9.3% of paint workers have good knowledge on lead exposure. So, awareness program on lead exposure and regular training programs on hazards and safety measures should be conducted.

Keywords: Knowledge, Kirtipur Municipality, Lead exposure, Nepal, Paint workers

Introduction

Lead is a toxic metal and its widespread use has resulted in adverse effects on the environment and human health.[1] People can become exposed to lead through occupational and environmental sources. Exposure routes of lead uptake in the workplace include ingestion and inhalation of inorganic lead.[2] In 2019, nearly half of the 2 million deaths due to known chemical exposure were due to lead exposure. Lead exposure is responsible for 21.7 million years lost due to disability and death worldwide due to its long-term deleterious effects on health.[3]

Among various occupational groups, paint workers are at increased risk of exposure to the chemicals used in their workplace.[4] Among various chemicals, lead-based paint is the major source of lead poisoning.[5,6] According to a WHO report, a human could be exposed to lead from paint through different routes, such as paint application, manufacturing, sanding, or removal of paint films.[7] No level of exposure to lead is known to be without harmful effects, but it can be prevented.[3] The inhaled/ingested lead can transport to the heart, bones, intestines, kidneys, reproductive, and nervous systems, causing tissue-specific adverse effects . 8, 9 Various health effects of lead exposure are anemia, loss of memory, nephropathy, neuropathy, encephalopathy, infertility, and even death. Risk of complications increases with duration of exposure and the only best treatment is to be prevented from exposure.[10]
The complexity of standard requirements and the weighting of their importance, it remains ambiguous and varies.

In this context, knowledge regarding various sources, modes of transmission, various health effects, and the use of personal protective devices is very important to prevent the harmful effects of lead exposure, especially on paint handlers. Therefore, this study will be of great help to the concerned authorities in increasing awareness of the hazardous effects of lead exposure on paint workers. Very few studies have been conducted to assess the knowledge related to lead exposure among paint workers in Nepal. The findings of this study might help strengthen the information available so far and encourage policy makers to design effective strategies to minimize the effect of lead exposure in this population. In this manner, this study will help to fill the research gap.

Methods

A community-based cross-sectional study was conducted in Kirtipur municipality among Paint workers with a minimum work exposure of 2 years duration. Kirtipur municipality was a preferred study site as it has numerous small to medium-sized enterprises, including workshops and construction sites where paint workers are commonly employed. The data collection period was from June to August 2024. The sample size was calculated based on a previous similar study, using the prevalence of knowledge of the hazards associated with the job (72.5%), an 8% margin of error, and a 95% confidence interval.[11] The final sample size was 120.

Out of 19 wards in Kirtipur Municipality, 8 wards were selected based on the high number of paint enterprises operating within them. We selected the participants by using a convenience sampling technique. Data were collected around the active working period at the work site where painters were actively engaged in paint handling. Paint workers with at least 2 years of exposure were included in study.

A semi-structured questionnaire and a blood sample were used as a tool for data collection. The questionnaires were self-constructed and included some questions from a previous study.[11] The questions were divided into four parts. The first part consists of socio-demographic profiles of the paint workers. The socio-demographic variables include age, gender, level of education, ethnicity, duration of employment (years), duration of working hours (hours/day) and formal training on hazards and safety measures in the workplace.

The second part consisted of 30 questions about knowledge on lead exposure. It included whether they have heard about lead or not, four questions about lead entering the body through the skin (absorption), inhalation, ingestion and through drinking water. Two questions on whether they eat/drink and smoke cigarettes in the work area or not. Other knowledge related questions are on washing hands before eating, using PPE to protect against lead exposure, correct use of PPE and wearing work clothes at home or not. Three questions are on the availability of facilities for eating, bathing and hand washing in the work area.

Others questions included whether they are aware of the hazards of lead exposure or not, use PPE properly while working with paints, sources of lead, danger of lead to a baby during pregnancy, availability of treatment and whether lead toxicity is preventable or not.

Ten questions on knowledge on lead exposure leading to anemia, impaired IQ, hypertension, low sperm count, abortion, cardiovascular diseases, neuropathy, nephropathy, encephalopathy and even death.

Proper use of Personal Protective Equipment (PPE) was defined as PPE covering the whole body with coveralls, gloves, boots, masks and goggles to protect against lead exposure. Those who answer more than or equal to 15 questions related to knowledge correctly are said to have good knowledge about lead exposure.

The third part consisted of self-reported symptoms of lead exposure, and the fourth part involved collecting a blood sample for the estimation of blood hemoglobin levels.

The questionnaire was first prepared in English. They were translated into Nepali so that participants could clearly understand the questions. In those who were illiterate, they were clearly explained in detail in presence of the relative. To maintain the consistency of the information collected, all the information from the questionnaire was checked on the same day as of the data collection.

For blood hemoglobin estimation firstly, the participants were made to sit comfortably and written consent was taken. Then, a tourniquet was applied to palpate the vein. The site was sterilized using the rectified spirit. At the angle of 30- 45º, the vein was penetrated with skin tight by another hand. The piston of the syringe was drawn slowly to prevent the hemolysis of the blood. Tourniquet was then removed, slowly with another hand. The needle was removed and blood was transferred to the EDTA vials and mixed properly. The specimen was labeled properly with the participant's identification number. The used needle was finally disposed of following health care waste management guidelines. The blood sample was transported in a cold ice bag to the Cutis Path Lab, New Baneshwor, Kathmandu on the same day.

For estimating Hemoglobin concentration Standard value of optical density was calculated by using distilled water in the test tube. For estimating optical density of testing sample, 5 ml drabkin solution was put in the plain tube along with 20-micron blood sample which is to be tested. Then it was mixed well. After 10 minutes reading was noted in clorimetre at 540 nanometre.

For calculating Hb % following formula was used:
Hb% = Optical density of the test sample X Concentration of standard (i.e 15%)/ optical density of standard.

Blood hemoglobin reference value: The cutoff value for males was taken 13 g/dl and for females 12 g/dl.[12]

The validity of the study was ensured through an extensive literature review, taking an adequate sample size and making the tool comprehensive. Before data collection, the questionnaires were validated by subject experts. The tools were pretested in Nagarjun Municipality in 10% of the sample population and revised accordingly. Additionally, participants were briefed on the tool through an information sheet prior to its administration. Trained data collectors conducted face-to-face interviews. The interview forms were reviewed daily for completeness and rechecked by the researcher for accuracy.

All the data were entered into MS Excel, and analysis was performed using SPSS version 16. Descriptive (mean, standard deviation, range, percentage, frequency) as well as inferential statistics (chi-square test) were used to analyze the results. The Chi-square test was applied to see the association between dependent and independent variables. The level of significance was set at $P<0.05$. For multivariate logistic regression, Variable with P value less than 0.2 was further analyzed using logistic regression to minimize the possible confounding factors.

Before starting the study, the proposal was approved by the institutional review committee of the Nepalese Army Institute of Health Sciences (IRC number: 1076). Informed verbal and written consent were obtained from each respondent, and in illiterate participants, thumbprints were taken after reading the consent paper in detail in presence of relative/friend. All respondents were interviewed in private. Any information that could disclose participants identity including names, phone number, and date of birth or national identification number were not included in the questionnaire to protect confidentiality of participants. Participation was fully voluntary, and no payment or other incentives were offered to the participants.

Results

Out of 120, only 108 participated in the study with the response rate of 90%. The mean age of the participants was 37.61 ±9.75 years, ranging from 17 to 69 years. The mean years of employment was 15.27 ±8.87 years, and the mean duration of working in the site was 9.39 ±2.07 hours per day.

Table 1: Demographic profile of the paint workers (n=108)

Variables	Number (Percentage)
Age (years)	**Mean: 37.61 ±9.75**
≤37	53(49.1)
>37	55(50.9)
Level of education	
Illiterate	10(9.3)
Literate	6(5.6)
Primary (1-5)	26(24.0)
Secondary (6-10)	50(46.3)
Intermediate (11-12)	16(14.8)
Ethnicity	
Brahmin	18(16.7)
Chhetri	3(2.8)
Janajati	82(75.9)
Dalit	5(4.6)
Got formal training on hazards and safety measures	
Yes	27(25.0)
No	81(75.0)
Duration of employment (years)	**Mean: 15.27 ±8.87**
≤15	56(51.9)
>15	52(48.1)
Duration of working hour(hours/day)	**Mean: 9.39 ±2.07**
≤9	63(58.3)
>9	45(41.7)

Out of 108 participants, 50(46.3%) had completed a secondary level of education. Majority of them followed Hindu religion (81.4%), followed by Buddhist (13.0%). The primary ethnicity was Janajati (75.9%) followed by Brahmin (16.7%). Only 25% of paint workers took formal training on hazards and safety measures. Around 52% of the participants had worked for less than or equal to 15 years and 48.1% had worked for more than 15 years. Similarly, 58.3% worked for ≤9 hours per day on the site whereas 41.7% worked for >9 hours per day **(Table 1). Table 2** shows the signs of lead poisoning. Among various signs, headache (22.2%) was the most common sign, followed by numbness or tingling sensation in hand and feet (21.3%), eye irritation (18.5%) and joint pain (16.7%).

Table 2: Signs of Lead poisoning (n=108)

Sign of Lead poisoning	Number (Percentage)
Headache	24(22.2)
Numbness or tingling sensation of hands and feet	23(21.3)
Eye irritation	20(18.5)
Joint pain	18(16.7)
Abdominal pain	11(10.2)
Myalgia	11(10.2)
Skin irritation	8(7.4)
Dizziness	8(7.4)
Fatigue	7(6.5)
Constipation	4(3.7)
Nausea/vomiting	3(2.8)
Pain in the teeth	2(1.9)
Weight loss	2(1.9)
Poor sleep	1(0.9)
Loss of appetite	1(0.9)

Table 3: Knowledge of participants about the lead exposure (n=108)

Knowledge statement	Correct n (%)	Incorrect n (%)
Have you heard about lead?	47(43.5)	61(56.5)
Lead enters the body by mouth?	20(18.5)	88(81.5)
Lead enters the body through the skin?	13(12.0)	95(88.0)
Lead enters the body by inhalation?	21(19.4)	87(80.6)
Lead enters the body through drinking water?	7(6.5)	101(93.5)
Should not eat/drink in the work area?	61(56.5)	47(43.5)
Should not smoke in the work area?	40(37.0)	68(63.0)
Do you wash your hands before eating?	95(88.0)	13(12.0)
Do you use any safety measures to protect against lead exposure?	44(40.7)	64(59.3)
Do you know about the correct use of PPE?	36(33.3)	72(66.7)
Should not wear your work clothes home?	89(82.4)	19(17.6)
Facilities for eating in clean area should be available?	108(100.0)	0(0.00)
Hand washing facilities should be available?	108(100.0)	0(0.00)
Facilities for bathing should be available?	108(100.0)	0(0.00)
Are you aware of the hazards of lead exposure?	42(38.9)	66(61.6)
Do you use PPE correctly while working with paint?	23(21.3)	85(78.7)
Do you know about the Source of lead?	8(7.4)	100(92.6)
Is lead dangerous to a baby during pregnancy?	14(13.0)	94(87.0)
Is treatment available for lead toxicity?	5(4.6)	103(95.4)
Is it preventable?	6(5.6)	102(94.4)

Do you know lead exposure leads to anemia?	7(6.5)	101(93.5)
Do you know lead exposure leads to Impaired IQ?	13(12.0)	95(88.0)
Do you know lead exposure leads to Hypertension?	3(2.8)	105(97.2)
Do you know lead exposure leads to Low sperm count?	3(2.8)	105(97.2)
Do you know lead exposure leads to Abortion?	3(2.8)	105(97.2)
Do you know lead exposure leads to CVD?	7(6.5)	101(93.5)
Do you know lead exposure leads to Neuropathy?	4(3.7)	104(96.3)
Do you know lead exposure leads to Nephropathy?	2(1.9)	106(98.1)
Do you know lead exposure leads to Encephalopathy?	3(2.8)	105(97.2)
Do you know lead exposure leads to death?	5(4.6)	103(95.4)

On assessing knowledge, 47 (43.5%) said that they have heard about the lead in the paint. Of the total, 20 (18.5%) said that the lead entered the body through ingestion, 21(19.4%) said through inhalation, 13 (12.0%) by dermal contact and 7(6.5%) through drinking water. Likewise, 61(56.5%) and 40 (37.0%) said that they should not eat/drink and smoke in the work area respectively. Ninety-five (88.0%) of the paint workers said that they wash hands before eating. Only 44 (40.7%) of the paint workers used PPE to protect against lead exposure. Out of 108 participants, only 36 (33.3%) knew about the correct use of PPE to protect against lead exposure. Most painters 89 (82.4%) said that they should not wear work clothes at home. All of the participants 108 (100.0%) said that facilities for eating in clean areas, handwashing and bathing should be available at the workplace site. Almost 42 (39.0%) of the participants are aware of the hazards of lead exposure. Out of 108 participants, only 23 (21.3%) said they used PPE correctly while working with the paints.

Only 8(7.4%) were aware about the sources of lead. Fourteen (13.0%) of the painter's said lead is dangerous to a baby during pregnancy. Only 5 (4.6%) said that treatment is available for lead toxicity. When asked about the various health effects caused due to lead exposure, 13 (12.0%) said it leads to impaired IQ, and 7 (6.5%) said it leads to CVD and anemia **(Table 3).**

The study showed that only 10 (9.3%) of the paint workers have good knowledge on lead exposure. The mean knowledge score was 8.65±3.92, ranging from 4-27.

The multivariate regression analysis revealed that individuals who had received formal training on hazards and safety measures demonstrated significantly greater knowledge regarding lead exposure, with the association being statistically significant ($P < 0.001$). In contrast, variables such as age, duration of employment, total years of work experience, and educational attainment did not exhibit any statistically significant association.

The mean hemoglobin level of the participants was 14.31±1.87 gm/dl, ranging from 10.30-18.20 gm/dl. Out of 108 participants, 28(25.9%) were anemic and the remaining 80 (74.1%) had normal level of blood hemoglobin.

Table 4: Association between selected variables and knowledge on lead exposure (n=108).

Variables	Knowledge on lead exposure					
Age	Poor Knowledge n (%)	Good knowledge n (%)	COR (95% CI)	P-value	AOR (95% CI)	P- value
≤37	49(92.5)	4(7.5)	1.50(0.39-5.64)	0.395	-	-
>37	49(89.1)	6(10.9)				

Mean Knowledge score	8.65 ± 3.92					
Level of education						
Primary and below	37(88.1)	5(11.9)	0.60(0.16-2.23)	0.333	-	-
Secondary and above	61(92.4)	5(7.6)				
No of years of exposure (Years)						
≤15	52(92.9)	4(7.1)	1.69(0.45-6.38)	0.325	-	-
>15	46(88.5)	6(11.5)				
Got formal training on hazards and safety measures						
No	79(97.5)	2(2.5)	16.63(3.26-84.75)	0.001	0.07(0.01-0.35)	0.001
Yes	19(70.4)	8(29.6)				
Duration of working hours in the site(hours/day)						
≤9	55(87.3)	8(12.7)	0.32(0.06-1.58)	0.130	1.71(0.30-9.70	0.543
>9	43(95.6)	2(4.4)				

Table 5: Prevalence of Anemia (n=108)

Hemoglobin level	Number (Percent)
Anemic	28(25.9)
Normal	80(74.1)

Discussion

Lead, a naturally occurring toxic metal, contaminates the environment through activities like mining, smelting, manufacturing, and recycling, and is found in various products such as paints, stained glass, lead crystal glassware, ammunition, ceramic glazes, toys, lead pipes in drinking water systems, and traditional cosmetics like sindoor and kohl.[13] Lead exposure from paints can occur, especially in young children, when they chew on painted surfaces, swallow or inhale lead-contaminated dust, or peel and crack lead-based paint, which leaves chips and dust on surfaces including windows, doors, floors, and furniture.[14] This indicates that people who come into direct contact with lead or lead based products, such as paint workers, are more likely to be exposed to lead.

This study determines the knowledge regarding lead exposure among the paint workers in Kirtipur municipality, Nepal. The mean age of the paint workers was 37 years ranging from 17 to 69 years. This finding was comparable with other studies.[15,16] Majority of paint workers in our study had more than 15 years of experience. This was similar to a study conducted in Japan where the majority of the paint workers had more than 10 years of experience in the painting industry.[16] The mean duration of working in the site was more than 9 hours per day in our study. The prolonged working hours and extended working spans of these paint workers greatly increase their risk of exposure to chemicals derived from paint. Just 25% of paint workers received official training on safety precautions and hazards. This result

contrasted with a research conducted in Japan, where 94.7% of paint workers reported that they had received advice and instruction about the hazardous and destructive elements of paint from senior employees at their places of employment.[16] A range of symptoms, such as abnormal behavior, anemia-like features, signs of encephalopathy (a disorder marked by brain swelling) with increased pressure within the skull, delirium, coma, seizures and headaches are caused by lead poisoning. Chronic exposure can cause depression, numbness and tingling in the limbs, nausea, abdominal pain, loss of coordination, and short-term memory or attention problems.[2,17] Headache was the most common symptom in our study participants followed by numbness or tingling sensation in hands and feet, eye irritation and joint pain.

In this study, 33.3% of the participants knew about the correct use of PPE but only 21.3% of them used PPE correctly while working with the paint. In contrast to this finding, in a study done among construction painters of Chennai, 73% of the workers were aware about the use of PPE but only 6% use PPE correctly during work. Some typical explanations given by the painters for not using PPEs correctly included extreme heat, increased sweating, discomfort during wear, and difficulty breathing.[15]

Only 43.5% of the paint workers in our study had heard of the chemical lead, whereas only 9.3% had good information regarding lead exposure. This result may have been caused by the low level of education of the paint workers, since 9.3% of them are completely illiterate and only 14.8% have received education above secondary level. In a research involving 84 bridge painters in New England, blood lead levels were greater in paint workers with only a high school degree than in those with at least some college education and the blood lead levels for each month that the bridge painter worked increased significantly.[18] The data suggest that lower education levels are associated with both limited awareness and higher blood lead levels. This highlights the need for better educational outreach and training to ensure the safety and health of paint workers. However, in our study, the association between no. of years worked, work duration, level of education and the knowledge on lead exposure was not statistically significant. The reason could be that a sample size of 108 paint workers may not be large enough to detect a statistically significant relationship, especially if the effect sizes are small. The study shows that those who have taken formal training on hazards and safety measures have good knowledge on lead exposure and the association was also statistically significant. (AOR: 0/068, 95% CI- 0.01, 0.35). This highlights how important it is for employers and employees to have better understanding of occupational safety and services through organized educational programs.[15] Conversely, a study conducted in Nigeria highlights a contrasting scenario.[11] While the level of awareness of occupational hazards among the paint workers was relatively high, the majority had not received formal training on occupational hazards and safety.[11] This indicates that despite the high level of awareness, formal training was not the primary source of knowledge in this setting. Workers might be relying on informal sources of information, peer learning, or personal experience, which may contribute to their awareness but may not provide the depth or accuracy needed to mitigate risks effectively.

Lead poisoning causes anemia by inhibiting heme synthesis enzymes, leading to ineffective heme production and microcytic anemia. It also damages red blood cell membranes, making them more fragile and contributing to anemia.[17,19] We also measured the hemoglobin level of the participants. The mean hemoglobin level was found to be around 14 gm/dl and 25.9% were found to have below normal level of blood hemoglobin. A study conducted among 52 paint industry workers in Indonesia had similar findings, where the mean hemoglobin level was around 15 gm/dl and only 7.6% were anemic.[19]

Limitations

Due to the small sample size and the restriction of the study setting to Kirtipur Municipality, the

findings of this research may have limited generalizability. The results may not be representative of broader populations or other geographic areas There is a risk of recall bias because only symptoms that need to be treated are remembered, and some symptoms of lead exposure are similar to symptoms from other common conditions (such as peripheral neuropathy and gastrointestinal disorders). Therefore, it is not possible to confirm that the symptoms experienced were exclusively caused by lead exposure. This could have been avoided if a control group of individuals with the same characteristics but no lead exposure had been included. Since this is a preliminary study, another disadvantage of the research is that we only evaluated knowledge, not practice.

Conclusion

Due to the small sample size and the restriction of the study setting to Kirtipur Municipality, the findings of this research may have limited generalizability. The results may not be representative of broader populations or other geographic areas There is a risk of recall bias because only symptoms that need to be treated are remembered, and some symptoms of lead exposure are similar to symptoms from other common conditions (such as peripheral neuropathy and gastrointestinal disorders). Therefore, it is not possible to confirm that the symptoms experienced were exclusively caused by lead exposure. This could have been avoided if a control group of individuals with the same characteristics but no lead exposure had been included. Since this is a preliminary study, another disadvantage of the research is that we only evaluated knowledge, not practice.

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Original Article

Musculoskeletal Pain of Gastrointestinal Endoscopists

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ABSTRACT

Introduction: Prolonged and repetitive musculoskeletal injuries are common among gastroenterologists who are overwhelmed with complex endoscopic procedures. Data is sparse regarding procedure-related musculoskeletal pain among endoscopists in Bangladesh. The objective of the study was to find out the frequency, sites, severity and factors related to musculoskeletal pain of practicing GI endoscopists in Bangladesh.

Methods: This cross-sectional study was conducted using Google Forms (a pre-designed structured questionnaire) among 91 Gastrointestinal Endoscopists of different gastroenterology centers of Bangladesh from 1st October 2021 to 30th June 2022. Data were collected using the total population sampling technique.

Results: The average weekly duration of doing endoscopic procedures was 8.1 ± 7.7 hours (median 5 hours). More than half (52.7%) of the endoscopists had musculoskeletal pain. The most painful site was the low back. On average, the severity of pain on a numerical rating scale is 3. 92 ± 1.74 out of 10. Musculoskeletal pain was significantly more common among endoscopists with more average weekly procedures (p = 0.029).

Conclusion: Musculoskeletal pain is frequent among endoscopists of Bangladesh. Reducing the number of procedures may help to some extent in this regard.

Keywords: Bangladesh, Endoscopy procedure, Gastroenterologist, Musculoskeletal injury, Musculoskeletal pain

Introduction

Occupational overuse injuries causing musculoskeletal pain are common in all interventionists, such as gastrointestinal endoscopists,[1–10] endoscopy nurses,[11] nursing assistants,[12] dentists,[10] surgeons,[13-16] and sonographers.[10] Endoscopic procedures are an integral part of gastroenterology practice. With the progressive development of medical science, open surgical procedures are being converted to microsurgical and endoscopic interventions as much as possible. Newer modalities of endoscopic interventions and diagnostic procedures, like endoscopic ultrasonography, are becoming popular and important tools for patient management.[17,18] These changes are causing more burden to the endoscopic interventionists. Occupational overuse injuries, causing musculoskeletal pain and the occupational hazards[19] of radiation, are important issues. In 2010, the American Society for Gastrointestinal Endoscopy published a paper on safety measures during endoscopy to prevent radiation exposure.[20] The prevalence of musculoskeletal pain in gastrointestinal endoscopists varies from 43% to

95.08% (95.08%,[2] 43%,[6] 89.1%,[7] 67%,[9] 74%,[21] 80%[22]). The commonest sites of pain were the back, neck, wrist, fingers (especially the thumb), shoulder, and elbow.[1,6,7,22] Studies found different risk factors for the injury, like an increased number of endoscopic procedures,[23] not taking breaks in between procedures,[2] age > 40 years, increased duration of a single procedure > half an hour, and > 3 procedures per day.[1] The American Society for Gastrointestinal Endoscopy published a guideline in 2023 on the role of ergonomics to prevent such injuries.[24] The setup and patient burden vary from country to country. Moreover, the number of gastroenterologists is very scarce in this densely populated country, where the doctor-patient ratio is 5.26 per 10000 population.[25] Hence, they are overwhelmed with endoscopic procedures, including gastroscopies, colonoscopies, enteroscopies, and endoscopic retrograde cholangiopancreatography (ERCP). However, there is sparse data related to musculoskeletal pain among gastrointestinal endoscopists in Bangladesh. Therefore, this study aims to evaluate the frequency, sites, severity, and factors related to musculoskeletal pain among gastrointestinal endoscopists in Bangladesh.

Methods

This cross-sectional research was carried out from October 1, 2021, to June 30, 2022, utilizing a pre-structured questionnaire. The questionnaire was piloted by ten gastroenterologists from the National Gastroliver Institute and Hospital, who were not involved in this research, resulting in a few adjustments to create the final version. Subsequently, a Google Form was employed for data collection, using a total population sampling approach. The study focused on gastroenterologists in Bangladesh as the target population. This research was conducted at the National Gastroliver Institute and Hospital in Dhaka, Bangladesh. A comprehensive list of gastroenterologists (totaling 227), along with their email addresses, was obtained from the Bangladesh Gastroenterology Society, excluding 21 individuals whose email addresses were unavailable. The Google form was distributed via email to gastroenterologists employed at various hospitals across Bangladesh, both government and private. They were asked to complete the form containing the survey questions. Follow-up requests to fill out the form were made at least three times. The outcome variables included the average weekly duration of endoscopic procedures and the number of endoscopists experiencing musculoskeletal pain after beginning these procedures, as well as the locations and intensity of the pain. A total of 91 gastrointestinal endoscopists participated in the survey. Data collected from Google Forms was transferred to Microsoft Excel and subsequently imported into SPSS version 25 for analysis. Numerical data were represented as mean ± standard deviation and median, while categorical data were shown as counts and percentages. The data were evaluated for normal distribution. Both parametric and non-parametric tests were employed to analyze data that were normally and non-normally distributed, respectively. The weekly average duration of endoscopy exhibited a non-normal distribution; therefore, to compare individuals with musculoskeletal pain to those without, the Mann-Whitney U test was utilized. All other numerical variables demonstrated a normal distribution; hence, a Student's t-test was conducted. To analyze categorical variables, the Pearson chi-Square test was applied. Before initiating this research, ethical approval was obtained from the institution's ethical review committee at the National Gastroliver Institute and Hospital (ex-Sheikh Russel National Gastroliver Institute and Hospital) in Dhaka, Bangladesh.

Results

A total of 91 gastrointestinal endoscopists were enrolled. The mean age of the participants was 42.8 ± 6.4 years. The average height was 65.6 ± 2.8 inches, and the weight was 71.7 ± 11.5 kg. The

mean body mass index (BMI) was 25.7 ± 2.8; 15 (16.5%) of them had a normal BMI (18.5 to 22.9), and the rest of them, 76 (83.5%), were either overweight or obese.

Among the participants, 50 (54.9%) were working both in government and private centers, 29 (31.9%) in government centers only, and 12 (13.2%) in private centers only. All of them were right-handed; 77 (84.6%) of them used 7-inch gloves. The average weekly duration of endoscopic procedures was 8.1 ± 7.7 hours (median 5 hours); 19 (20.9%) of them were engaged in endoscopic procedures for ≥ 15 hours weekly. Among the 91 study participants, all were doing upper gastrointestinal endoscopy (UGIE), 85 (93.4%) of them were doing colonoscopy, 28 (30.8%) endoscopists were doing ERCP, 10 (11%) endoscopists were assisting ERCP, 18 (19.8%) endoscopists were doing enteroscopy, and one (1.1%) was doing endoscopic ultrasonography. 54 (59.3%) of them received hands-on training on endoscopic procedures after completion of post-graduation. The completed year of doing different endoscopic procedures, the average number of procedures per week, and the lifetime total number of procedures are shown in Table 1.

Table 1: Number of endoscopic procedures by Endoscopists (n=91)

Name of procedure		Completed year of the procedure	Average number of procedures per week	Lifetime total number of procedures
UGIE†, n=91	Mean ± SD§	6.5 ± 6.3	34.1 ± 29.7	9159.5 ± 13791
	Median	5	25	3500
Colonoscopy, n=85	Mean ± SD	6.2 ± 5.5	14.5 ± 65.1	2298.0 ± 4352.5
	Median	5	5	600
ERCP‡, n=28	Mean ± SD	4.9 ± 5.3	2.7 ± 2.2	1030 ± 2457.9
	Median	3	2	125

†UGIE-Upper Gastrointestinal endoscopy, ‡ ERCP-Endoscopic retrograde cholangiopancreatography, § SD-Standard deviation

For upper gastrointestinal endoscopy (UGIE), 70 (76.9%) used one hand, 6 (6.6%) used both hands simultaneously to do UGIE, and 15 (16.5%) of them sometimes used one hand, sometimes used both hands to do UGIE. Out of 91 participants, 85 (93.4%) did a colonoscopy; of them, 27 (31.7%) did it using a single hand. Regarding ERCP, 28 (30.8%) were doing ERCP, 10 (11.1%) were only assisting, and the rest were not involved in either doing or assisting ERCP. Among those who were either doing or assisting (n=38), 33 (86.8%) had a fixed ERCP team.

Regarding the musculoskeletal pain, out of 91 study participants, 48 (52.7%) endoscopists reported musculoskeletal pain. 10 (11%) of them had a different type of musculoskeletal pain before starting the endoscopy carrier; 4 had cervical spondylosis, 2 had lumbar spondylosis, 2 had gout, 1 had a prolapsed lumbar intervertebral disc, and 1 had pain in multiple joints diagnosis of which was not made. Among the persons (n=81) who did not have any musculoskeletal pain before, 38 (46.9%) developed musculoskeletal pain after starting the endoscopy procedure; however, half of them, 19 people (50% of those who developed pain), did not have a diagnosis for the pain. The rest of the 19 people (50% of those who developed pain) had a diagnosis; 6 with cervical spondylosis, 5 with tennis elbow, 2 with lumbar spondylosis, 2 with de-Quervain's tenosynovitis, 2 with 1st carpometacarpal joint osteoarthritis, 1 with prolapsed lumbar vertebral disc with nerve root compression, and 1 with gout. Among these 38 persons who developed musculoskeletal pain after starting endoscopy careers, their mean age is 44.1 ± 6.4 years. 11 (28.9%) of them believe that his/her pain was surely related to the endoscopic procedure; 25 (65.8%) and 2 (5.3%) believe that the pain was possibly related and not related to the endoscopic procedure, respectively. The most painful sites perceived by endoscopists who developed pain after starting to do endoscopic procedures were the low back in 9, neck in 7, upper

back in 4, shoulder in 3, elbow in 4, wrist in 5, thumb in 3, fingers in 2, and great toe in 1 study participant. The severity of pain on a numerical rating scale was 3. 92 ± 1.74 out of 10. Among these 38 endoscopists, those who developed pain after starting to do endoscopy found that pain used to interfere with activities of daily life in 13 (34.2%). 16 (42.1%) of them needed to take painkillers, 9 (23.7%) modified their endoscopy practice to reduce pain, and 10 (26.3%) consulted a physician for the management of pain. Among 91 study participants, 52 (57.1%) have height-adjustable endoscopy procedure tables. Only 18 (19.8%) of them used to take regular breaks in between procedures, 48 (52.7%) occasional breaks, and 25 (27.5%) no breaks. On average, the break time duration was 5.85 ± 6.78 min. Among those who developed musculoskeletal pain after starting the endoscopy career, their weekly average duration was more than that of those who did not develop pain (p-value .029) (Table 2).

Table 2: Musculoskeletal pain after starting endoscopy career (n=38)

		Musculoskeletal pain after starting the endoscopy career		*p*-value
		Yes (n=38)	No (n=43)	
Having height height-adjustable procedure table	Yes	20 (43.5%)	26 (56.5%)	.478†
	No	18 (51.4%)	17 (48.6%)	
The weekly average duration of endoscopy		19.2 ± 9.1	6.3 ± 6.2	.029††
Body mass index (BMI)		26.1 ± 3.4	25.4 ± 2.3	.306§
Taking a break in between procedures	No break	12 (52.2%)	11 (47.8%)	.695 †
	Occasional break	19 (47.5%)	21 (52.5%)	
	Regular break	7 (38.9%)	11 (61.1%)	

†Pearson Chi-square test, §Students t-test, ††Mann-Whitney U test

Discussion

In this study, out of 91 endoscopists, 48 (52.7%) had musculoskeletal pain. A survey-based study showed the prevalence of musculoskeletal injury pain from 37% to 89%.[26] The American Society of Gastroenterology (ASGE) survey revealed that about 35.3% of American endoscopists experienced endoscopy-related musculoskeletal injuries.[27] A study conducted in Canada noted that 67% of endoscopists out of 114 participants had endoscopy-related musculoskeletal pain. On the contrary, 95.08% of endoscopists among 61 respondents had musculoskeletal injuries in Pakistan.[2] The vast majority of the endoscopists (83%) in our study were either overweight or obese, which reflects that inadequate exercise, as well as the increased weight of the body, might have worked as a contributing factor to the pathogenesis of musculoskeletal pain amongst endoscopists of our study.[28] The most frequent painful site is the right thumb (51.6%), followed by low back (6.6%) and the neck (5.5%). The weekly average duration of endoscopy was significantly associated with musculoskeletal pain (Table 2) ($p<0.029$). Several factors come into play to cause musculoskeletal pain among endoscopists. Repetitive hand movements, repetitive torquing of the shafts of the scopes, and fine maneuvers of the scope knobs or wheels cause mechanical stress on the hand joints. Prolonged stress causes inflammation and damage to the joint tissues. Hence, pain ensues. Moreover, prolonged working hours cause repetitive tissue injuries to aggravate. Also, prolonged standing and bad postures while performing endoscopies contribute to musculoskeletal pain.[4,19] Our study showed, taking regular breaks while performing endoscopies reduced the frequency of having musculoskeletal pain, although the result was not significant. Similar findings were also found in

studies done in Canada and Pakistan.[2,9] Taking regular breaks might reduce the repetitive damage to the collagen tissues and provide adequate time for the already compromised connective tissue to heal.[7]

Most musculoskeletal injuries are easily avoidable. Regular breaks between endoscopic procedures and reducing the volume of procedures per week are of utmost importance. Moreover, avoiding awkward postures and providing adequate height-adjusted tables are other notable measures to be taken as preventive measures[29]. Moreover, regular exercises provide an excellent mechanism to remain fit, reducing the chances of developing musculoskeletal pain.[29] The present study showed that only 23.7% of endoscopists modified their endoscopy practices, and 26.3% of endoscopists sought professional advice to alleviate the musculoskeletal pains. More awareness among the endoscopists regarding the ergonomic factors related to musculoskeletal pain needs to be raised. Moreover, endoscopists are also reluctant to consult professionals regarding their musculoskeletal pain.[29] So, endoscopists should be educated to consult professionals as soon as they experience any musculoskeletal pain.

Limitations

This study is not without of limitations. The sample size is small. The questionnaire was filled out by the respondents using Google Forms. Therefore, the chances of recall bias could not be alleviated. However, our study will stimulate to conduct of the large-scale survey to find out the factors related to musculoskeletal pain among endoscopists and will help policymakers to take necessary steps to help endoscopists get rid of the endoscopy-related musculoskeletal pains.

Conclusion

In conclusion, the frequency of musculoskeletal pains among endoscopists is high. A high weekly average duration of procedure was found to be a factor associated with pain in this study. Raising awareness regarding their occupational musculoskeletal injuries and educating them to prevent those injuries is of utmost importance, as the number of endoscopists is very low in this populous country.

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Original Article

Perceived effectiveness of near-miss reporting on proactive safety performance in construction: A mixed-methods study from India

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ABSTRACT

Introduction: Construction industry is one of the most dangerous industries involving 5.5 million work-related accidents and nearly 60,000 fatalities every year across the world. Near-Miss Reporting Systems (NMRS) is one of the proactive safety management options to identify hazards prior to any major accidents contributing to injury prevention. While NMRSs are increasingly adopted in construction, there remains a gap in understanding how their effectiveness is perceived by frontline workers. This research evaluated the perceived effectiveness of the NMRS among construction employees and tested its relationship with other safety management practices and outcomes.

Methods: A quantitative, cross-sectional, and correlational research design was used, gathering data from 475 construction workers in 18 Indian units and five-year accident and near-miss reporting trends. Descriptive analysis, Pearson correlation, and linear regression were applied to evaluate worker perceptions of NMRS effectiveness, safety interventions, and safety performance, as well as the relationship between accident and near-miss reporting trends.

Results: The analysis demonstrated NMRS's effectiveness in boosting safety awareness, preventing accidents [84.5% affirmation], and increasing job satisfaction [84.6% affirmation]. This effectiveness was strongly linked to robust safety management practices, including an open safety culture [r=0.56], regular safety audits [r=0.22], and employee engagement [r=0.16]. Critically, higher near-miss reporting frequencies correlated negatively with accident rates, signifying a proactive role of NMRS in reduction in incidents.

Conclusion: NMRS effectiveness is closely tied to safety culture and management practices. Integrating NMRS into broader safety frameworks enhances construction site safety outcomes.

Keywords: Accident Prevention, Construction Safety, Near-Miss Reporting, Risk Management, Safety Culture

Introduction

The construction sector is always ranked among the most dangerous in the world, with a high number of injuries, accidents, and deaths being recorded. It is estimated by the International Labour Organization (ILO) that more than 5.5 million accidents and close to 60,000 fatal construction cases occur worldwide per year.[1] These dismal numbers compel the necessity of having effective and proactive safety measures. Conventional, reactive methods of safety mainly look into past incidents, and in most instances, they are inadequate in predicting future incidents. Conversely, Near Miss Reporting Systems (NMRS) have been effective

internationally in not only preventing injuries but also playing key roles in carrying out critical proactive risk management. According to the Occupational Safety and Health Administration (OSHA,2020), a near miss refers to an unintended occurrence that did not cause harm, illness, or damages, yet could have caused those. They are very important leading indicators of safety performance, and they provide priceless insights into unsafe conditions and risky behaviours that would otherwise contribute to a serious accident.[2,3,4] The NMRS play a central role in enhancing and actively ensuring safety in construction environments by establishing improvement-proactive and risk-based prioritization systems,[5,6] thus promoting resilience. This idea is developed and embodied in the concept of the so-called 'The accident triangle', which states that every serious injury has a prehistory of thousands of minor incidents and countless near misses [7] Herein lies the extreme significance of the gathering of such early signals.[8,9] The research findings also confirm the negative interrelation between near-miss reporting and injury incidences, which further indicates the proactive nature of NMRS as a safety performance-enhancing tool.[10] Near-miss reporting at the institutional level significantly enhances the overall safety culture of an organization by encouraging preventive action and fostering a culture of transparency within it.[11] In a similar way, research determined that the integration of effective reporting systems and a high level of management commitment are crucial to positive safety results, which further confirms the role of NMRS in safety culture and performance.[12,13,14]

Although the theoretical benefits and predictive capabilities of near-miss systems exist, human, cultural, behavioral, and structural obstacles to their implementation are common in the construction industry. The primary barrier is a worker's perception of usefulness and risk on reporting.[15,16] The general barriers include the fear of blame, uncertainty about what to do next, and a lack of awareness about the significance of reporting.[15,16] Studies emphasize that psychological safety, trust, and proper training are key factors in nurturing an open reporting culture.[17,18,19] Although studies suggest that NMRS can be used to detect and correct the processes that create accidents,[15,20] not all organizations have incorporated NMRS into their thinking and safety practices.[18,21,22] The effectiveness of any Near-miss system is not only based on its technical structure but also on how the workforce accepts it.[22] The perceptions of the workers are critical in shaping the levels of participation, reporting frequency and the general trust in the system. The reason is that when workers feel safety programs are in place, effective and promoted by management, they would tend towards implementing safe behaviour and even reporting near misses.[23] Managerial commitment and methodical feedback are essential to realize the best use of the near-miss data and a prevention-oriented approach to safety management.[24,25,26] Safety training and visual aids to boost awareness and reporting, safety committees for follow-up, and incentives that foster a genuine safety culture.[27] Proactive safety culture, which is associated with active communication on lessons learned due to near misses, plays a big role in the prevention of accidents and the enhancement of better safety results.[13,14,26] Quality supervision, toolbox talks, and audits build trust. Crucially, systematic analysis of reports helps prioritize risks and improve safety.

Nevertheless, there is a significant lack in the scholarly literature, with many studies focusing on incident records or the technical efficiency of such systems, but not on how employees at the ground level perceive and value them.[9,10,14,16,25,28] This forms a significant research gap. The other gaps include a lack of research examining the correlation between perceived NMRS effectiveness and other active industrial safety management practices, as well as their correlation with measures of safety performance. Although near-miss and accident data are typically accessible, little research has combined these with tools that examine the effectiveness of the system based on perception to provide a multidimensional view of the system's effectiveness. Even as Hasanspahic et al. demonstrate the significance of analyzing near-miss reports during risk prioritization, corrective actions, and safety enhancement comments in the building industry,[21] little is known about how data is collected through workers' perceptions. This study is based on the assumption that worker perception is not only vital in the assessment of safety outcomes, but also vitally important in the creation of an organizational culture that encourages proactive accident and injury prevention through harmonizing efforts. Although they are increasingly being adopted, the performance of NMRS in construction has never been exhaustively studied.[10,15,25,29,30] The current study will: determine how the system of near-miss reporting is perceived as enhancing

safety performance, employee awareness, and satisfaction on construction sites; investigate the relationship between the perceived effectiveness of the system of near-misses and the level of other formal systems and strategies of industrial safety management; and relate the trends of near-misses and accidents data of selected units of the construction over the period of five years to provide a context to perception-based findings.

Methods

The research study used a cross-sectional, quantitative, and correlational research design. It mainly aimed to identify how effective NMRS were perceived to be in enhancing safety performance on construction sites. It also examined the statistical correlations between the perceived effectiveness of NMRS and the prevalence of different organizational industrial safety management practices in the eighteen units of the construction. To give contextual depth, the study also analysed five years of past near-miss and accident data of three large construction units.

Population, Sampling and Study Setting

The research was conducted at eighteen construction sites in northern India. They were selected because these sites have already adopted the practice of implementing and regularly using industrial safety management practices, including NMRS, to improve safety performance. The target audience consisted of construction workers, supervisors, engineers, and managers who were directly involved in site operations and industrial safety management practices. The selection of participants was based on their willingness to participate in the study, with a convenience sampling strategy adopted to cover the various job levels within the units. A total of 475 valid responses were received out of the 500 questionnaires administered resulting in an amazing response level of 95 percent.

Data Collection and Designing of Instrument

The main instrument of data collection was a structured questionnaire. It was designed based on the author's previous experience, the results of related research, and compliance with international safety management standards (e.g., ISO 45001). Three principal sections constituted the questionnaire:

Demographics: Collected data about the age, education, monthly income, marital status, job role, experience and gender of the participants.

Perceived Effectiveness of Near-Miss Reporting: Applied Likert-scale questions to gauge the variables of accident prevention, safety awareness, sense of safety and job satisfaction.

Presence and Perceived Effectiveness of Industrial Safety Management Practices: The effectiveness of several practices to manage safety (interventions), such as safety training programs, safety committees, safety professionals, safety posters visible, rewards of near misses, pep-talks/toolbox talks, supervision, safety auditing, and participation of employees and the open safety culture, was assessed by the participants.

All items of perception were measured using a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). To provide proper insight into what the survey instrument covers, a sample of questions, along with the accompanying Likert scale, is presented in Table 1 below. These questions would be used to capture respondents' perceptions of different safety practices and the effectiveness of Near-Miss Reporting Systems (NMRS) as a whole.

Table 1: Sample Survey Questions on Safety Management Practices and NMRS Effectiveness

S. No.	Question / Statement	Likert Scale
Part 1: Perceived Effectiveness of Industrial Safety Management Practices		
1	**Safety Training** is effective in preventing accidents in our organization.	1 (Highly Ineffective) to 5 (Highly Effective)
2	**Pep-Talks** and **Tool Box Talks** are very effective in enhancing safety awareness.	1 (Highly Ineffective) to 5 (Highly Effective)
3	**Work Supervision** is effective in ensuring safety compliance at our workplace.	1 (Highly Ineffective) to 5 (Highly Effective)
4	**Work culture** in our organisation encourages reporting of safety issues, accidents and NMAs.	1 (Highly Ineffective) to 5 (Highly Effective)
5	**Near Miss Reporting System** aids in prevention of accidents in our units.	1 (Highly Ineffective) to 5 (Highly Effective)

6	**Safety Audits** are effective in enhancement of safety performance in our organisation.	1 (Highly Ineffective) to 5 (Highly Effective)
Part 2: Overall Impact of Near Miss Reporting System		
1	There is an overall improvement in **safety awareness** and **safety compliance** in our organization.	1 (Strongly Disagree) to 5 (Strongly Agree)
2	I feel very **safe** in carrying out work in my organization.	1 (Strongly Disagree) to 5 (Strongly Agree)
3	In my opinion, Near Miss Reporting helped in **accident prevention** and improved overall safety performance in our organisation.	1 (Strongly Disagree) to 5 (Strongly Agree)

Validity, Reliability, and Data Collecting Procedure

Pilot-testing was conducted with 25 people to determine the clarity and reliability of a questionnaire. The construct validity was strictly checked by professionals who are well versed in construction work and safety management. Its internal consistency and reliability were at an excellent level, recording a Cronbach alpha on the perception-related constructs of 0.83.[24]

The data collection process was divided into two sections. The primary data were collected through a paper survey, a mode of survey adopted due to the limitations of the number of respondents and the location. There was willing participation and all the respondents gave informed consent. None of the personal identifiers were recorded to ensure high levels of strict confidentiality. This data-gathering exercise took three months during the peak stages of the project. In the case of secondary data, historical records of near-misses and accidents over five years were captured through the safety departments of three large participating construction units. The datasets were anonymized and grouped by year and severity to identify temporal patterns.[21]

Data Analysis

The responses to the questionnaires were tabulated and coded with MS Excel. Demographic characteristics, overall perception scores, and reported status of industry safety management practices were described using descriptive statistics (frequencies, percentages, means, and standard deviations). Internal consistency and reliability of all multi-item constructs were determined using Cronbach's alpha. Pearson correlation coefficients were calculated to measure the relationships between perceived effectiveness of an NMRS and the other safety management practices in industry and measures of safety performance. Thereafter, the multiple linear regressions were used to assess the predictive associations between NMRS effectiveness and other industrial safety management practices. Further, trend analysis was done descriptively based on plotting and analysis of five-year records of the accidents and near-miss incidents in three chosen construction units. The purpose of this assessment was to identify temporal trends, differences between occurrences, and put perception-based results into perspective, with possible links to safety interventions.[14,21]

Ethical Considerations

All the ethical guidelines were followed such as ensuring that the participants were informed, participation was voluntary, and the studies and all the participants remained anonymous and their data confidential. No personal identifiers have been recorded or synchronized, and information has been managed securely.

Results

This section presents the results of the perception survey conducted among employees working in eighteen construction units, as well as the analysis of accident and near-miss data from three selected participating units. The findings are classified into four subsections: respondent demographics, descriptive statistics of perceptions towards the NMRS, correlation analysis of the effectiveness of the NMRS with other selected industrial safety management practices and safety performance indicators, and trends in the number of accidents and near-misses over consecutive five-year intervals.

Respondent Demographics

The questionnaire yielded 475 valid responses from the eighteen participating construction units. The sample comprised a diverse representation of job roles: 29.3% workers, 27.8% site supervisors, 31.2% engineers, and 11.8% management personnel. A majority of the participants (64.5%) reported having over five years of experience in the construction industry.

Perceptions about the Effectiveness of NMRS

A descriptive analysis of the Likert-scale data indicated a generally positive perception among respondents toward the NMRS. The average score for the perceived level of NMRS effectiveness (on a 5-point scale) was 4.15 (SD = 0.76), suggesting a strong overall agreement among respondents regarding the positive impact of NMRS on safety management.

Perceptions about the Impact of NMRS on Safety Performance Indicators

The study also measured the perceived effectiveness of NMRS on specific safety performance indicators, including accident prevention, safety awareness, feeling of safety, and overall job satisfaction. The findings are as follows:

- 84.5% of respondents affirmed that the NMRS is beneficial in the future prevention of accidents.
- 81.8% believed that it contributed to their personal sense of safety.
- 82.9% stated that it helped raise overall safety awareness and compliance.
- 83.8% opined that it made their units more secure in their performance.
- 84.6% of respondents expressed increased job satisfaction due to a prevailing proactive safety culture in their units.

Correlation Analysis

Pearson correlation analysis was conducted to examine the relationships between the perceived effectiveness of NMRS and various safety performance indicators, as well as its associations with other industrial safety management practices. The strength of the correlation was interpreted using conventional guidelines: $|r| \geq 0.5$ suggests a strong correlation, $0.3 \leq |r| < 0.5$ indicates a moderate correlation, and $|r| < 0.3$ suggests a weak correlation. The results, as detailed in Figure 1 and Figure 2, provide a quantitative measure of the strength and direction of these relationships, with statistical significance determined at the $p < 0.05$ level.

Correlation between NMRS and Safety Performance Indicators

Pearson correlation analysis indicated a statistically significant positive impact of the NMRS on various safety performance indicators, as shown in Figure 1.

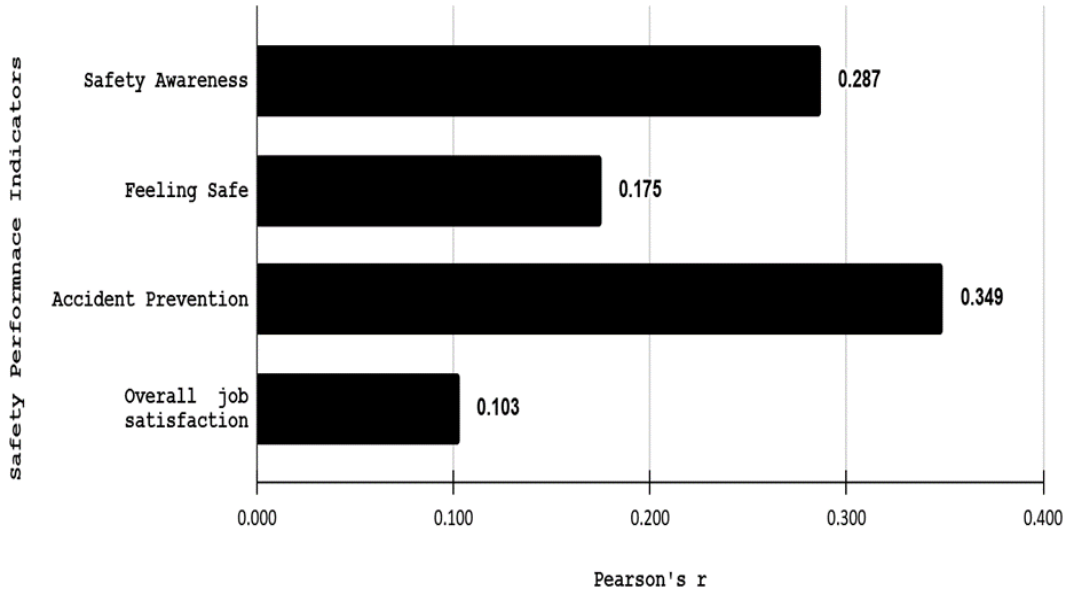

Figure 1: Correlation Between NMRS and Safety Performance Indicators

As depicted in Figure 1, the NMRS demonstrated a moderate positive correlation with accident prevention (r = 0.349), followed by safety awareness, feeling of safety, and overall job satisfaction. These results suggest that near-miss systems are an effective means of improving safety performance on construction sites.

Correlation between Near-Miss System Effectiveness and Other Industrial Safety Management Practices

Pearson correlation analysis also revealed statistically significant and positive associations between the perceived effectiveness of the NMRS and several other industrial safety management practices in the construction industry, as presented in Figure 2.

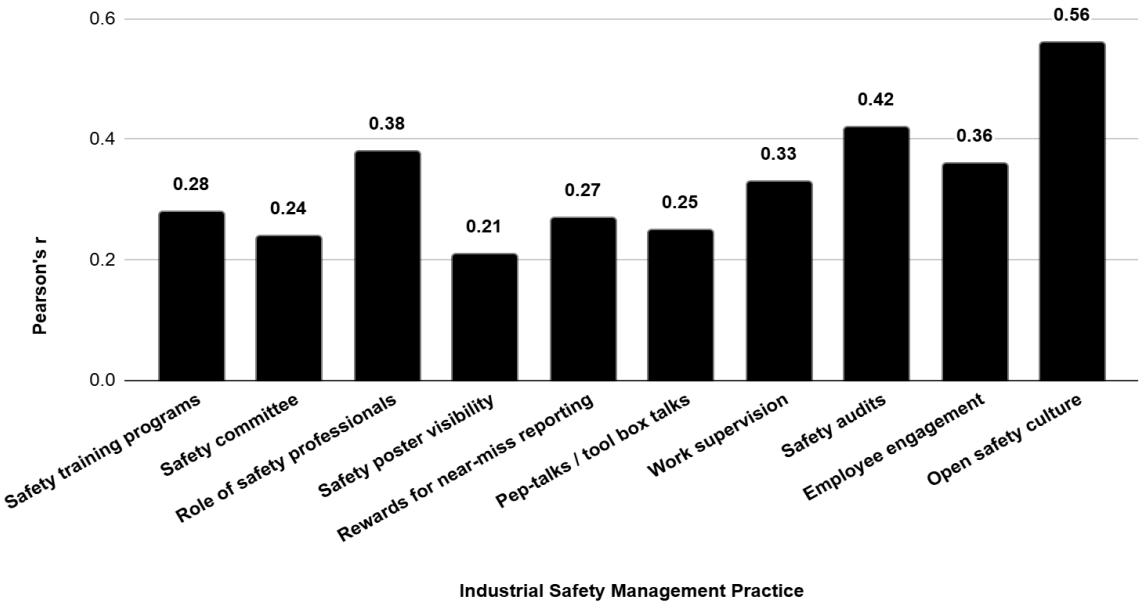

Figure 2: Correlation Between Near-Miss System Effectiveness and Other Safety Management Practices

A high correlation was observed between an open safety culture and near-miss effectiveness (r = 0.56), followed by safety audits, the role of safety professionals, and employee involvement in safety matters, as illustrated in Figure 2. These findings further indicate that the effectiveness of NMRS is directly linked to broader employee engagement and a comprehensive review of industrial safety management practices.[24,31]

Regression Analysis between NMRS Effectiveness and Other Industrial Safety Management Practices

To explore the correlation between NMRS effectiveness and key predictors in more detail, given that there is insight that allows for establishing which predictors are the main determinants of NMRS efficacy, a multiple linear regression analysis was conducted using Jamovi, version 2.5.5.0. The visualization of the results is presented through a pair of charts created using Google Sheets. Figure 3(a) visually presents a Cobweb (Radar Chart) of the magnitude of relationships between NMRS effectiveness and a number of industrial safety management practices and Figure 3(b), visually presents a Coefficient Plot of the statistical significance and direction of each of these predictors, in greater detail.

Cobweb (radar) chart, as shown in Figure 3(a), visualizes the perceived effectiveness of various industrial safety management practices on NMRS effectiveness at construction sites. The figure evidently shows that Reporting Culture and Safety Audit depicts the highest scores represented in the longest points on the radar. This implies that, according to the perception of the employees in the surveyed construction units, these two factors are viewed as the most effective and influential Industrial Safety Management Practices in supporting a successful NMRS at construction sites.

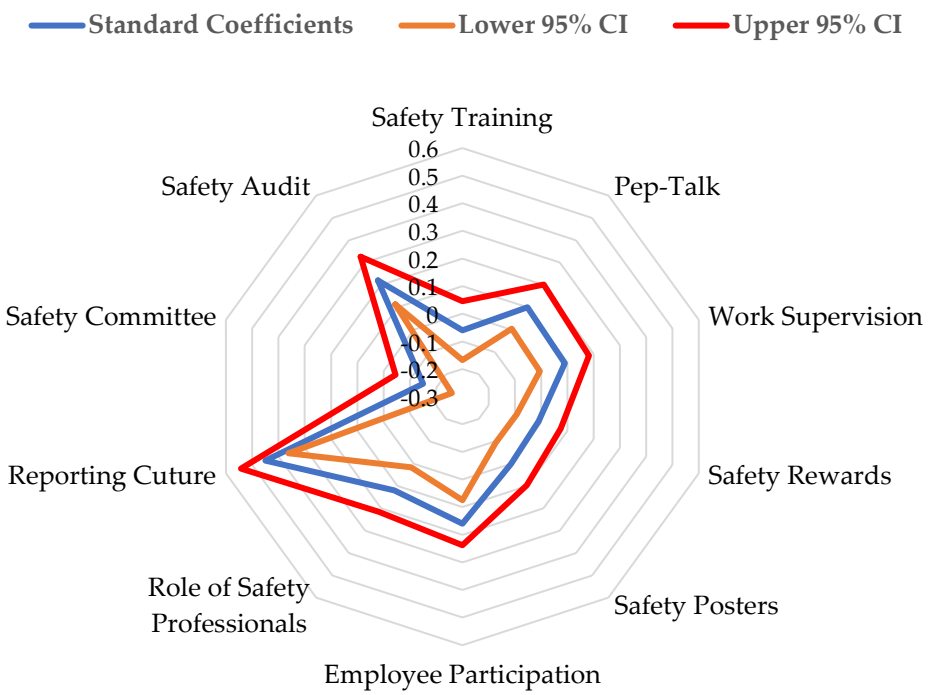

Figure 3 (a): Cobweb (Radar) Chart- Regression Analysis Between NMRS Effectiveness and Other Industrial Safety Management Practices

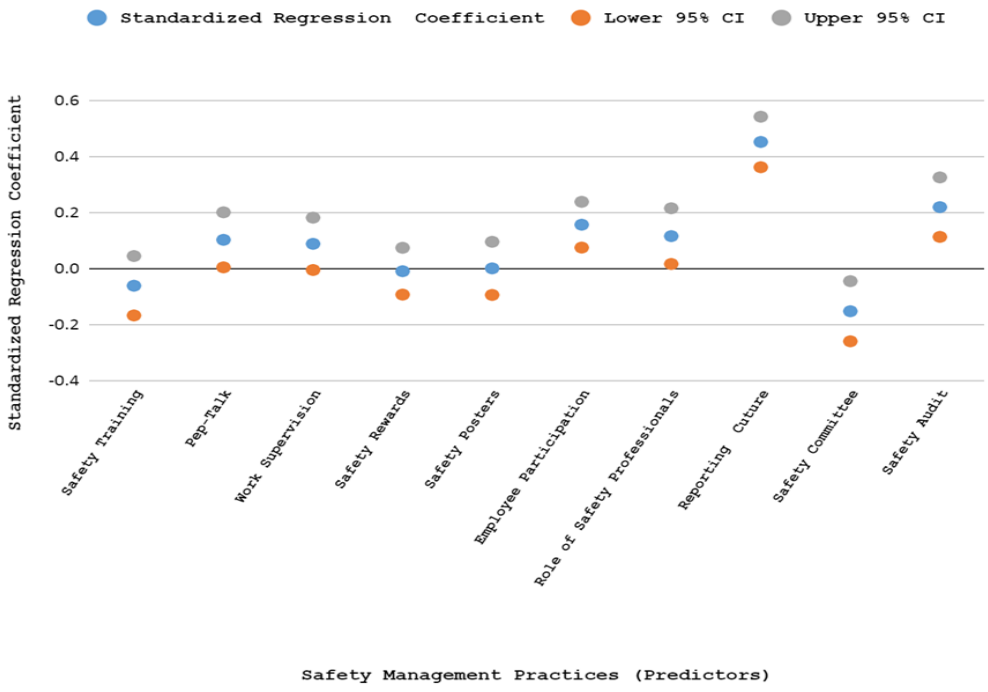

Figure 3 (b): Coefficient Plot - Regression Analysis Between NMRS Effectiveness and Other Industrial Safety Management Practices

These relationships are shown in greater statistical detail in **Figure 3(b)**, a **Coefficient Plot** of the results of the multiple linear regression. This analysis identified important predictors influencing the effectiveness of NMRS at construction sites. In line with the visual pattern as demonstrated in Figure 3(a), a coefficient plot as depicted in Figure 3 (b) visualized that amongst all the variables, **reporting culture** exhibited the strongest positive association with NMRS effectiveness ($\beta = 0.45$, $p < 0.001$), indicating that fostering an open and proactive reporting environment significantly enhances NMRS functionality.

Additionally, regression analysis, as shown in Figure 3 (b), also revealed that Safety audits (β = 0.22, $p < 0.001$) and employee participation (β = 0.16, $p < 0.001$) also demonstrated substantial positive impacts, highlighting the importance of formal safety evaluations and inclusive engagement in safety processes.[31] Moderate yet significant contributions were made by the involvement of safety professionals (β = 0.12, $p < 0.01$), pep talks (β = 0.10, $p < 0.01$), and work supervision (β = 0.09, $p < 0.05$), suggesting that continuous motivation, expert input, and supervisory oversight further reinforce NMRS. These findings underscore the multifactorial nature of NMRS success and the need for a holistic safety management approach.[21]

Trends in Near-Miss and Accident Data (2019–2023)

An analysis of unit-level data from 2019 to 2023 reveals a sustained upward trend in near-miss reporting, consistently accompanied by a gradual decline in recorded workplace accidents (Table 2). The total number of reported near-misses across the three units increased significantly from 96 in 2019 to 189 in 2023, while the total number of accidents decreased from 3 to 1 over the same five-year period.

Table 2: Trends in Near-Miss and Accident Reports (2019–2023)

Year	Unit-A (NMA/Accident)	Unit-B (NMA/Accident)	Unit-C (NMA/Accident
2019	36 /1	32/1	28/1
2020	59/0	40/0	30/2
2021	75/0	47/1	38/1
2022	79/0	57/0	45/1
2023	85/0	48/1	56/0

Unit-wise Observations:

Unit A demonstrated the most significant improvement, with near-miss reports rising sharply from 36 in 2019 to 85 in 2023. Simultaneously, reported accidents declined from 1 to 0, indicating effective hazard identification and potential mitigation of risks, as shown in Figure 4.

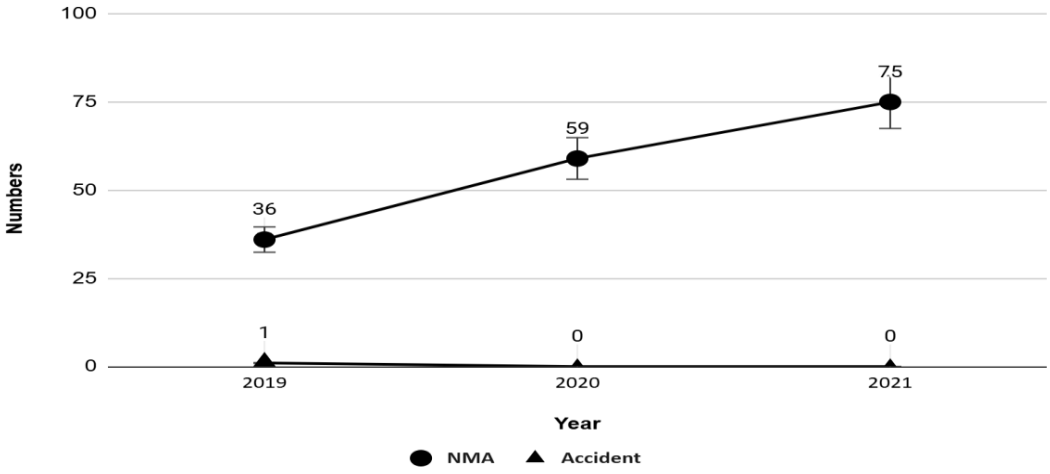

Figure 4: Year-wise Data of Near Misses and Accidents for Unit-A

Unit B had a comparatively stable trend in the number of near misses reported, with a slight increase from 32 in 2019 to 48 in 2023. As shown in Figure 5, the number of accidents varied, indicating less consistent effectiveness of safety interventions.

Unit C also made positive progress, with the number of near-miss reports increasing steadily from 28 to 56 in 2023. Concurrently, the number of accidents dropped to 0 in 2023 after reaching 1 in 2019, with slight surges in 2020 and 2022, as reflected in Figure 6.

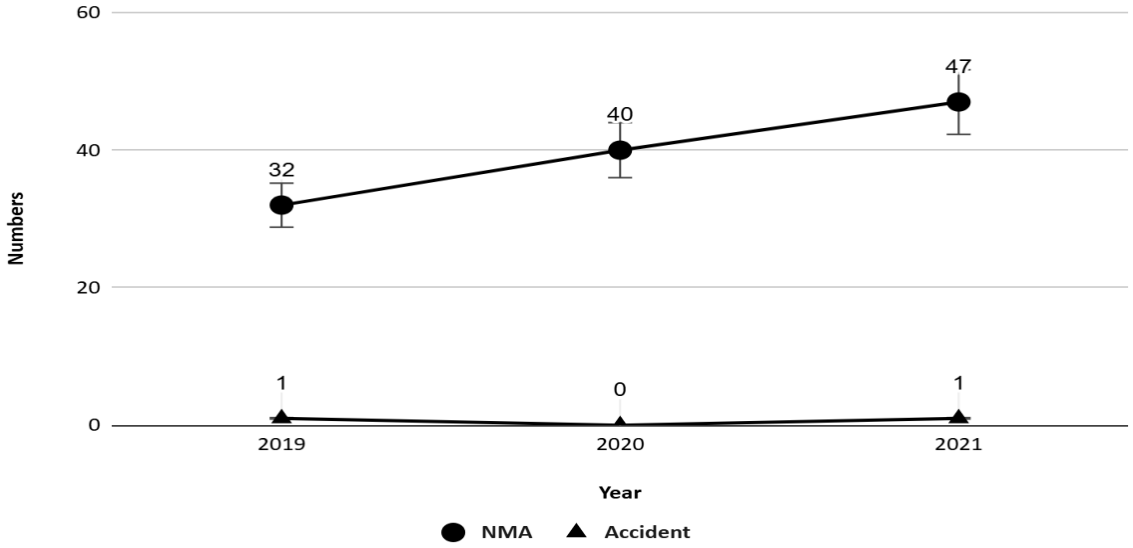

Figure 5: Year-wise Data of Near Misses and Accidents for Unit-B

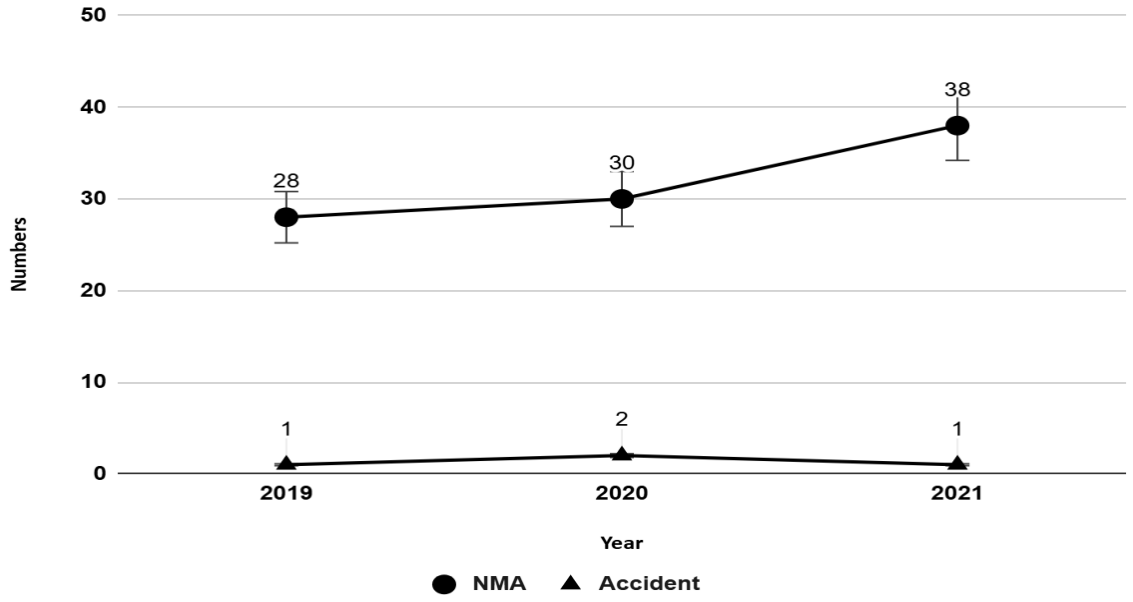

Figure 6: Year-wise Data of Near Misses and Accidents for Unit-C

These patterns align with literature on safety management, which emphasizes that proactive reporting of near-misses is a valuable practice. Such reporting systems, when paired with comprehensive investigation and corrective procedures, can help organizations identify early warning signs and prevent more severe accidents.[8,21] Prompting more near-miss reports can reduce injuries, thus identifying near-miss reports as an indicator of proactive safety improvement.[10,32]

Discussion

This paper examined the perceptions of employees of construction towards Near Miss Reporting Systems (NMRS) and their combination with other safety management and performance measures to offer an insightful understanding into proactive industrial safety. The research results indicate a

high level of positive perception among employees regarding the effectiveness of NMRS as a safety management tool.[31] There was a very strong correlation between the scales of perceived NMRS effectiveness and many important safety outcomes such as accident prevention, personal safety awareness, sense of safety, and overall job satisfaction. In addition, NMRS effectiveness exhibited strong correlations with the development of an open safety culture, safety audits, participation by safety professionals, and employee involvement in safety issues.[31] The reporting culture, safety audits and the participation of employees were also revealed as key drivers of the effectiveness of NMRS through regression analysis. Most importantly, a prospective and historical analysis of five years of selected unit data reflected an inverse relationship between the frequency of near-miss reporting and accident rates, confirming the validity of such perception-based results in practice.[33]

The high mean perception score of 4.15, with NMRS effectiveness provided by the study, demonstrates that construction workers perceive the systems as beneficial learning stages and means of intervention. This finding is consistent with available literature, which places near-miss reporting as a dominant leading indicator in monitoring safety performance and a precursor to proactive safety and injury prevention.[3,4,10,15,20,34] The most significant relationship was between NMRS and accident prevention (r=0.349), making it evident that NMRS is a precursor of hazards and preventive measures that inherently lower the number of accidents, as demonstrated by studies that highly effective near-miss management decreases accidents.[35] The strong correlation with safety awareness (r=0.287) also speaks in favour of NMRS, its importance in modelling a safety-oriented culture and compliance.[6,15] Although NMRS was found to be positively correlated with a high sense of safety among workers (r=0.175), it had a lower impact in association with job satisfaction (r=0.103), which implies that even though NMRS instigates strong safety frameworks with its direct effects, its indirect effects on satisfaction should be addressed on a larger scale in terms of organizational strategy.[2,20,36]

Significant positive relationships between the perceived NMRS effectiveness and other safety management practices, especially open safety culture (r=0.56), safety audit (r=0.42), the role and place of safety professional (r=0.38) and the employee participation on safety matters (r=0.36) underline the imperative role of the cultural and procedural parameters.[31] Its close connection to open safety culture highlights transparency and proactiveness as the key aspects of effective NMRS,[35] which requires non-punitive policies and, possibly, incentive schemes, as well as corresponding training and expandable models of technological implementation.[16,17,19] The recognition of the major role of safety auditing and professionals corresponds with the supporters of premeditated examinations and professional involvement.[29,37] On the other hand, correlations with more generalized practices, such as safety rewards (r=0.268) or posters (r=0.212), indicate their weaker direct effect on the studied parameter in contrast to the embedded cultural-procedural factors, which is consistent with the understanding that accountability and motivation present a more effective intrinsic scaling.[27,36] These findings confirm the theory of safety climate raised by Zohar,[23] in which their organization culture moulds the employee attitude. The level of worker engagement positively influences quality and quantity of near-miss reports,[9,30] and it is worth noting that open and non-punitive culture adds additional value.[15,16] The nature of the organizational policies affects reporting trends in the context of complex construction settings; therefore, specific safety measures are necessary to adjust to the system dynamics.[26,38] In addition, high correlations with safety training, pep talks/toolbox talks, safety committees, work supervision, rewards/incentives, and visual aids make it clear that NMRS success is embedded within a multidimensional safety management environment.[27] Investigating near miss reports can be used to set priorities and align feedback mechanisms to improve safety,[34] whereas dissemination of lessons learned can create a proactive safety culture, enhancing accident prevention and performance.[26]

Practical Implications

This research provides important practical implications for the construction stakeholders. NMRS should be an integral part of a comprehensive safety management system and not treated in isolation.[38] It is important to develop an open reporting culture that is fair and based on transparent rewards and non-punitive feedback to enhance the frequency of reporting and build trust.[16,25] Near-miss identification and reporting should be expressly taught during training, particularly during training of new and contract workers.[19] Active engagement of employees and strong safety leadership from supervisors and professionals must be continually used to encourage reporting as a form of vigilance and

overall good.[11,31,39] Finally, a culture of positive reinforcement and decisive action regarding near-miss reports will allow achieving an important transformation of reactive to proactive safety management.[13,14,32]

Conclusion

This paper provides a comprehensive overview of the perceived effectiveness of Near Miss Reporting Systems (NMRS) in enhancing safety on construction sites, as well as their relationship with other organizational safety practices and indicators. The results of a survey conducted among 475 construction workers in India consistently indicate that the NMRS can be perceived as a highly effective method in the accident prevention process, enhancing safety awareness, fostering a sense of safety, and positively influencing job satisfaction.

The statistical analysis revealed robust positive correlations between the perceived effectiveness of NMRS and critical safety management interventions, particularly open safety culture, safety audits, active safety professionals, and effective employee engagement. Although safety incentives and training are also associated with positive outcomes, the information here clarifies that NMRS success is firmly grounded in a more comprehensive, holistic safety management system. An open reporting culture largely depends on the psychology of safety and trust, which in turn is facilitated by leadership that encourages non-punitive reporting and aligns safety strategies with systemic dynamics. The promotion of worker participation brings a dramatic improvement in the quantity and quality of reports.

Most importantly, a five-year historical data analysis revealed that the frequency of near-miss reporting had an inverse proportional relationship with actual accident rates, confirming that proactive reporting brings direct benefits to safety. The findings are relevant to the theory and practice of safety because they enlighten on the essential counterbalance that must exist between the perceptions of workers, the organizational behaviour and the effectiveness of NMRS in high-risk construction. NMRS can also serve as a priceless tool in active safety management, helping to avoid an accident and develop a culture of prevention. Its effects on more downstream outcomes such as job satisfaction, however, seem more indirect, only becoming manifest with the integration of the strategy in broader strategies. Effective safety audits (r=0.428) and active safety professionals (r=0.381) turned out to be the greatest facilitators and extrinsic motivators such as posters (r=0.212) and incentives (r=0.268) were less correlated indicating that NMRS engagement seems to be more strongly reinforced by culture and procedure. Nevertheless, within its limitations, this study conclusively demonstrates that NMRS is a revolutionary tool that can easily be used in enhancing construction safety. The subject of future research should be a scalable and adaptive NMRS model that incorporates advanced analytics.

Limitations and Future Research

The research offers valuable insights, although its cross-sectional nature does not permit the establishment of causal links. Perception data may be subject to self-report bias, and the sample is not extensive in its applicability (18 units, Northern India); thus, the findings may not be generalizable. Future studies should conduct longitudinal research to collect data on changes over time, conduct intervention-based research, and consider the integration of digitalization/technology in reporting. Additionally, a qualitative approach may provide further insight into the motivation of workers to report and their perceptions.

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Original Article

Prevalence and associated factors of musculoskeletal disorders among aquaculture workers in Vietnam: A cross-sectional study

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ABSTRACT

Introduction: Aquaculture work is a physically demanding occupation with numerous risk factors for musculoskeletal disorders (MSDs), including exposure to cold water, heavy lifting, and repetitive tasks. This study aimed to determine the prevalence and associated factors of MSDs among aquaculture workers in Vietnam.

Methods: A cross-sectional descriptive study was conducted involving 768 aquaculture workers aged 20 to 65 years. Participants were interviewed and clinically examined to assess their MSD status. The Nordic Musculoskeletal Questionnaire (NMQ) was utilized to assess symptoms of MSDs.

Results: The prevalence of MSDs within the past seven days among aquaculture workers was 472/768 (61.5%), (95%confidence interval [CI]: 58.1%–64.9%). The most commonly affected body regions were the lower back 206 (43.6%), knee joints 166 (35.2%), and wrists/hands 149 (31.6%). Identified associated factors for MSDs included female gender (adjusted odds ratio [AOR] = 2.21, 95%CI: 1.64–2.97), work experience of 10 to 19 years (AOR = 1.43, 95%CI: 1.01–2.05) and over 20 years (AOR = 2.17, 95%CI: 1.45–3.19) compared to less than 10 years, being overweight or obese (AOR =1.89, 95%CI: 1.26–2.79), working underwater (AOR =3.01, 95%CI: 2.17–4.16), frequently lifting heavy loads (AOR = 2.92, 95%CI: 2.07–4.03), and regularly feeding seafood (AOR =2.48, 95%CI: 1.83–3.33).

Conclusion: MSDs are common health problems among aquaculture workers. To alleviate the burden of MSDs among aquaculture workers, its prevention should be integrated into occupational health policies, and evidence-based ergonomic interventions and improvements in working conditions must be implemented. Particular attention should be given to high-risk groups, including female workers, those with prolonged work hours, overweight individuals, and those performing physically demanding tasks.

Keywords: aquaculture workers, associated factors, musculoskeletal disorders (MSDs), Vietnam.

Introduction

Musculoskeletal disorders (MSDs) are defined as diseases or injuries affecting the joints, bones, muscles, nerves, tendons, ligaments, soft tissues, cartilage, and spinal discs.[1] They are among the most common occupational health problems and have a significant impact on physical and mental health, quality of life, and work productivity.[1,2] According to the World Health Organization (WHO), MSDs are the leading cause of reduced or lost work capacity worldwide, particularly in occupations that involve intensive manual labor, such as agriculture, fishing, and aquaculture.[3]

The prevalence of MSDs varies across occupations and study populations. A systematic review by Akbar KA et al. found high rates of MSDs among farmers in Southeast Asia, reporting prevalence figures of 78.3% in Thailand, 81.27% in Indonesia, and 88.39% in Malaysia.[4] Among Brazilian fishermen, the prevalence was 93.5%, with the lower back (86.4%), wrists/hands (73.5%), and upper back (66.8%) being the most commonly affected areas.[5] MSD prevalence among fish processing workers was reported at 71.0%,[6] while among shoemakers, it was 45.6%.[7]

The development of MSDs is influenced by multiple interrelated factors. Individual risk factors include age, sex, high body mass index (BMI), and low physical fitness.[8] Occupational exposures such as repetitive tasks, forceful exertions, awkward postures, prolonged standing, and manual handling are strongly associated with MSDs.[9] Environmental conditions, including cold temperatures, vibration, and unstable surfaces, further increase the risk.[10,11]

The aquaculture industry encompasses fishing, farming, and processing of aquatic products. Labor in this sector is physically demanding, highly specialized, and often repetitive. Workers are frequently exposed to cold and humid conditions in the outdoors environment and perform tasks such as net pulling, feed carrying, harvesting, and pond renovation.[12,13] These factors are well-established contributors to various occupational diseases, particularly MSDs.[14–16]

Although MSDs are a prevalent and significant occupational health concern among aquaculture workers, research on their epidemiology and associated risk factors remains limited, especially in developing countries.[17] In Vietnam, no official data are currently available on MSDs in this workforce. Therefore, it is essential to determine the prevalence and associated risk factors of MSDs among aquaculture workers. Generating such evidence will help inform appropriate intervention strategies to protect workers' health and improve working conditions.

Methods

This was a cross-sectional descriptive epidemiological study.

A total of 768 aquaculture workers aged 20–65 years, employed in lagoons, sea cages, and coastal areas in Hai Phong, Vietnam, were recruited for the study between February and October 2023.

Participants were eligible for inclusion if they had at least two years of experience in aquaculture work and provided informed consent to participate in the study.

The sample size was calculated using the following formula for estimating the sample size for a proportion:

$$n = Z^2_{1-\frac{\propto}{2}} \frac{p(1-p)}{(d)^2}$$

In this formula, Z represents the confidence level (CI) of 95% (Z = 1.96), and p is the estimated prevalence of MSDs from a previous study. Due to the lack of data on the prevalence of MSDs among aquaculture workers in Vietnam, we chose p = 0.5, and d = 0.05 as the margin of error. The minimum sample size (n) was calculated to be 384 participants. To enhance the reliability and precision of the study, the sample size was doubled to 768. This adjustment accounts for potential issues such as non-response and incomplete data, allowing for more robust subgroup and multivariable analyses. Increasing the sample size in this manner is a widely accepted practice in public health and occupational epidemiology to ensure that findings are generalizable and statistically valid, particularly in populations with potential heterogeneity in exposure and outcome.[18]

A simple random sampling method was employed. A complete list of households with aquaculture workers in Hai Phong was prepared, and 768 households were randomly selected using a random number table. One aquaculture worker from each selected household was invited to participate. If a household was absent or declined to participate (97 households), it was replaced by another randomly selected household from the remaining list to maintain the planned sample size. Consequently, a total of 768 aquaculture workers were successfully enrolled in the study.

Participants underwent a clinical examination to assess MSD conditions. Height and weight were measured, and BMI was calculated. A structured face-to-face interview was conducted to collect information on the following variables:

Demographic characteristics: Gender, age, work experience, and education level.

Work-associated factors: Working underwater (yes/no), carrying heavy loads (yes/no), and regular seafood feeding duties (yes/no).

Musculoskeletal symptoms: Classification of patients as symptomatic or asymptomatic (for each region) based on self-reported pain, discomfort, or limited mobility in the past seven days in any of the

nine anatomical regions: neck, shoulders, upper back, elbows, lower back, wrists/hands, hips/thighs, knees, and ankles/feet.

Diagnosis of musculoskeletal disorders: MSDs were assessed using the Nordic Musculoskeletal Questionnaire (NMQ), a standardized instrument developed by Kuorinka et al. in 1987. The questionnaire demonstrates high internal consistency, with a Cronbach's alpha > 0.945, and excellent inter-rater reliability, with a Cohen's Kappa ranging from 0.88 to 1.00.[19] The NMQ has been validated and widely used in Vietnam.[20] The instrument consists of 40 forced-choice questions targeting musculoskeletal symptoms in various anatomical regions, supported by a body map illustrating nine specific areas: neck, shoulders, upper back, elbows, lower back, wrists/hands, hips/thighs, knees, and ankles/feet. Respondents were asked whether they had experienced musculoskeletal symptoms in the past seven days and whether these symptoms interfered with their normal daily activities. MSDs were defined as pain, discomfort, or limited movement in at least one of the nine anatomical locations.

The assessment of overweight and obesity was based on BMI, calculated using the formula weight (kg)/height (m^2) according to WHO standards for Asian adults.[21] Underweight is defined as BMI < 18.5 kg/m^2, normal weight as BMI 18.50–22.9 kg/m^2, overweight as BMI 23.00–24.9 kg/m^2, and obesity as BMI ≥ 25 kg/m^2.

The study data were analyzed using biomedical statistical methods with SPSS for Windows, version 22.0 (SPSS Inc., Chicago, IL, USA). Categorical variables were represented by frequency and percentage (%), while continuous variables were expressed as mean and standard deviation (SD). Multivariable logistic regression analysis was employed to calculate odds ratios (ORs) along with 95% CIs to assess the relationship between risk factors and MSDs among aquaculture workers. Statistical significance was determined at $p < 0.05$. Risk factors were identified through multivariable logistic regression analysis, utilizing binary dependent variables representing MSDs. The model included potential risk factors such as gender, working experience, education level, BMI, working underwater (yes/no), heavy lifting (yes/no), and frequent seafood feeding (yes/no).

This study was approved by the Ethics Committee in Biomedical Research of the Maritime Medical Institute under Decision No. 08/2024/QĐ-YHB, dated February 5, 2024. Participation in the study was entirely voluntary for all seafarers, and written informed consent was obtained prior to enrollment.

Results

In a study involving 768 aquaculture workers in Hai Phong, Vietnam, focusing on MSDs and associated factors, we obtained the following results:

Table 1: General characteristics of the study participants (n=768)

Variable		No. (%)
Gender	Male	339 (44.1)
	Female	429 (55.9)
Age (years)	mean (SD); min - max	41.7 ± 11.8; 20 - 65
	<30	142 (18.5)
	30-39	189 (24.6)
	40-49	228 (29.7)
	50-59	145 (18.9)
	≥60	64 (8.3)
Work experience (years)	mean (SD); min - max	16.2 ± 8.8; 2 - 41
	<10	206 (26.8)
	10-19	311 (40.5)
	20-29	165 (21.5)
	≥30	86 (11.2)
Education level	Illiteracy	4 (0.5)
	Elementary	121 (15.8)
	Secondary school	425 (55.3)
	High school	201 (26.2)
	College	17 (2.2)

Note: SD = standard deviation; No. = number

Study results (Table 1) indicated that most aquaculture workers were female 429 (55.9%), while males accounted for 339 (44.1%). The participants' ages ranged from 20 to 65 years, with a mean age of 41.7 ± 11.8 years. Age distribution was as follows: under 30 years 142 (18.5%), 30–39 years 189 (24.6%), 40–49 years 228 (29.7%), 50–59 years 145 (18.9%), and 60 years or older 64 (8.3%). The mean working experience was 16.2 ± 8.8 years, ranging from 2–41 years. Workers with less than 10 years of experience accounted for 206 (26.8%), those with 10–19 years for 311 (40.5%), 20–29 years for 165 (21.5%), and 30 years or more for 86 (11.2%). Participants' educational level was generally low, with most having completed secondary school 425 (55.3%), followed by high school 201 (26.2%), elementary school 121 (15.8%), and college 17 (2.2%). Only four participants (0.5%) were illiterate. The results (Figure 1) further revealed that the prevalence of MSDs among aquaculture workers was 472/768 (61.5%); (95% CI: 58.1%–64.9%).

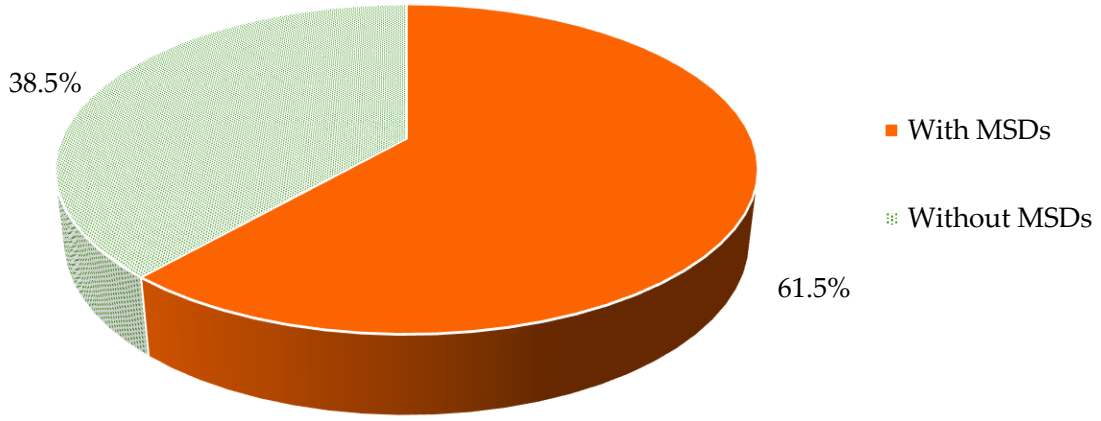

Figure 1: Prevalence of musculoskeletal disorders in study participants (n=768)

Table 2: Distribution of musculoskeletal disorders in the study participants by anatomical location (n = 472)

Location	No. (%)
Neck	140 (29.7)
Shoulder	93 (19.7)
Upper back	138 (29.2)
Elbow	129 (27.3)
Wrist/hand	149 (31.6)
Lower back	206 (43.6)
Hips/thighs	71 (15.0)
Knees	166 (35.2)
Ankles/feet	101 (21.4)

Regarding the distribution of MSDs by anatomical location, results (Table 2) showed that these disorders were most common in the lower back region 206 (43.6%), followed by the knees 166 (35.2%), wrists/hands 149 (31.6%), neck 140 (29.7%), upper back 138 (29.2%), elbows 129 (27.3%), ankles/feet 101 (21.4%), shoulders 93 (19.7%), and hips/thighs 71 (15.0%).

Table 3: Multivariable analysis of factors associated with musculoskeletal disorders in aquaculture workers

Variable	n	With MSDs n (%)	Without MSDs n (%)	AOR (95%CI)	p-value
Gender					
Male (Ref)	339	167 (49.3)	172 (50.7)	1	
Female	429	305 (71.1)	124 (28.9)	2.21 (1.64-2.97)	<0.001
Working experience (years)					
<10 (Ref)	206	106 (51.5)	100 (48.5)	1	
10-19	311	189 (60.8)	122 (39.2)	1.43 (1.01-2.05)	0.047
≥ 20	251	177 (70.5)	74 (29.5)	2.17 (1.45-3.19)	0.001

Variable	n	With MSDs n (%)	Without MSDs n (%)	AOR (95%CI)	p-value
Education level					
High school, college (Ref)	218	127 (58.3)	91 (41.7)	1	
Secondary school	425	265 (62.4)	160 (37.6)	1.09 (0.78-1.53)	0.582
Elementary, illiterate	125	80 (64.0)	45 (36.0)	1.32 (0.83-2.08)	0.239
BMI (Body Mass Index):					
<23 (Ref)	610	356 (58.4)	254 (41.6)	1	
≥ 23	158	116 (73.4)	42 (26.6)	1.89 (1.26-2.79)	0.004
Working underwater					
No (Ref)	477	245 (51.4)	232 (48.6)	1	
Yes	291	227 (78.0)	64 (22.0)	3.01 (2.17–4.16)	<0.001
Carrying heavy loads					
No (Ref)	498	263 (52.8)	235 (47.2)	1	
Yes	270	209 (77.4)	61 (22.6)	(2.07-4.03)	<0.001
Feed seafood regularly					
No (Ref)	317	150 (47.3)	167 (52.7)	1	
Yes	451	322 (71.4)	129 (28.6)	2.48 (1.83-3.33)	<0.001

Note: AOR = Adjusted odds ratio, CI: Confidence Interval, Ref: Reference

Multivariable logistic regression analysis of factors associated with MSDs among aquaculture workers identified several factors (Table 3), including female gender (AOR = 2.21, 95%CI: 1.64–2.97, p < 0.01) and working experience of 10–19 years (AOR = 1.43, 95%CI: 1.01–2.05, p = 0.047) and 20 years or more (AOR = 2.17, 95%CI: 1.45–3.19, p = 0.01) compared to workers with less than 10 years of experience. Being overweight and obese (AOR =1.89, 95%CI: 1.26–2.79, p = 0.04), working underwater (AOR = 3.01, 95%CI: 2.17–4.16, p < 0.01), regularly carrying heavy loads (AOR = 2.92, 95%CI: 2.07–4.03, p < 0.01), and regularly feeding seafood (AOR = 2.48, 95%CI: 1.83–3.33, p < 0.01) were also significant.

Discussion

The study revealed that the prevalence of MSDs among aquaculture workers in Vietnam was 61.5%, highlighting the significant impact of these health issues on the workforce. The most commonly affected anatomical regions were the lower back (43.6%), followed by the knees (35.2%), wrists/hands (31.6%), neck (29.7%), upper back (29.2%), elbows (27.3%), ankles/feet (21.4%), shoulders (19.7%), and hips/thighs (15.0%). The prevalence of MSDs in our study was higher compared to some other occupational groups. For instance, MSDs were reported in 37.9% of office workers,[22] 62.56% of teachers,[23] and 45.6% of shoemakers.[7] Several factors may explain this higher prevalence among aquaculture workers. Research has shown that aquaculture work is physically demanding, with workers often exposed to cold water, high humidity, and strenuous outdoor labor. Additionally, tasks such as carrying heavy loads, feeding seafood, renovating ponds, working long hours, and performing repetitive movements contribute to the physical strain.[13]

A meta-analysis by Ngajilo D et al. found that MSDs are the most prevalent occupational health issue among aquaculture workers, with reported rates ranging from 21.0% to 63.0%. This was followed by respiratory symptoms and bronchial asthma (4.0%–65.0%), skin infections (2.2%–15.7%), and contact dermatitis (6.0%).[17] Similarly, a study by Yalamanchi V et al. on aquaculture workers in Visakhapatnam, India, found MSDs to be the most common health issue (56.3%), followed by neurological problems (48.1%), injuries (43.0%), and skin infections (23.0%).[24] These findings support the conclusion that the physical demands of aquaculture work are closely linked to a variety of health problems, particularly MSDs.

MSDs among aquaculture workers in our study were most prevalent in the lower back (43.6%) and knees (35.2%), reflecting the physical demands of aquaculture work. Workers frequently perform tasks such as lifting heavy loads, bending over to pull nets, and feeding or transporting fish and shrimp.[25] These activities place significant strain on the lumbar spine and knees, especially when combined with risk factors like poor posture and prolonged working hours. Additionally, the prevalence of MSDs in the wrists and hands was notably high (31.6%). This may be attributed to repetitive tasks such as netting, scooping fish, and manually feeding seafood—activities associated with conditions like tendinitis, carpal tunnel syndrome, and degeneration of the small joints in the hand.[26]

The prevalence of MSDs in our study was lower

than that reported in some studies on fishing and seafood processing workers—industries known for their physically demanding labor, prolonged standing, and repetitive tasks. For example, among fishing workers, MSD prevalence was particularly high, with the lower back (92.4%), shoulders (64.8%), knees (31%), and hands (25%) being the most commonly affected regions.[27] Likewise, a study by Nag A et al. reported a 71% prevalence of MSDs among seafood processing workers, with the upper back (54%), lower back (33%), knees (35%), and shoulders (27%) being the most affected areas.[6]

Multivariate logistic regression analysis of factors associated with MSDs in aquaculture workers (Table 3) showed that women were at a higher risk of developing MSDs compared to men. This finding is consistent with results from several other studies.[22,28] In the aquaculture industry, women often perform highly repetitive tasks—feeding, harvesting, and processing seafood—that can contribute to conditions such as tendinitis and carpal tunnel syndrome.[6] Furthermore, hormonal changes also play a role. After menopause, the decline in estrogen levels has been linked to an increased risk of joint pain and osteoarthritis, particularly in the knees and lower back.[29]

Workers with 10–19 years of experience and those with 20 or more years had 1.43 and 2.17 times higher risks of developing MSDs, respectively, compared to workers with less than 10 years of experience. A study by Okezue OC et al. also identified significant factors associated with MSDs, including female gender ($p = 0.004$), long working hours ($p = 0.003$), and work experience ($p = 0.014$).[30] Similar findings have been reported in several other studies.[4,22] As work experience increases, prolonged exposure to mechanical and environmental stressors may elevate the risk of developing MSDs.[31]

The results (Table 3) also indicated that overweight and obesity were associated with an increased risk of MSDs ($p = 0.04$). This finding aligns with previous studies,[22,32] which have shown that excess body weight not only affects cardiovascular health but also impairs musculoskeletal function. Carrying extra weight places additional stress on weight-bearing joints, particularly the knees and hips, which can lead to diminished synovial fluid quality and increased joint pain.

Aquaculture workers who regularly worked underwater had a significantly higher risk of MSDs (OR = 3.01, $p < 0.01$). Previous studies suggest that underwater work often involves exposure to low temperatures, which can lead to muscle spasms, reduced blood circulation, and an increased risk of musculoskeletal injuries.[33] Moreover, working underwater typically requires repetitive movements, awkward postures, and carrying heavy loads in a high-resistance water environment—factors that contribute to conditions such as tendinitis, back pain, and knee osteoarthritis.[34] Similarly, workers who regularly fed seafood also faced a significantly elevated risk of MSDs (OR = 2.48, $p < 0.01$). This may be due to physically demanding tasks such as carrying feed, maintaining repetitive postures, and prolonged exposure to wet and cold environments, all of which can place considerable strain on the musculoskeletal system.[33,35]

Strengths and limitations of the study: This study has several strengths, including a large sample size and the use of a random sampling method, both of which enhance the generalizability of the findings. Further, it provides the first epidemiological evidence on MSDs among aquaculture workers in Vietnam, thus contributing valuable data to an under-researched population. However, some limitations should be noted. For instance, the cross-sectional design restricts the ability to draw causal inferences between exposures and outcomes. Additionally, the reliance on self-reported data may introduce recall bias and reporting bias, potentially affecting the accuracy of the findings.

Conclusions

MSDs are common occupational health issues among aquaculture workers, with a prevalence of 61.5%. The most frequently affected body regions were the lower back, knees, and wrists/hands. Several factors were associated with a higher risk of MSDs, including being female, having longer work experience, being overweight or obese, working underwater, heavy lifting, and frequently feeding seafood. To mitigate these risks, it is essential to improve working conditions and strengthen occupational healthcare. Integrating MSD prevention strategies into occupational health programs—particularly targeting high-risk groups such as female and older workers—should be prioritized.

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Conflicts of interest

There are no conflicts of interest.

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Original Article

Prevalence and determinants of depression, anxiety, and stress among IT professionals working from home in Kerala, India

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ABSTRACT

Introduction: Working from Home (WFH) has become a defining aspect of the modern work landscape, especially in the wake of the COVID-19 pandemic. The Information Technology (IT) sector, seamlessly transitioned to WFH during the pandemic, thanks to both the urgent need and the technological infrastructure supporting this alternative work arrangement. The objectives of this study were to measure the prevalence and factors associated with anxiety, stress and depression among IT professionals working from home in two districts of Kerala.

Methods: Data was collected from 400 IT professionals working in four IT companies located in two districts in Kerala, through a simple random sampling method between December 2022 and March 2023. The study questionnaire consisted of two parts - the socio demographic and the Depression, Anxiety, Stress Scale (DASS) 21. Data was analyzed using IBM Statistical Package for Social Sciences V20. A p-value < 0.05 was considered statistically significant.

Results: Among the study participants, 48.5% were female, majority were between 22 and 45 years and 80.25% were undergraduates. The prevalence of depression among IT professionals WFH was found to be 22.75%; 0.75% had severe and 1.5% had extremely severe depression. The prevalence of anxiety was 24%; 1.75% had severe and 2.5% had extremely severe anxiety. The prevalence of stress was 11%; 1.5% had severe and 0.25% had extremely severe stress. There was a significant association between depression, anxiety and stress with employees in the low-income range, those working on night shift and those without a weekly day-off.

Conclusion: This first study on Kerala IT professionals working from home highlights that lower income, night shifts, lack of weekly offs, substance abuse, physical inactivity, and long working hours are significantly linked to poor mental health. It underscores the need for organizational interventions to promote work-life balance, healthy lifestyles, adequate rest, and accessible mental health support to safeguard both employee well-being and productivity.

Keywords: Anxiety, depression, IT professional, stress, work from home

Introduction

The rapid growth of the Information Technology (IT) sector has transformed the way people work globally, with arrangements such as working from home (WFH) becoming increasingly common in recent years.[1,2] In India, especially in the state of Kerala, better internet access, digital tools, and flexible company policies have made it possible for employees to do their job effectively without constantly being in the office.[3] WFH has its

benefits – no daily commute, greater control over one's schedule, and the comfort of home.[4]

But it also has its own set of problems, especially mental health. Longer working hours, workload overload, and fewer opportunities to socialise with co-workers could be caused by the boundary between work and personal life becoming less defined.[5] These factors can lead to feelings of loneliness, inability to maintain work-life balance, and higher susceptibility to mental illness such as depression, anxiety, and stress.[6] Additionally, irregular timing, night shifts, and the absence of regular week breaks can also add to psychological distress.[2,5]

It is essential to know the effects of mental health outcomes of active WFH in the IT sector as the health of workers is essential in maintaining productivity and employee satisfaction. This research aims to assess the prevalence and factors associated with depression, anxiety, and stress among IT professionals who work from home in selected districts of Kerala.

Methods

The study was conducted among IT professionals aged 20 to 54 years and actively engaged in WFH. The study area included Kerala's dynamic IT landscape, encompassing four IT companies that agreed to part in the study. Among the four IT companies, two were based in Ernakulam and two in Calicut, providing diverse geographical representation.

The sample size was calculated based on the formula:

$$n = \frac{Z\,\alpha/2pq}{d^2}$$

Assuming the maximum variability, which is equal to 50% (P = 0.5), and taking a 95% confidence level with ±5% precision, the required sample size was calculated using the following details: p = 0.5 and hence q = 1 - 0.5 = 0.5; e = 0.05 and z = 1.96. The calculated sample size was 385 and was rounded off to 400. Based on our previous experience, we assumed that the non-response rate of 25%, 500 employees were contacted to participate in the study. This was a cross-sectional study; the names of all the employees involved in WFH were obtained from the human resources (HR) department for all four companies, and 125 employees were chosen in each company using a computer-generated simple random sampling technique. A total of 500 employees were selected as study participants. Data was collected through a structured questionnaire, the first part included the socio-demographic details, including the working hours, days, and personal habits, including exercise for 30 minutes or more apart from work at the office, and the second part included the Depression, Anxiety, and Stress Scale – 21 (DASS-21) questionnaires. The DASS-21 is designed to measure three negative emotional states i.e., depression, anxiety and stress. It contains 21 items under three subscales, which assess symptoms of depression (dysphoria, hopelessness, devaluation of life, self–deprecation, lack of interest/ involvement, anhedonia, and inertia), anxiety (autonomic arousal, skeletal muscle effects, situational anxiety, and subjective experience of anxious affect) and stress (difficulty relaxing, nervous arousal and being easily upset/ agitated, irritable/over-reactive, and impatient) indicate whether any of these issues are having a significant effect on the person's life at present. The degree to which respondents endorsed the symptoms over the course of the last week is rated on a scale that ranges from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time). Before interpreting the scores, the summed numbers in each sub-scale need to be multiplied by 2.

Those participants who had not signed the consent form or answered all the questions were excluded.

Recommended cut-off scores for conventional severity labels (normal, moderate, severe) are as follows:

Severity Level	Depression	Anxiety	Stress
Normal	0-9	0-7	0-14
Mild	10-13	8-9	15-18
Moderate	14-20	10-14	19-25
Severe	21-27	15-19	26-33
Extremely severe	28+	20+	34+

Ethical clearance was obtained from the Institutional Ethics Committee (no. 187/2023). The statistical analysis was performed using Microsoft Excel and IBM Statistical Package for Social Sciences V20.0. The categorical data were presented in the form of frequency tables along with percentages, and the association between the socio-demographic factors, depression, anxiety, and stress was computed along with a 95% confidence interval. Pearson's chi-square test was applied, and results were considered statistically significant wherever $p < 0.05$.

Results

In the present study, among 400 IT professionals, 205 (51.25%) were male and 195 (48.5%) were female. A majority, 380 (95%), were aged between 20 and 45 years, and 321 (80.25%) had undergraduate qualifications. The income of 172 (42.5%) participants was in the range of thirty thousand to sixty thousand, 209 (52.25%) between sixty thousand to one lakh, and 21 (5.25%) received more than 1 lakh per month. Among the study participants, 276 (69%) were married and 141 (35.25%) had at least one child. Consumption of tobacco and alcohol was positive among 33 (8.25%) and 76 (19%), respectively. Regarding exercise for more than 30 minutes a day, at least 5 days a week, 195 (48.75%) respondents followed this practice.

With respect to working hours, 154 (38.5%) IT professionals worked 8 hours per day, 180 (45%) people worked 10 hours and 66 (16.5%) worked more than 10 hours; 209 (52.25%) worked between 8 pm and 8 am and 388 (97%) IT Professionals had a day off weekly.

Based on self-reported medical history, among the 400 IT professionals, 9 (2.25%) had hypertension, 10 (2.5%) had diabetes, 47 (11.75%) had high BMI, 18 (4.5%) had high cholesterol, and 5 (1.25%) had problems related to thyroid and skin. Among women employees, 36 (9%) had irregular menstrual cycles and 18 (4.5%) had gynaecological issues.

The prevalence of depression among the study population was 90(22.75%); 28 (7%) had mild, 54 (13.5%) had moderate, 3 (0.75%) had severe, and 6 (1.5%) had extremely severe depression.

The prevalence of anxiety among the study population was 96 (24%); mild anxiety among 16 (4%), moderate among 63 (15.75%), severe in 7 (1.75%), and extremely severe in 10 (2.5%).

The prevalence of stress among the study population was found to be 44 (11%). Among them, 24 (6%) had mild, 13 (3.25%) had moderate, 6 (1.5%) had severe, and 1 (0.25%) had extremely severe stress.

Table 1: Association of sociodemographic variables with depression

Factors	**Respondent with depression**	**Respondents without depression**	**Total**	**P value**
Gender				
Male	45 (21.95%)	160 (78.05%)	205	0.08
Female	45 (23.08%)	150 (76.92%)	195	
Education status				
Undergraduate	74 (23.05%)	247 (76.95%)	321	0.88
Postgraduate	17 (21.52%)	62 (78.48%)	79	
Monthly income				
30000 to 60000	28 (16.47%)	142 (83.53%)	170	**0.03***
60000 to 80000	40 (24.84%)	121 (75.16%)	161	
80000 to 100000	17 (34.69%)	32 (65.31%)	49	
>100000	6 (30%)	14 (70%)	20	
Working hours				
8 hrs	29 (18.83%)	125 (81.17%)	154	0.30

10 hrs	44 (24.44%)	136 (75.56%)	180	
More than 10 hrs	18 (27.27%)	48 (72.73%)	66	
Working between 8 pm and 8 am				
Yes	27 (13.64%)	171(86.36 %)	198	**0.00 ***
No	70 (34.65%)	132 (65.35%)	202	
Having a weekly day off				
Yes	85 (21.91%)	303 (78.09)	388	**0.02 ***
No	6 (50%)	6 (50%)	12	
Marital status				
Single	22 (17.74%)	102 (82.26%)	124	0.12
Married	69 (25%)	207 (75%)	276	
Tobacco consumption				
Yes	8 (24.24%	25 (75.76%)	33	0.82
No	83 (22.63%)	284 (77.37%)	367	
Alcohol consumption				
Yes	20 (26.32%)	56 (73.68%)	76	0.44
No	71(21.91 %)	253 (78.09%)	324	
Performing any exercise for more than 30 minutes apart from office work				
Yes	44 (22.56%)	151 (77.44%)	195	**0.03 ***
No	47 (22.93%)	158 (77.07%)	205	

Factors associated with depression, anxiety, and stress were analysed using the chi-square test.
*Statistically significant

According to the data in Table 1, there is no statistically significant association between depression and gender, educational status, or working hours. There was a significant association between employees in low-income households, those working night shifts, those without a weekly day off, and those who were not exercising. These findings suggest that those with low income, working on night shift, and having no weekly day off were the factors associated with depression among IT professionals working from home.

Table 2: Association of sociodemographic variables with anxiety

Factors	Respondent with Anxiety	Respondents without Anxiety	Total	P value
Gender				
Male	52 (25.37%)	153 (74.63%)	205	0.48
Female	43 (22.05%)	152 (77.95%)	195	
Education status				
Undergraduate	75 (23.36%)	246 (76.64%)	321	0.55
Postgraduate	21 (26.58%)	58 (73.42%)	79	
Monthly income				
30000 to 60000	24 (14.12%)	146 (85.88%)	170	**0.00 ***
60000 to 80000	44 (27.33%)	117 (72.67%)	161	
80000 to 1 lakh	21(42.86 %)	28 (57.14%)	49	
Above 1 lakh	7 (35%)	13 (65%)	20	
Working hours				
8 hrs	32 (20.78%)	122 (79.22%)	154	0.40
10 hrs	45 (25%)	135 (75%)	180	
More than 10 hrs	19 (28.79%)	47 (71.21%)	66	
Working between 8 pm and 8 am				
Yes	75 (35.89%)	134 (64.11%)	209	**0.00 ***
No	21 (10.99%)	170 (89.01%)	191	
Having a weekly day off				
Yes	90 (23.2%	298 (76.8%)	388	**0.04 ***
No	6 (50%)	6 (50%)	12	
Marital status				
Single	23 (18.55%)	101(81.45 %)	124	0.10
Married	73 (26.45%)	203 (73.55%)	276	
Tobacco consumption				
Yes	15 (45.45%)	18 (54.55%)	33	**0.00 ***
No	81 (22.07%)	286 (77.93%)	367	

Alcohol consumption				
Yes	26 (34.21%)	50 (65.79%)	76	**0.02***
No	70 (21.6%)	254 (78.4%)	324	
Performing any exercise for more than 30 minutes apart from office work				
Yes	41 (21.03%)	154 (78.97%)	195	0.10
No	55 (26.83%)	150 (73.17%)	205	

*Statistically significant

Factors associated with depression, anxiety, and stress were analysed using the chi-square test.

The prevalence of anxiety did not have a significant association with gender, educational status, and marital status. However, lower income, long working hours, working on night shifts, having no weekly day-off, consuming tobacco and alcohol had significant associations with anxiety. Significantly lower anxiety levels were seen among those with higher income levels, having a weekly day off, and among those not consuming tobacco or alcohol.

Table 3: Association of sociodemographic variables with stress

Factors	Respondent with Stress	Respondents without Stress	Total	P value
Gender				
Male	53 (25.85%)	152 (74.15%)	205	0.48
Female	44 (22.56%)	151 (77.44%)	195	
Education status				
Undergraduate	78 (24.3%)	243 (75.7%)	321	1.0
Postgraduate	19 (24.05%)	60 (75.95%)	79	
Monthly income				
30000 to 60000	28 (16.47%)	142 (83.53%)	170	**0.00***
60000 to 80000	52 (32.3%)	109 (67.7%)	161	
80000 to 1 lakh	13 (26.53%)	36 (73.47%)	49	
Above 1 lakh	4 (20%)	16 (80%)	20	
Working hours				
8 hrs	22 (33.33%)	44 (66.67%)	66	0.085
10 hrs	45 (25%)	135 (75%)	180	
More than 10 hrs	30 (19.48%)	124 (80.52%)	154	
Working between 8 pm and 8 am				
Yes	71 (33.97%)	138 (66.03%)	209	**0.00***
No	26 (13.61%)	165 (86.39%)	191	
Having a weekly day off				
Yes	92 (23.71%)	296 (76.29%)	388	0.173
No	5 (41.67%)	7 (58.33%)	12	
Marital status				
Single	23 (18.55%)	101 (81.45%)	124	0.079
Married	74 (26.81%)	202 (73.19%)	276	
Tobacco consumption				
Yes	24 (31.58%)	52 (68.42%)	76	0.104
No	73 (22.53%)	251 (77.47%)	324	
Alcohol consumption				
Yes	24 (31.58%)	52 (68.42%)	76	0.104
No	73 (22.53%)	251 (77.47%)	324	
Performing any exercise for more than 30 minutes apart from office work				
Yes	45 (21.95%)	160 (78.05%)	205	0.641
No	52 (26.67%)	143 (73.33%)	195	

Factors associated with depression, anxiety, and stress were analysed using the chi-square test.

*Statistically significant

Table 3 data reveals that there's no statistically significant association between stress and gender, educational status, working hours and marital status. However, there is a significant association between stress and those with higher income, working night shifts and tobacco consumption. Those who exercise regularly and have a weekly day off were also found to be protected against stress.

Discussion

This cross-sectional study assessed the prevalence and contributing factors of depression, anxiety, and stress among IT professionals working from home (WFH) in Kerala during the COVID-19 pandemic. Our findings showed that 11% had stress, 24% reported anxiety, and 22.75% experienced depression. These psychological distress levels are in line with earlier studies reporting increased mental health problems among IT professionals during the pandemic.[7] Reduced social interactions, fear of acquiring the disease either themselves or family members, including elderly parents, morbidity and mortality associated with the disease, information overload from social media, social-domestic dynamics at home, prolonged screen exposure, and changes in work routines are likely to be contributing factors.

The study's findings on the mental health burden are parallel with a study conducted among software engineers in South India, which found that 8.1% of them had severe psychological stress and 32.4% were distressed.[8] In Chennai, more than 55% of female IT professionals reported moderate to severe stress[9], while another study in Delhi found that 35% of IT professionals were stressed.[10] Similar increases in stress, anxiety, and depression among working populations during the pandemic were also documented by a global meta-analysis.[11] These numbers highlight the negative psychological toll of remote work environments, especially in industries like information technology that are deadline-driven and fast paced.[12]

This study showed significant associations between psychological distress and weekly vacation time, work shifts, and income levels. People who earn less than ₹60,000 per month were more likely to suffer from depression and anxiety. This aligns with findings that show a substantial correlation between mental health problems and financial insecurity during the pandemic because of employment instability, fear of retrenchment, and rising living expenses.[13]

Notably, those who worked nights reported significantly higher levels of stress, anxiety, and depression. Hormonal imbalances, emotional dysregulation, changes in the circadian rhythm, alterations in eating habits, and sleep disturbances have all been negatively associated with shift work, particularly night work.[14] IT professionals, due to global time zones and client demands, often engage in nocturnal schedules, making them more vulnerable to these risks.

In this study, 45% of the respondents worked more than 10 hours a day. Remote workers' mental fatigue and burnout have been linked to extended work hours.[15] Moreover, in a work-from-home environment, extended working hours and blurred work-life boundaries lead to diminished recovery time and increased stress.[16]

In contrast to some earlier research that suggested women experienced higher levels of stress [(4)], this study found no discernible gender difference. This could be because of shared household duties during lockdowns, flexible timetables, or reduced commuting. Similarly, there was no significant association between stress and marital status, which may be because of the perceived emotional support that family members gave throughout the crisis.[17]

Higher levels of anxiety and depression were observed among participants who did not engage regularly in physical activity. This is consistent with research indicating that engaging in moderate-to-intense physical activity helps prevent psychological distress during isolation.[18] Even in a remote setting, promoting regular movement can be a successful mental health intervention. The production of endorphins and the regulation of the hypothalamic-pituitary-adrenal (HPA) axis through physical activities help overcome anxiety and depression.

Furthermore, the use of substances was also found to have a close connection with anxiety. The participants who use tobacco and alcohol were found to be more likely to report anxiety. In previous studies, such behavior could be a coping

mechanism that ultimately exacerbates anxiety.[10]

Sudden technological change, frequent software updates, and constant need for skill enhancement are features of the IT sector. Such personnel going through this continuous transformation might develop a fear of becoming obsolete and suffer from ongoing anxiety and tension.[19,20] The absence of human interaction in working from home and the isolating nature of programming or software testing tasks might also predispose IT professionals to depression.[17]

The study emphasizes the critical need for IT professionals to have access to mental health care services. Instituting weekly off days, encouraging physical well-being, providing counseling, and offering employee assistance programs are some healthy practices that can be explored and adopted as standard procedures by organizations. Developing a supportive virtual work culture with assertive expectations and proper communication can also alleviate feelings of loneliness and stress.[21]

Strengths and Limitations

Strength:

1. This research is one among the few to investigate the prevalence and predictors of depression, anxiety and stress among Kerala's work-from-home IT professionals with the aid of a standard and validated instrument. (DASS-21)

2. The research involved samples from more than one firm in two districts. Thus, it covered a diverse sample, enhancing the generalizability in the region.

Limitation:

1. The participants were limited to IT professionals in Kerala, which may reduce the applicability of findings to other regions and industries.

2. The data were collected through a self-reported questionnaire, which may be subject to recall bias.

Conclusion

It was the first study that investigated the burden of depression, anxiety, and stress among Kerala IT professionals who are working from home. The implications of this research are well defined, indicating that lower income, night shifts, absence of a weekly day off, substance abuse, physical inactivity, and extended working hours are significantly associated with adverse mental health outcomes. The implications highlight the need for organizational intervention in promoting work-life balance, providing adequate rest breaks, fostering healthy lifestyle habits, and offering easily accessible mental health support services. Improving these factors is imperative not only to protect the well-being of employees but also to enhance productivity and performance in the rapidly evolving IT sector.

Recommendations:

- IT firms should encourage a work-life balance, flexible working hours, fixed time shifts, and designated off-days every week.
- Open communication and positive work cultures can reduce isolation and improve mental well-being.
- Encouragement of physical activity and stress management techniques (including mindfulness and breathing techniques) can reduce depression, anxiety, and stress.
- Offering access to mental health services, including counselling and employee assistance programs, is essential.
- Knowledge of psychological issues in WFH environments can inform public health policy and enhance efficiency.

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Original Article

Prevalence of musculoskeletal disorders among female workers in the fish processing industry in Odisha, India

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ABSTRACT

Introduction: The fish processing industry in India has experienced significant growth in the recent years, contributing substantially to the national economy. Several tasks involved in processing are dependent on manual handling which lead to development of work related musculoskeletal disorders (wMSDS). The aim of study was to assess the prevalence of wMSDs among the female fish processing workers.

Methods: Two hundred female workers were randomly selected from three fish processing units of Mancheswar of Khurda district of Odisha. A descriptive study design was chosen, and it involved assessment of physical and demographic parameters work organization and work stress of the female workers. A modified Nordic Questionnaire was used for the assessment of pain and discomfort among the workers. The study also included posture analysis by using Rapid Upper Limb Assessment (REBA) tool. The study was carried out for ten months from February 2024 to November 2024.

Results: The female fish processing workers reported experiencing discomfort in various parts of their bodies. The risk estimates also indicated that workers performing sorting were at 3.2 times (95% CI 2.0-5.1) at higher risk of developing pain and discomfort in the upper back, 10.2 times (95% CI 4.0-26.1) in the wrist and 3.8 times (95% CI 2.1-6.7) in the finger. The RULA score for the posture practiced during sorting indicated a medium risk of MSD injury occurrence. Awkward posture increased the risk of MSD injury occurrence by 9.5 times (95% CI 2.2-11.3).

Conclusion: Female workers in the fish processing industry experience pain and discomfort. Prolonged working in static, awkward, and standing postures, along with performing repetitive jobs, increases the risk of developing work-related MSDs.

Keywords: Awkward Posture, Ergonomic risk factors, Female fish processing workers, Repetitive job, Work-related Musculoskeletal Disorders

Introduction

The fisheries and aquaculture sectors are vital drivers of global employment, and India's seafood industry plays a significant role in this landscape. Odisha, with its extensive 480 km coastline, stands

out as a leading contributor to India's thriving seafood processing sector.[1] The division of labor typically follows gender lines, with men primarily engaged in seafood harvesting, while women are involved mainly in processing-related tasks.[2] The processing sector is heavily reliant on women, with over 90% of the workforce involved in shrimp peeling and 70% in the processing of other fish products being comprised of women.[3] The female workers are outnumbering men in the work associated with fish processing. The majority of manual material handling tasks performed by men involve carrying fish in cartoons, thoroughly washing them in chlorine water, putting them in boxes, and using a cart to move them to cold storage.[4] Processing involves a variety of processes, but the most common in the processing sector are freezing (71%), cutting (63%), and degutting (58%).[5] Women in aquaculture play a crucial role in holding major activities such as processing and marketing of fish products. However, the socio-economic conditions of the workers in such factories are below International standards.[6] Increased levels of production and processing of seafood and physical exposures differences make them victims of occupational health problems, among which Musculoskeletal disorders are a notable one, resulting in increased incompetency to work in female workers. 7A study highlighted a significant proportion of workers reported musculoskeletal discomfort in various body regions. Specific tasks within the industry showed varying levels of risk for WRMSDs.[8] For instance, workers engaged in material handling tasks reported high rates of discomfort in the elbows, wrists, and hands (71.4%), along with significant neck symptoms (57.1%), indicating a higher likelihood of developing musculoskeletal disorders.[9] One-third of all lost workday illnesses is caused by the high prevalence of Work-related musculoskeletal disorders (WMSDs). Among which WMSDs predominantly affecting the hand and wrist are associated with longer durations of work absences, resulting in a more substantial impact on productivity and wages compared to disorders in other anatomical regions.[10] The development of musculoskeletal pain is the detrimental result of poor posture adoption and repetitive strain.[11] A research indicated a high incidence of lower back pain, upper back pain, and hand injuries among the workers, attributing these to prolonged standing, repetitive motions, and inadequate workstation design.[12] Prolonged static postures without adequate rest intervals have been associated with increased musculoskeletal discomfort and heightened pain perception, particularly affecting the lower back, cervical and thoracic regions, as well as the wrists and fingers.[13] The present study aimed to assess the prevalence of work-related musculoskeletal disorders and to identify the ergonomics risk factors leading to the development of MSDs among the female workers of the fish processing industry in Odisha.

Methods

Two hundred female fish processing workers were randomly selected from three fish processing industries in Mancheswar, Khurda District, Odisha. The study participants belonged to the 18-45 age group and had a minimum of one year of experience working in the fish processing industry. The data were collected over a 10-month period, from February 2024 to November 2024. Written consent was obtained from the workers before the commencement of the study. Workers with any prior non-occupational history (accident) and history of non-occupational musculoskeletal disorders (congenital conditions, age-related degeneration) were excluded from the study. The height and weight of the female workers were recorded using the Martin's Anthropometer rod and the OMRON weighing machine. The BMI of the study participants was calculated using the collected data by applying a standardized equation. A modified Nordic questionnaire was used to assess work-related discomfort and pain in various body parts.[14] If the participants experience any discomfort, it would be in regions including neck, shoulders, elbows, wrists, hands, upper and lower back, hips, knees, and ankles,

along with any other related disabilities. The questionnaire was used to assess the likelihood of developing musculoskeletal disorders (MSDs) in the study participants. The questionnaire was administered in one-on-one interviews with the study participants. The Rapid Upper Limb Assessment (RULA) tool was utilized to evaluate postural discomfort among female fish processing workers in Odisha. The assessment process was conducted using digital videography, which enabled the capture of working postures. Subsequently, stick diagrams were developed based on still images extracted from the video footage. These diagrams were analyzed using Ergo Fellow 3.0, an ergonomics software developed by FBF Sistemas, Brazil. A chi-square test of independence at the chosen significance level of $p < 0.05$ was conducted to determine the association between ergonomics risk factors, selected demographic characteristics, and work tasks and the occurrence of MSDs among female workers. The odds ratio was used to analyze the risk associated with the development of MSDs. For each task (e.g., sorting, grading, peeling, packaging), odds ratios (ORs) were calculated by comparing the odds of pain among workers engaged in the specific task to those not involved in that task. Thus, for each work task, the reference group consisted of all participants not performing that particular task. Data analysis was performed using SPSS software version 29. The ethical approval for the present study was received from the Institutional Ethical Committee (IEC) of Sri Sri University.

Results

Demographic variables related to the study population, primarily including age, height, weight, and BMI, are presented in Table 1. The mean BMI of the female fish processing workers, as shown in the table, indicates a standard range of physiological characteristics.

Table 1: Demographics of the female Fish Processing Workers (n=200)

Variables	Female fish processing workers (M±SD)
Age (years)	31.57 ±4.51
Height (Cm)	170.08 ±3.27
Weight (kg)	55.37 ±1.04
BMI (kg/m2)	19.1 ±2.45
Duration of work per day (in hours)	10±0.50
Duration of rest per day (in hours)	1
No. of working days in a week	6

Notes: BMI is Body Mass Index, M±SD, Mean and Standard Deviation

The fish processing workers had a poor educational background, which significantly increased the risk of MSD injury (p=0.05). Twenty percent of the study participants had more than 9 years of experience, as shown in Table 2. Work experience of the female workers (p=0.01) has a significant effect on the occurrence of MSD injury, leading to an indication that the female workers with higher work experience are at increased risk of MSD injury.

The majority of the workers (71%) also reported repetitive motion of the body segments, particularly of hands, which increased the risk of MSD injury by 12.9 times (p=0.02,95% CI 6.9-24.3). The awareness about PPE use among workers was found to be poor (35%), which increased the MSD injury risk by 18.6 times (p=0.01, 95% CI 11.5-27.9). The female workers need to stand for a prolonged period, which increased the risk of MSD injury by 11 times (p=0.0004, 95% CI 1.9-22.0).

Table 3: Association of selected demographic factors, ergonomic risk factors with occurrence of MSD injury

SL No.	Parameters	Category	Frequency Distribution	OR	95% CI	P value
1.	Age	18-29	67(34%)	-	-	0.05*
		30-39	92(49%)			
		40-45	41(27%)			
2.	Education	Primary school	66(33%)	-	-	0.002*
		Secondary School	56(28%)			
		Higher secondary school	30(15%)			
		Illiterate	48(24%)			
3.	Marital Status	Married	105(65%)	3.5	2.1-7.5	0.03*
		Unmarried	95(35%)			
4.	Working Experience	1-4 years	58(29%)	-	-	0.01*
		5-9 years	102(51%)			
		>9 years	40(20%)			
5.	Rigidity in work methods and procedure	Yes	140(70%)	13.8	8.6-23.1	0.03*
		No	60(30%)			
	Work demand targets specific productivity	Yes	160(80%)	0.5	0.1-1.3	0.22
		No	40 (20%)			
6.	Use of PPE	No	128 (64%)	3.3	1.1-9.5	0.01*
		Yes	72(36%)			
7.	Job demands repetitive motion of body segments	Yes	142(71%)	12.9	6.9-24.3	0.02*
		No	58(29%)			
8.	Awareness about Personal Protective Devices	Yes	70(35%)	18.6	11.5-27.9	0.003*
		No	130(65%)			
9.	Prolong Standing	Yes	200(100%)	11.0	1.9-22.0	0.0004*
		No	-			
10.	Awkward posture	Yes	146 (78%)	9.5	2.2-11.3	0.04*
		No	54 (22%)			
		No	54 (22%)			

*significant at 0.05 level of significance, OR-Odds Ratio, χ2-Chi-Square value

According to the questionnaire, musculoskeletal discomfort was prevalent among female workers in the fish processing industry. The majority of workers (61%) reported experiencing pain in their

lower back. The pain in the upper back was also prevalent among the female workers by 50%, neck (34%), shoulder (31%), forearm (20%), wrist (32%). They also experienced pain in the leg region (42%) due to prolonged standing during work, as shown in Figure 1.

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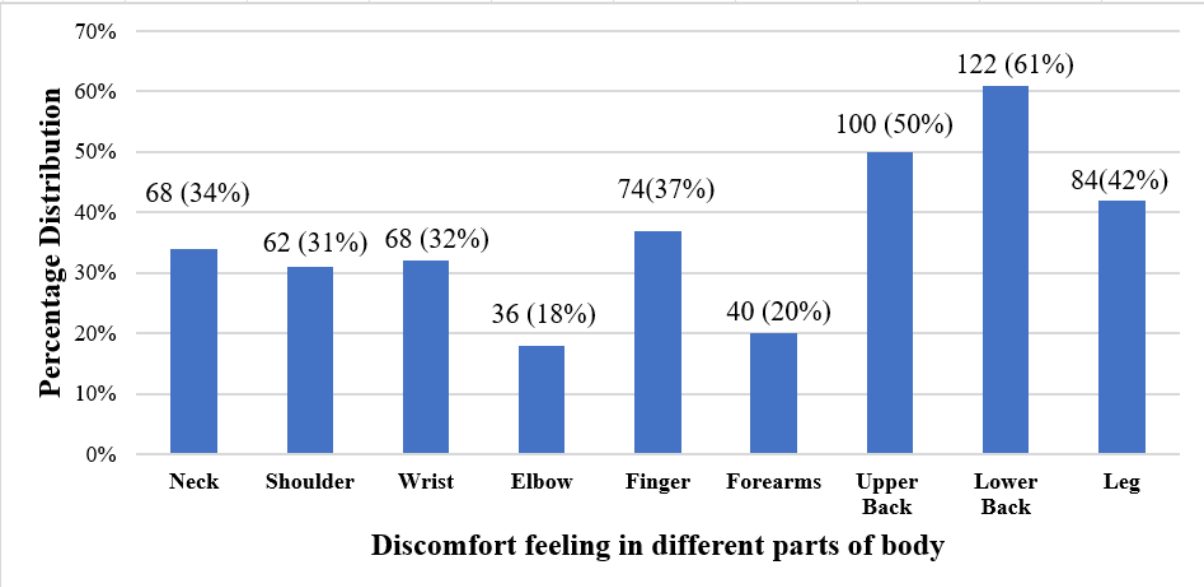

Figure 1: Discomfort feelings of female fish processing workers at different body parts (n=200)

The working posture of the female workers in their different job tasks was analyzed using the RULA method, as shown in Table 3. It was found that the medium risk of MSD was found to be in peeling, grading , sorting, beheading, and washing of fish with a RULA score of 5. The analysis of the posture required further investigation and changes as soon as possible. This also leads to an indication that female workers adopted poor and awkward posture for a prolonged period at their working place.

Table 3: Analysis of working posture of the female fish processing workers (By RULA method)

SL No.	Job Task	Posture	RULA Score	Action Level
1.	Peeling		5	Medium risk, further investigation, changes soon
2.	Beheading		5	Medium risk, further investigation, changes soon

3.	Grading		5	Medium risk, further investigation, changes soon
4.	Sorting		5	Medium risk, further investigation, changes soon
5.	Washing		5	Medium risk, further investigation, changes soon
6.	Packaging		4	Low risk, changes may be needed

*RULA Method: Rapid Upper Limb Assessment method

Female workers are involved in various job tasks. Approximately 71% are involved in sorting fish. The study participants were engaged in peeling (62%), grading (55%), packaging (52%), and a combination of these tasks (26%). The percentage distribution of various job tasks in the fish processing industry is illustrated in Figure 2.

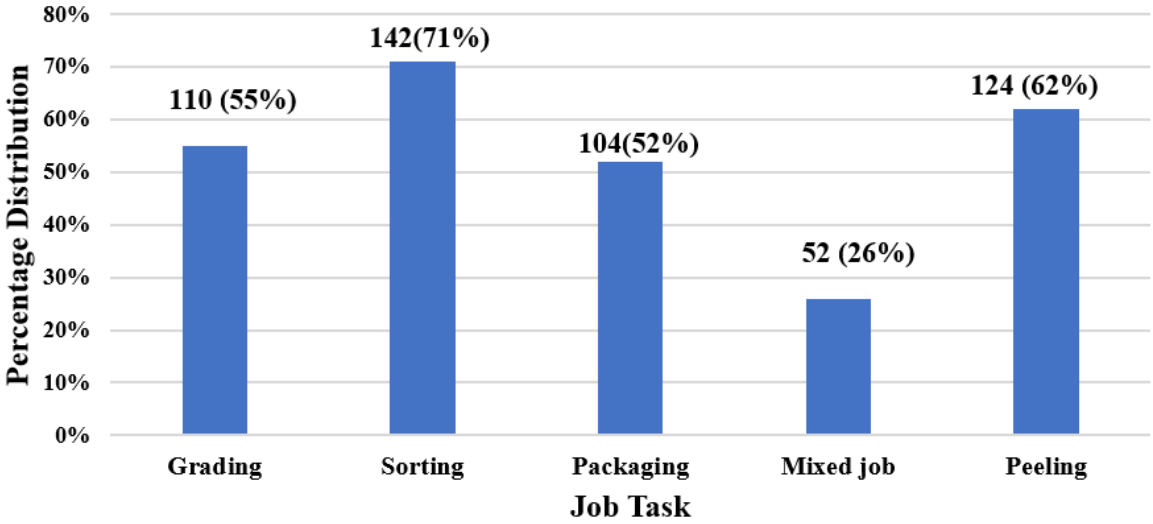

Figure 2: Work Tasks Involved in the Fish Processing Industry

The test of significance of the relative risk estimates was made for four major job task variables (sorting, grading, packaging, and peeling) against MSDs in different regions of the body (upper back, lower back, shoulder, neck, leg, wrist, and finger), and their statistical association

is shown in Table 4. The analysis of the results showed a significant association between discomfort and pain in the upper back, lower back, neck, legs, wrists, and fingers, respectively. The risk estimates also indicated that workers performing sorting were at 3.2 times (95% CI 2.0-5.1) at higher risk of developing pain and discomfort in the upper back, 10.2 times (95% CI 4.0-26.1) in the wrist, and 3.8 times (95% CI 2.1-6.7) in the fingers. However, the female workers performing grading were at 9.4 times higher risk of developing pain (95% CI 3.7-17.8) in the upper back, 2.3 times (95% CI 1.0-3.3) in the lower back, and 3.7 times (95% CI 2.0-3.3) in the wrist. Workers performing peeling were at high risk of developing musculoskeletal pain, with a 2.1 times (95% CI 2.7-4.4) increased risk in the shoulder and a 3.4 times (95% CI 1.6-4.7) increased risk in the neck, respectively.

Table 4: Association of job tasks and ergonomic risk factors with occurrence of MSDs

Work Task	Pain region	OR	95% CI	P value
Sorting	Upper back	3.2	2.0-5.1	0.03*
	Lower back	3.0	1.9-4.8	0.05*
	Shoulder	1.8	1.2-2.8	0.04*
	Neck	0.9	0.2-1.5	0.2
	Leg	1.8	1.2-2.8	0.04*
	Wrist	10.2	4.0-26.1	0.001*
	Finger	3.81	2.1-6.7	0.01*
Grading	Upper back	9.4	3.7-17.8	0.02*
	Lower back	2.3	1.0-3.3	0.05*
	Shoulder	1.9	1.9-2.1	0.07
	Neck	0.7	0.5-1.7	0.4
	Leg	1.5	1.0-1.7	0.05*
	Wrist	1.7	1.0-3.3	0.03*
	Finger	1.6	1.2-2.9	0.04*
Peeling	Upper back	1.0	0.5-1.8	0.7
	Lower back	0.5	0.1-1.1	0.3
	Shoulder	2.1	2.7-4.4	0.04*
	Neck	3.4	1.6-4.7	0.001*
	Leg	1.3	0.4-1.8	0.1
	Wrist	3.8	2.2-7.8	0.01*
	Finger	7.2	3.5-17.2	0.001*
Packaging	Upper back	1.9	1.2-3.0	0.004*
	Lower back	0.9	0.6-1.4	0.8
	Shoulder	1.1	0.7-1.6	0.5
	Neck	1.9	1.1-3.2	0.01*
	Leg	1.0	0.6-1.3	0.7
	Wrist	1.9	1.1-3.1	0.01*
	Finger	1.6	1.0-2.5	0.03*

*significant at 0.05 level of significance, OR - Odds Ratio, χ2-Chi Square value

Discussion

Approximately 71% of workers reported that their processing job required frequent repetitive motion of body segments, and all female workers reported prolonged standing as the primary form of work in the processing industry, which may lead to the development of pain in various body regions. This statement is supported by Rathore et al. (2020), who highlighted that highly repetitive, labor-intensive, and prolonged standing lead to

the development of musculoskeletal disorders.[15] The analysis of posture from Table 3 showed that most of the postures that were practiced by the workers while carrying out their job tasks, mainly beheading, peeling, Grading, sorting, washing, and packaging, required rectification as soon as possible, as indicated by the RULA analysis. The workers were found to adopt an awkward posture, which may lead them to suffer from musculoskeletal problems. From the investigation, it can be said that female workers are exposed to various risk factors, among which a predominant one is repetitive tasks that they perform in awkward postures. It is observed that the work in the fish processing industry is too short-cycled and carried out without any pauses. This leads to increased work strain and muscle tension, which results in an increased risk of developing musculoskeletal pain in different regions of the body. This observation of the researcher has been supported by a larger number of workers experiencing musculoskeletal discomfort in different body parts. 90% of the female fish processing workers complained of having discomfort in different parts of their bodies as represented in Figure 1. Das (2020) also found that the sawmill workers suffered from musculoskeletal disorders resulting from the development of poor working postures.[16] However, these workers were found to work in a constrained, awkward posture for a prolonged period of time, which leads to the amplification of discomfort feelings. About 70% of the workers responded that the fish processing task involved rigidity in work methods and procedure, while 80% responded that work demanded target-specific productivity, and 65% of the workers did not have awareness about the correct use of PPE. These can be referred to as work stress factors and lead to the development of MSD problems among the female processing workers. A significant association was found between multiple work factors, such as job repetition ($p>0.05$), awareness about PPE ($p>0.05$), prolonged standing ($p>0.05$), rigidity in work ($p>0.05$), and occurrence of musculoskeletal injury (Table 2). The risk estimates indicated that the workers performing job repetition were 12.9 times more likely to develop MSD injury, and workers performing their task in an awkward posture were 9.5 times more likely to develop MSD injury. Similar results were found by Das (2020) in their study on railway track maintainers, where workers with repetitive hand movement were at 16.25 times (OR 16.25, 95%CI 8.100–32.622) and workers with awkward posture were 311.40 times (OR 311.40, 95% CI 89.18–1087.34) at higher risk of developing MSD.[17] Education is crucial for raising awareness and comprehension of occupational risks and hazards among workers. The present study showed a significant association, indicating that higher education is associated with decreased risk of MSD injury. This statement was supported by Percin et al. (2012), who found that higher degrees of education were associated with increased awareness and reduced the risk of occupational hazards compared to lower levels of education ($\chi 2=7.84, p<0.001$) among fishermen.[18] Marital status was found to show a significant association with developing MSD injury, indicating married women were more prone to the risk of MSD ($p<0.05$). However, Saha A et al. (2006) did not find a significant association between marital status and injury occurrence.[19] The employment of females in large numbers in India has been a notable characteristic of the fish processing industry, and a majority of them have a limited educational background and live in low socio-economic conditions. There is a higher tendency for women aged 25-26 years to quit their jobs, with marriage being the major reason. The significant association in the present study may be due to mental stress, which can also be a result of staying away from families for married women, increasing their vulnerability and contributing to the increased risk of injury among female workers. The present study demonstrated that work experience has a significant effect ($p < 0.05$) on the occurrence of occupational injuries. The workers with higher job experience have a greater risk of occurrence of MSD injury due to prolonged exposure to work stress factors. The statement is buttressed by a study that showed an increase in

the prevalence rate of MSD with increased years of working experience, using correlation (r = 0.8, p = 0.001) among dentists.[20] Age had a significant effect on MSD injury occurrence, indicating that older individuals are at a higher risk of developing MSD injury than younger individuals. This stated varied by the study of Breslin et al. (2007) who showed that younger workers were at 1.2 times higher risk of developing occupational risk in comparison to older ones on account of their ignorance and underestimation of health and safety.[21] It was found that the female workers were engaged in different job tasks majorly sorting (55%), grading (71%), packaging (44%), and peeling(62%) which required the repetitive movement of various body parts leading to the occurrence of MSD injury. The risk estimates in the present study indicated that workers performing sorting, grading, and packaging were at a higher risk of developing pain in the upper back. In addition to it, workers performing sorting were at relatively higher risk of developing MSD pain in the wrist and fingers, respectively. The findings coincided with the studies of Nag A et al. (2012), who showed workers in fish processing who were involved in mixed jobs were 13.8 times and in ring cutting were 18.3 times at higher risk of developing discomfort and pain in the knee and upper back, respectively.[22]

Limitations

One of the limitations of this study was the restricted accessibility to participants due to limited permission from the competent authorities of the fish processing units. This limits the scope of data collection, preventing a more in-depth exploration of several important personal and occupational characteristics of the study participants.

Conclusion

From the comprehensive investigation, it can be said that female workers in the fish processing industry are highly susceptible to musculoskeletal disorders (MSDs) due to their repetitive tasks and awkward postures. The RULA analysis indicated that the majority of postures during critical tasks such as receiving materials, beheading, grading, sorting, peeling, and packaging are detrimental and require immediate correction. Work-related stressors, including rigid work methods, target-specific productivity demands, and the necessity for frequent body segment rotation, as well as awkward posture, were identified as significant contributors to the development of MSDs. The prevalence of musculoskeletal discomfort and these stressors was found to be strongly correlated by the study, with a substantial portion of workers reporting prolonged standing and lack of awareness about proper personal protective equipment (PPE) usage as exacerbating factors leading to the development of MSDs. It can be said that the result findings call for immediate and sustained efforts to implement ergonomic interventions to promote better postures, introducing regular breaks to reduce muscle strain, and provide comprehensive training and education to the workforce which includes ergonomic practices, such as the correct use of PPE (personal protective equipment), proper lifting techniques, as well as body mechanics, will lead to reduce their vulnerability. The use of PPE, such as cut-resistant latex gloves, waterproof aprons, and non-slip aprons, will help enhance hygiene and safety in the fish processing industry. However, looking into these issues is not only crucial for the well-being of workers but also for the sustainable development and productivity of the fish processing industry.

Acknowledgment

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Original Article

Psychological morbidity and its risk factors among migrant construction workers in Chengalpattu district – A cross-sectional study

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ABSTRACT

Introduction: Migrant construction workers, who form an essential workforce in the construction industry, face distinctive challenges such as job-related stress, workplace safety issues, financial instability, and difficulties arising from communication and cultural differences. Addressing psychological morbidity in this population is crucial not only to improve their quality of life. Hence, this study was conducted to assess the psychological factors such as anxiety, depression, and stress among migrant construction workers, as well as to evaluate the influence of social factors such as isolation, housing conditions, and cultural adaptation.

Methods: This cross-sectional study was carried out among 350 migrant construction workers in the Chengalpattu district. A total of 4 construction sites were randomly chosen by lottery method and stratified random sampling was done in each construction site to obtain the required sample size. The Data was collected using a pretested semi-structured questionnaire and validated Depression, Anxiety, and Stress (DASS-21) Scale for assessing depression, anxiety, stress, and relevant data. Informed consent was obtained, and data were entered in MS Excel and analyzed by SPSS version 22.

Results: Among the study participants, the prevalence of Depression, Anxiety, and Stress was found to be 44%, 32% and 38.6% respectively. Factors such as male gender, age ≤ 29 years, sleeping less than 6 hours per day, working more than 8 hours per day, lack of adequate housing facilities, and limited access to healthcare services were essential predictors for depression and stress. Working more than 8 hours per day was a necessary predictor of anxiety.

Conclusion: Migrant construction workers are more prone for stress and other psychological health problems. Routine screening of both physical and mental health for workers should be carried out to ensure their well-being. Additionally, policies that address discrimination, improve living conditions, and enhance access to social services can contribute to a more equitable and fulfilling experience for migrant construction workers.

Keywords: Depression, Financial stress, Mental health, Migrants, Social isolation, Stress

Introduction

Migrant construction workers are individuals who relocate, often from rural areas or other countries, to work in the construction industry in urban or industrial regions.[1] They represent a significant part of the labor force in many developing countries. These workers typically

move temporarily or seasonally to areas where construction projects are underway, seeking employment opportunities that may not be available in their home regions.[2] They often face unique and challenging conditions that can adversely impact their mental health. Psychological morbidity, encompassing conditions such as anxiety, depression, and stress, is a growing concern among this population.[3]

Several risk factors lead to psychological morbidity among migrant construction workers. Social isolation, resulting from separation from family and familiar social networks, is a significant factor.[4] Many workers live in substandard housing conditions, which adds to their stress and anxiety levels. Additionally, the process of cultural adaptation can be challenging, as these workers often migrate from diverse locations with different cultural practices, which can lead to feelings of isolation and discomfort.[5]

The interaction of these risk factors with the psychological well-being of migrant construction workers requires a thorough understanding to design effective solutions. Addressing psychological morbidity in this population is crucial not only for improving their quality of life but also for enhancing their productivity and overall contribution to the workforce.[6] This study aims to evaluate the prevalence of psychological morbidity among migrant construction workers in Chengalpattu District and identify the key social and environmental factors influencing their mental health.

Methods:

Between November 2023 and April 2024, a cross-sectional study was undertaken among 350 migrant construction workers in the Chengalpattu district, India. The sample size was determined using a 27.5% prevalence of psychological distress among migrant workers from a prior study by Mathew G et al[7] factoring in a 5% margin of error, a 95% confidence level, and a 10% buffer for non-responses, which led to a final required sample of 350 participants.

Out of the eight blocks in the Chengalpattu district, four were randomly selected. One construction site was then randomly chosen from each of these blocks. Stratified random sampling was employed at each site to recruit an equal number of participants proportionate to size, totaling 350 (80+94+84+92). The study included all migrant construction workers who were at least 18 years old and had been residing in the area for at least six months. Workers with a known psychiatric illness or those currently on psychiatric medications were excluded following a detailed history. Before participating in the study, each potential participant was provided with a Participant Information Sheet (PIS), and informed consent was obtained through a Participant Informed Consent Form (PICF). Ethical clearance for this study was obtained from the Institutional Human Ethics Committee on Human Subjects (Approval No: IHEC-I/2328/23). Safeguarding participants' privacy by protecting personal and sensitive information to prevent any risk of stigma or discrimination due to mental health disclosure, and providing referrals or resources for psychological support for those in need.

Data was gathered directly from eligible participants using a semi-structured proforma, which covered their basic sociodemographic information as well as work-related details such as job type and working conditions. To ensure the reliability and validity of the proforma, a pilot study was conducted with 30 migrant workers in a neighboring area to the study site. Following revisions based on this initial feedback, the proforma's internal consistency was evaluated through reliability analysis, with Cronbach's alpha of 0.87 demonstrating strong internal validity.

The DASS-21 questionnaire was employed to assess the psychological well-being of the participants. This tool is designed to measure

three key emotional states: depression, anxiety, and stress. Each of these psychological aspects is evaluated through separate subscales within the questionnaire. The study participants rated their experiences on a Likert scale, ranging from 0 (does not apply to me) to 3 (applies to me most of the time). The total scores for each of the three subscales are aggregated and classified into four levels of severity: mild, moderate, severe, and extremely severe. The DASS-21 scale has been validated for assessing depression, anxiety, and stress in adult populations.[8]

Microsoft Excel was used to enter the collected data and for more advanced statistical analysis, the data was imported into SPSS (Statistical Package for the Social Sciences) version 22. Frequencies and percentages were used to express categorical variables. The significance of categorical variables was assessed using the Chi-square test, with a p-value <0.05 considered statistically significant. Bivariate logistic regression was conducted to determine the unadjusted odds ratios. Variables with a p-value <0.05 from the bivariate analysis were included in a multivariate model to calculate adjusted odds ratios.

Results:

A total of 350 migrant construction workers participated, with 50.6% being under 29 years old and 49.4% being over 30 years old. The majority were male (72.6%), and 60.3% were unmarried. Among the participants, 51.1% used tobacco, 36.6% consumed alcohol, and the prevalence of depression, anxiety, and stress was 44%, 32%, and 38.6%, respectively (Figure 1).

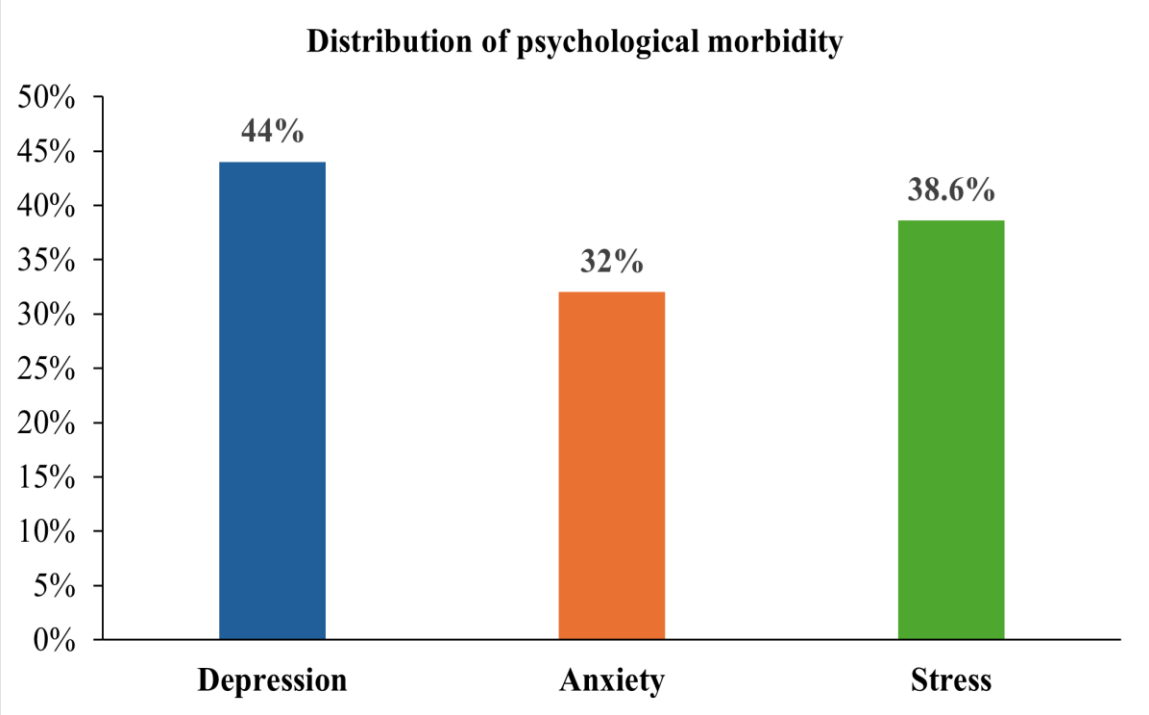

Figure 1: Distribution of psychological morbidity among the study participants

Table 1: Variables associated with Depression among study participants, n=350

Variables	Depression			OR (95% CI)	p-value
	Yes n (%)	No n (%)	Total (N = 350)		
Age (years)					
≤ 29	89 (57.8)	88(44.9)	177 (50.6)	1.680 (1.09 – 2.57)	0.017*
> 29	65(42.2)	108(55.1)	173(49.4)		
Gender					
Male	128 (83.1)	126 (64.3)	254 (72.6)	2.735 (1.63 – 4.56)	<0.001*
Female	26 (15.9)	70 (35.7)	96 (27.4)		
Monthly income (rupees)					
≤ 6000	97(63)	137 (69.9)	234 (66.9)	0.733 (0.46 – 1.15)	0.173
> 6000	57 (37)	59 (30.1)	116 (33.1)		
Marital Status					
Unmarried	59 (38.3)	80(40.8)	139 (39.7)	0.901 (0.58 – 1.38)	0.635
Married	95 (61.7)	116 (59.2)	211 (60.3)		
Staying with family					
No	120 (77.9)	146 (74.5)	266 (76)	1.209 (0.73 – 1.96)	0.455
Yes	34 (22.1)	50 (25.5)	84 (24)		
Tobacco consumption					
Yes	100 (64.9)	79 (40.3)	179 (51.1)	2.743 (1.77 – 4.24)	0.001*
No	54 (35.1)	117 (59.7)	171 (48.9)		
Alcohol Consumption					
Yes	51 (33.1)	77 (39.3)	128 (36.6)	0.765 (0.49 – 1.19)	0.234
No	103 (66.9)	119 (60.7)	222 (63.4)		
Sleep (hours)					
≤ 6	125 (81.2)	122 (62.2)	247 (70.6)	2.614 (1.59 – 4.29)	0.001*
> 6	29 (18.8)	74 (37.8)	103 (29.4)		
Working hours/day					
> 8	131 (85.1)	186 (94.9)	317 (90.6)	0.306 (0.14 – 0.66)	0.002*
≤ 8	23 (14.9)	10 (5.1)	33 (9.4)		
Adequate housing facilities					
No	116 (75.3)	126 (64.3)	242 (69.1)	1.696 (1.06 – 2.71)	0.026*
Yes	38 (24.7)	70 (35.7)	108 (30.9)		
Access to healthcare services					
No	48 (31.2)	40 (20.4)	88 (25.1)	1.766 (1.08 – 2.87)	0.021*
Yes	106 (68.8)	156(79.6)	262(74.9)		

*** P Value < 0.05 - Statistically significant at 95% Confidence Interval**

The findings indicate that workers aged 29 or younger were 1.68 times more likely to experience depression than those older than 29. Male participants had a higher probability of depression (OR = 2.74, CI=1.63 – 4.56) compared to females. Key factors associated with increased depression risk included tobacco use (OR = 2.74, CI=1.77 – 4.24), insufficient sleep (OR = 2.61, CI=1.59 – 4.29), inadequate housing conditions (OR = 1.69, CI=1.06 – 2.71), and limited access to healthcare services (OR = 1.76, CI=1.08 – 2.87). Additionally, participants who worked more than eight hours a day had significantly lower chances of depression (OR = 0.306, CI=0.14 – 0.66), Table 1. Gender had a significant association, with males having lower odds of anxiety compared to females (OR = 0.28). Additionally, working hours >8 hours per day was significantly associated with higher odds of anxiety (OR = 2.85) Table 2.

Table 2: Variables associated with Anxiety among study participants, n =350

Variables	Anxiety			OR (95% CI)	p-value
	Yes n (%)	No n (%)	Total (N = 350)		
Age (years)					
≤ 29	53(47.3)	124(52.1)	177(50.6)	0.826 (0.52 – 1.29)	0.404
> 29	59(52.7)	114(47.9)	173(49.4)		
Gender					
Male	61(54.5)	193(81.1)	254(72.6)	0.279 (0.17 – 0.45)	0.001*
Female	51(45.5)	45(18.9)	96(27.4)		
Monthly income (rupees)					
≤ 6000	78(69.6)	156(65.5)	234(66.9)	1.206 (0.74 – 1.95)	0.448
> 6000	34(30.4)	82(34.5)	116(33.1)		
Marital Status					
Unmarried	47(42)	92(38.7)	139(39.7)	1.147 (0.72 – 1.81)	0.555
Married	65(58)	146(61.3)	211(60.3)		
Staying with family					
No	85(75.9)	181(76.1)	266(76)	0.991 (0.58 -1.67)	0.974
Yes	27(24.1)	57(23.9)	84(24)		
Tobacco consumption					
Yes	50 (44.6)	129 (54,2)	179 (51.1)	0.681 (0.44 – 1.08)	0.095
No	62 (55.4)	109 (45.8)	171(48.9)		
Alcohol Consumption					
Yes	37(33)	91(38.2)	128(36.6)	0.797 (0.49 – 1.27)	0.346
No	75(67)	147(61.8)	222(63.4)		
Sleep (hours)					
≤ 6	76(67.9)	171(71.8)	247(70.6)	0.827 (0.50 – 1.34)	0.445
> 6	36(32.1)	67(28.2)	103(29.4)		
Working hours/day					
> 8	107(95.5)	210(88.2)	317(90.6)	2.853 (1.07 – 7.60)	0.029*
≤ 8	5(4.5)	28(11.8)	33(9.4)		
Adequate housing facilities					
No	84 (75)	158(66.4)	242(69.1)	1.519 (0.91 – 2.51)	0.104
Yes	28(25)	80(33.6)	108(30.9)		
Access to healthcare services					
No	28 (25)	60 (25.2)	88 (25.1)	0.989 (0.59 – 1.67)	0.966
Yes	84 (75)	178 (74.8)	262 (74.9)		

The results indicate significant associations between stress and various factors. Participants aged 29 or younger were less likely to experience stress (OR = 0.551, CI=0.35 – 0.85), while males had a higher likelihood (OR = 1.655, CI=1.01 – 2.73). Stress was also significantly associated with working over 8 hours per day (OR = 3.89, CI = 1.46 – 10.34), inadequate housing (OR = 1.76, CI=1.08 – 2.86), limited healthcare access (OR = 2.129, CI=1.31 – 3.45), and sleeping 6 hours or less (OR = 2.19, CI=1.32 – 3.63), Table 3.

Table 3: Variables associated with Stress among study participants, n=350

Variable	Stress			OR (95% CI)	p-value
	Yes n (%)	No n (%)	Total (N = 350)		
Age (years)					
≤ 29	56(41.5)	121(56.3)	177(50.6)	0.551 (0.35 – 0.85)	0.007*
> 29	79(58.5)	94(43.7)	173(49.4)		
Gender					
Male	106(78.5)	148(68.8)	254(72.6)	1.655 (1.01 – 2.73)	0.048*
Female	29(21.5)	67(31.2)	96(27.4)		
Monthly income (rupees)					
≤ 6000	94(69.6)	140(65.1)	234(66.9)	1.228 (0.77 – 1.94)	0.383
> 6000	41(30.4)	75(34.9)	116(33.1)		
Marital Status					
Unmarried	45(33.3)	94(43.7)	139(39.7)	0.644 (0.41 – 1.01)	0.053
Married	90(66.7)	121(56.3)	211(60.3)		
Staying with family					
No	105(77.8)	161(74.9)	266(76)	1.174 (0.70 – 1.95)	0.537
Yes	30(22.2)	54(25.1)	84(24)		
Tobacco consumption					
Yes	75(55.6)	104(48.4)	179(51.1)	1.334 (0.86 – 2.05)	0.191
No	60(44.4)	111(51.6)	171(48.9)		
Alcohol Consumption					
Yes	53(39.3)	75(34.9)	128(36.6)	1.207 (0.77 – 1.88)	0.408
No	82(60.7)	140(65.1)	222(63.4)		
Sleep (hours)					
≤ 6	108(80)	139(64.7)	247(70.6)	2.187 (1.32 – 3.63)	0.002*
> 6	27(20)	76(35.3)	103(29.4)		
Working hours/day					
> 8	130(96.3)	187(87)	317(90.6)	3.893(1.46 – 10.34)	0.004*
≤ 8	5(3.7)	28(13)	33(9.4)		
Adequate housing facilities					
No	103 (76.3)	139 (64.7)	242 (69.1)	1.760 (1.08 – 2.86)	0.022*
Yes	32 (23.7)	76 (35.3)	108 (30.9)		
Access to healthcare services					
No	46 (34.1)	42 (19.5)	88 (25.1)	2.129 (1.31 – 3.45)	0.002*
Yes	89 (65.9)	173 (80.5)	262 (74.9)		

Variables significantly associated with depression, anxiety and stress in bivariate analysis were further analyzed using multiple logistic regression to control for confounders. The study identified that age ≤ 29 years (AOR = 2.10, CI=1.3 – 3.3), male gender (AOR = 2.46, CI=1.6 – 4.3), tobacco use (AOR = 2.38, CI=1.3 – 4.2), inadequate sleep (< 6 hours) (AOR = 3.33, CI=1.8 – 6.1), lack of adequate housing (AOR = 2.12, CI=1.2 – 3.6), and limited healthcare access (AOR = 2.07, CI=1.1- 3.7) were significant predictors of depression, while working hours of more than 8 hours per day was a protective factor (AOR = 0.14, CI=0.05 – 0.3), Working hours >8 hours/day (AOR = 4.06) was found to be an important predictor of anxiety. It was found that

Age ≤ 29 years being a protective factor (AOR= 0.41, CI=0.26 – 0.67), male gender (AOR = 2.493, CI=1.5 – 4.4), inadequate sleep (< 6 hours) (AOR = 3.02, CI=1.19 – 5.62), working more than 8 hours per day (AOR = 6.54, CI=2.1 – 19.3), lack of adequate housing facilities (AOR = 2.43, CI=1.37 – 4.23) and limited access to healthcare services (AOR = 3.01, CI=1.7 – 5.33) were important predictors for stress, Table 4.

Table 4: Predictors of depression, anxiety and stress among study participants through multiple logistic regression, n= 350

Variables	AOR	95% CI	p-value
Predictors of depression			
Age ≤ 29 years	2.101	1.3 – 3.3	0.003*
Male gender	2.460	1.6 – 4.3	0.002*
Tobacco consumption	2.383	1.3 – 4.2	0.003*
Sleep < 6 hours	3.329	1.8 – 6.1	<0.001*
> 8 hours work per day	0.144	0.05 – 0.3	<0.001*
lack of adequate housing facilities	2.119	1.2 – 3.6	0.007*
limited access to healthcare services	2.074	1.1- 3.7	0.014*
Predictors of anxiety			
> 8 hours work per day	4.057	1.5 – 10.9	0.006*
Predictors of stress			
Age ≤ 29 years	0.412	0.26 – 0.67	<0.001*
Male gender	2.493	1.5 – 4.4	0.002*
Sleep < 6 hours	3.023	1.19 – 5.62	0.022*
> 8 hours work per day	6.542	2.1 – 19.3	0.001*
lack of adequate housing facilities	2.425	1.37 – 4.23	0.002*
limited access to healthcare services	3.007	1.7 – 5.33	<0.001*

Discussion:

The prevalence of depression among migrant construction workers in this study was found to be 44%, which aligns closely with findings from other research involving migrant workers and similar occupational groups. For instance, a study conducted by Hovey and Magaña[9] reported a 41% prevalence of depression among migrant farmworkers in the United States, highlighting a similar trend. Another study by Peconga et al[10] found that 40.9% of migrant workers experienced depression, further emphasizing the consistency of these findings across different populations and settings. These consistent prevalence rates underscore the significant mental health challenges faced by migrant populations. Migrant workers often encounter numerous stressors, such as socio-economic instability, which include job insecurity and low wages, inadequate living conditions, such as overcrowded or substandard housing, and limited access to healthcare services.[11]

The current study revealed that individuals aged 29 years or younger are more susceptible to depression, a finding that is consistent with previous research, such as the study conducted by Kessler et al[12] which also reported higher prevalence rates of depression among younger adults. This pattern of increased vulnerability in younger age groups can be explained by several factors unique to this demographic. Younger individuals, particularly those in the early stages of adulthood, often face significant life transitions

and stressors that can heighten their risk for depression. These transitions include adjusting to new environments, which is particularly relevant for migrant workers who may have relocated to unfamiliar settings, away from their support networks. The stress of adapting to a new cultural and social environment, learning to navigate different social norms, and possibly facing language barriers can contribute to feelings of isolation and anxiety, which are known precursors to depression.

This study also reported that, depression was more prevalent among males compared to females. This contrasts with the findings of Hong J et al[13] which reported higher depression rates among females. This disparity could be attributed to the majority of the study population being female (85%) in the study, while in our present study, male (50.6%) and female (49.4%) participants were equally distributed. Among migrant workers, males may face unique pressures such as financial responsibilities and occupational hazards, contributing to higher depression rates.[14]

Tobacco consumption was associated with a higher prevalence of depression in the present study. Research conducted by Byeon[15] and Wu[16] et al. has also shown that tobacco consumption is linked to an increased risk of depression, with daily users having the highest risk. Tobacco use may serve as a coping mechanism for stress and anxiety, which are prevalent among migrant workers due to their challenging living and working conditions.[17] Additionally, the social and economic hardships faced by migrant workers, coupled with the adverse health effects of tobacco, may further contribute to the higher prevalence of depression in this population.[18]

In the present study, working for more than 8 hours per day was found to be protective against depression. This interesting finding suggests that extended work hours could provide a sense of purpose and financial stability, potentially reducing some stressors associated with depression. However, it is important to consider the possibility of a healthy worker effect, where healthier individuals are more likely to engage in longer working hours.[19]

In this study, 32% of participants experienced anxiety. A study by Essayagh et al[20] reported a 39.1% prevalence of anxiety among migrant workers, while research by Peconga EK et al[10] found a 26.7% prevalence among Syrian migrants. The differences in anxiety prevalence across these studies may be due to the varying geographical settings and the different socio-environmental factors in each study area.

The present study identified that working hours of >8 hours/day is a key predictor of anxiety and stress among migrant construction workers. A study by Virtanen et al[21] found that individuals working more>55 hours/week had a higher risk of anxiety, stress, and depressive disorders compared to those working standard hours. Studies have shown that the construction industry has higher rates of anxiety and other mental health problems compared to other sectors. Salgado et al[22] highlighted that construction workers experience significant occupational stress, which is exacerbated by long working hours, contributing to higher anxiety levels.

In this study, the prevalence of stress among migrant construction workers was found to be 38.6%. This figure, while significant, is lower than the stress prevalence reported in other studies involving different groups of migrant workers. For example, research conducted by Anjara S.G. et al on migrant domestic workers in Singapore revealed a higher stress prevalence of 52.5%.[23]

Similarly, research by Sanchez et al[24] among migrant workers found that 45% reported significant levels of stress. The difference in stress levels between these two groups may be attributed to various factors related to their work environments and the nature of their occupations. Migrant domestic workers, who often live with their employers, may experience

unique stressors such as limited personal space, long and unpredictable working hours, and a lack of separation between work and personal life. These conditions can contribute to a heightened sense of isolation and vulnerability, leading to higher stress levels.

The prevalence of stress was higher among male migrant construction workers. This finding is consistent with existing literature that highlights gender differences in stress levels within occupational settings, particularly in male-dominated industries. A study by Kim et al[25] on construction workers in Korea found that male workers reported significantly higher stress levels compared to their female counterparts. Similarly, research done by Hovey et al[9] found that male migrant workers in the United States experience higher stress levels due to their demanding work and societal expectations of men being primary financial providers for their families.

In this study, stress among migrant construction workers was higher in those over 29 years old. Similar findings by Choi et al showed that older construction workers reported more work-related stress due to the physically demanding nature of their jobs and the pressure to meet expectations.[26] Mutambudzi M et al also found that older workers are more prone to chronic health conditions, adding to their stress.[27] Additionally, greater financial and familial responsibilities, coupled with the physical strain of construction work, contribute to higher stress levels in this age group.[28]

In this study, depression and stress were significantly linked to inadequate sleep (less than 6 hours), consistent with Mucci et al's findings, which showed a strong correlation between poor sleep and increased risk of depression and stress.[18] Al-Maddah et al also found that both sleep duration and quality were strongly associated with depressive symptoms among residents.[29] The living conditions and work patterns of migrant workers might not always facilitate proper sleep. Employers should consider implementing methods to enhance sleep hygiene, such as providing better living conditions and adjusting work hours to allow for adequate rest.[30]

Inadequate housing and limited access to healthcare were significantly linked to higher rates of depression and stress. Similarly, a study by Organista et al found that poor living conditions contributed to psychological distress among Latino migrant workers.[31]

Research by Dhungana et al[32] and Tilahun M et al[33] identified limited access to healthcare in the host country as a key risk factor for mental health issues among migrant workers. The correlation between poor living conditions and mental health is well-documented, with housing insecurity contributing to stress and depression. At the same time, limited healthcare access exacerbates the inability to address these mental health concerns.[34] Migrant workers commonly experience financial limitations which restrict them from seeking healthcare services.[35] These findings are in line with the social determinants of health concept, which states that poor living conditions and limited access to healthcare are major factors influencing mental health outcomes.[36]

By examining psychological morbidity in migrant construction workers, the study addresses mental health in a vulnerable and often overlooked group, providing valuable insights into this population's unique challenges. The study's comprehensive assessment of various risk factors, including working hours, housing conditions, and access to healthcare, helps identify key contributors to psychological morbidity. The present study, being cross-sectional in design, has its limitations in its ability to establish causality between psychological morbidity and its risk factors. Longitudinal studies would be needed to assess the incidence of psychological morbidity and provide a better understanding of its progression over time.

Conclusion:

The current study underscores the significant psychological strain experienced by migrant construction workers in the Chengalpattu district. The rates of depression, anxiety, and stress among these workers were found to be 44%, 32%, and 38.6%, respectively. Migrant construction workers are particularly vulnerable to stress and various psychological health issues due to the challenging nature of their work environment and living conditions. Routine screening of both physical and mental health is essential to address and mitigate these issues. Regular health check-ups can help in early identification of psychological conditions such as depression, anxiety, and stress, allowing for timely intervention and support. Participants in this study who have been identified with psychiatric illness were referred to the nearby health centre for further evaluation and management. Additionally, policies to improve living conditions and enhance access to social services can contribute to a more equitable and fulfilling experience for migrant construction workers.

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Original Article

Relationship between potential ergonomic hazard factors and musculoskeletal disorders in Nipah leaf crafters in Terjun Village, Indonesia

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ABSTRACT

Introduction: Nipah leaf crafters regularly perform tasks involving awkward postures—such as sitting on the floor without back support—repetitive hand movements, manual handling of Nipah leaves and sticks, and working in physically uncomfortable environment. These factors present potential ergonomic hazards that can lead to musculoskeletal disorders (MSDs), often manifesting as pain in various body parts. This study aimed to identify potential ergonomic hazards and the presence of MSDs, as well as to analyze their relationship.

Methods: This quantitative study employed a cross-sectional design and involved 35 Nipah leaf crafters. Potential ergonomic hazards were measured using a standardized checklist, and musculoskeletal disorders were assessed using a survey based on Appendices D and B of the Indonesian National Standard (SNI) 9011:2021. The research utilized univariate and bivariate methods, and relationship between ergonomic risks and musculoskeletal outcomes was analyzed using analysis of variance (ANOVA).

Results: Common ergonomic hazards identified included awkward postures, repetitive motion, lifting, poor lighting, and exposure to solar heat. Twenty-two participants (62.90%) were classified as "requiring further observation." Reports of MSDs varied in frequency and severity across body regions, with 21 individuals (60.00%) categorized as low-risk. A statistically significant relationship ($p < 0.05$) was found between potential ergonomic hazards and incidence of MSDs.

Conclusion: This study highlights the urgent need to address occupational health risks among Nipah leaf crafters to prevent MSDs, promote worker health, and improve productivity.

Keywords: Musculoskeletal disorders, Nipah leaf crafters, potential ergonomic hazard factors

Introduction

Nipah plants are commonly found in mangrove forest environments along rivers, beaches, and coastal regions. These plants offer numerous benefits, such as fuel, roofing materials, wall components, and raw material for handicrafts. The midrib of the Nipah leaf is widely used in crafting, where the stick serves for plaiting and broom-making, and the leaf is often used for wrapping cigarettes.

Indonesia's informal sector has been expanding rapidly, providing employment opportunities for a substantial portion of the workforce. Nipah leaf

crafting is one such activity within the informal economy that can serve as a primary or supplementary income source. It requires relatively low capital investment and can be performed from home. In Medan City, Nipah leaf crafters are predominantly located in Terjun Village, within the Medan Marelan Sub-district, where this work constitutes the main or additional livelihood for many residents. Products include woven plates, broomsticks, and cigarette wrappers.

Most of the workers in this sector are women (homemakers), with 30 out of the 35 surveyed being female. Their ages range from 15 to 71 years, and their work experience spans between 3 and 58 years. The work is typically conducted indoors or outdoors (e.g., on terraces or in yards) and follows irregular hours, often beginning between 9:00 a.m. and 12:00 p.m. and continuing from 2:00 p.m. to 4:00 p.m. or from 2:00 p.m. to 8:00 p.m. after completing household duties. The average working duration ranges from 5 to 9 hours per day. Crafters are paid based on output—IDR 3,000 per kilogram—processing between 25 and 50 kilograms of Nipah leaves daily.

A preliminary survey conducted among 10 Nipah leaf crafters in Terjun Village, using interviews and observations, identified several potential ergonomic hazards. All crafters work in seated posture without proper backrests, or with makeshift supports such as small benches or walls), often for extended durations, as shown in Figure 1. Their tasks involve repetitive and intensive upper limb movements, exposure to direct sunlight, inadequate indoor lighting, and the manual handling of Nipah leaves and sticks.

Figure 1. Work posture with a sitting position on the floor

Awkward working postures, such as prolonged neck flexion during leaf shredding, contribute to musculoskeletal complaints, including pain in the neck, shoulders, elbows, and arms. Discomfort in the spine, back, hips, buttocks, thighs, and knees are also prevalent, primarily due to sustained poor posture while sitting (on the hips). Prolonged exposure to these ergonomic risk factors may lead to significant occupational health issues, particularly musculoskeletal disorders, which can reduce productivity. Musculoskeletal disorders affect muscles, tendons, joints, nerves, and the circulatory system, commonly involving regions such as the neck, upper limbs, and back.[1,2]

This study aimed to identify potential ergonomic hazards, assess the prevalence of musculoskeletal disorders, and analyze the relationship between ergonomic risk factors and musculoskeletal disorders among Nipah leaf crafters in Terjun Village, Medan City.

Methods

This study utilized a quantitative, cross-sectional design and was conducted from November 2023 to January 2024. The target population consisted of all Nipah leaf crafters in Terjun Village, situated in the Marelan Sub-district of Medan City, Indonesia. A census method was employed, resulting in a sample size of 35 participants.

Potential ergonomic hazards were assessed using a standardized ergonomic factor checklist. Musculoskeletal disorders were evaluated using a survey instrument adapted from SNI 9011:2021, which concerns the Measurement and Evaluation of Potential Ergonomic Hazards in the Workplace. Each participant's potential ergonomic hazard score was calculated by summing the checklist items. Scores were then categorized into three ergonomic risk levels: safe workplace conditions (score < 2), requiring further observation (score 3–6), and hazardous (score > 7).

The musculoskeletal disorders assessment evaluated pain presence or absence across various body regions, including the neck, shoulders (left and right), elbows (left and right), upper and

lower back, arms (left and right), hands (left and right), hips, thighs (left and right), knees (left and right), calves (left and right), and feet (left and right). Both the frequency and severity of reported symptoms were taken into consideration. Risk levels for musculoskeletal disorders were classified as low (scores 1–4), moderate (score 6), and high (scores 8–16), in accordance with the scoring criteria from SNI 9011:2021.

Data analysis consisted of univariate and bivariate approaches. Univariate analysis described the frequency distribution of ergonomic risk levels and musculoskeletal complaints. Bivariate analysis was conducted using ANOVA with SPSS version 21 to examine the relationship between potential ergonomic hazards and musculoskeletal disorders. Ethical approval was granted by the Health Research Ethics Committee of Universitas Sumatera Utara (Approval No. 02/KEPK/USU/2024). All participants provided informed consent, and their confidentiality and right to withdraw were fully respected throughout the research process.

Results

Table 1: Potential Hazards of Ergonomic Factors for Nipah Leaf Crafters

No	Description	n (%)
1. The Upper Body	Awkward postures:	
	a. Neck flexion > 20°	23 (75.71)
	b. Unsupported arms or elbows	35 (100)
	c. Rapid and repetitive forearm rotation	23 (65.71)
	d. Wrist bending	35 (100)
	Intensive arm movements	35 (100)
	The working environment:	
	a. Inadequate lighting	6 (17.14)
	b. Exposed to solar heat during indoor work	20 (57.14)
2. The Back and Lower Body	Awkward postures:	
	a. 20-45° trunk flexion	21 (60)
	b. > 45° extreme trunk flexion	18 (51.42)
	c. Kneeling or squatting	16 (45.71)
	d. Sitting posture for 3 to 9 hours per day	35 (100)
3. Manual Lifting	Distances ≥ 3-9 m	24 (68.57)

Based on the collected data, potential ergonomic hazards were categorized into three main body regions: the upper body, the back, and the lower body. In the upper body, several awkward postures were observed, including neck flexion greater than 20° in 23 participants (75.71%), unsupported arms or elbows in all 35 participants (100%), rapid and repetitive forearm rotation in 23 participants (65.71%), and wrist bending in all 35 participants (100%) during Nipah leaf shaving. These conditions were recognized as potential ergonomic hazards contributing to musculoskeletal disorders in the neck, shoulders, elbows, and arms. Additionally, all 35 participants (100%) demonstrated intensive arm movements during leaf shredding, a repetitive and rapid activity maintained throughout working hours, further increasing risk to the shoulders, elbows, and arms. Proper working posture has been shown to reduce such musculoskeletal problems.[3]

Intensive arm movements were observed in all 35 individuals (100%) during leaf shredding. Intensive arm movements with the fastest work rhythm when shredding Nipah leaves and lasting throughout the working time produce an increasing number of sticks. Therefore, intensive arm movements are a potential ergonomic hazard factor that can cause musculoskeletal disorders in

the right and left arms, right and left elbows, and right and left shoulders. Inhibited movement of body parts (biomechanics) has a high risk of musculoskeletal disorders in various joints and upper limbs in carpet weavers.[4]

Workplace environmental conditions also posed hazards: six participants (17.14%) reported inadequate lighting, and 20 participants (57.14%) experienced solar heat during indoor work. Indoor lighting relied solely on sunlight, leading to potential eyestrain. Adequate lighting, tailored to task demands, is crucial to protect worker health. Therefore, the lighting intensity level must be determined by the needs of the workers to avoid any adverse effects on their health.[5] The workplace must have sufficient lighting to avoid eye strain.[3] Exposure to solar radiation heat contributed to discomfort, thirst, and sweating, with implications for productivity and health. Heat exposure can affect worker productivity and health.[6]

In the back and lower body regions, 21 participants (60%) exhibited awkward postures involving 20–45° trunk flexion while lifting Nipah leaves weighing between <7 kg and 23 kg from storage or delivery areas to the shredding zone. Lifting heavier Nipah leaves with 20-45° bending position of trunk flexion presents a significant ergonomic risk factor, potentially contributing to musculoskeletal disorders in both the upper and lower back. Furthermore, 18 individuals (51.42%) exhibited more extreme trunk flexion (>45°) when lifting lighter Nipah leaf sticks (<7 kg) from the floor to the collection point. The greater the weight lifted in such stooped positions, the higher the risk of developing musculoskeletal disorders affecting not only the upper and lower back but also the hips and thighs bilaterally.

An awkward posture involving kneeling or squatting was observed in 16 individuals (45.71%) as they moved Nipah leaves into closer positions to facilitate the shaving process. Frequent repetition of these kneeling or squatting postures significantly increases the risk of ergonomic hazards, particularly musculoskeletal disorders in the knees. Additionally, all 35 individuals (100%) reported adopting a prolonged sitting posture for 3 to 9 hours per day. Sitting on the floor without backrests or adequate lumbar support for extended periods poses a serious ergonomic risk, potentially leading to musculoskeletal disorders in the upper and lower back, hips, knees (especially when bent), and thighs. Prolonged exposure to physically demanding tasks and awkward work postures contributes to a higher incidence of musculoskeletal disorders.[7] Furthermore, such postures can impair worker concentration and increase the likelihood of occupational accidents.[8] To mitigate these risks, workstations should be adjusted to match the anthropometric measurements of each worker.[9]

Manual lifting over distances of 3 to 9 meters or more was reported by 24 individuals (68.57%), often involving body twisting, one-handed lifting, handling unexpected loads, lifting at a frequency of 1 to 5 times per minute or more, and moving objects positioned at or below shoulder level. Some individuals also lifted loads while resting them on the knee. These actions occurred while transporting Nipah leaves from vehicles or storage to the shaving area, as well as while moving bundled Nipah leaf sticks to the collection point. Such lifting practices significantly increase the risk of musculoskeletal disorders in the hands, arms, upper and lower back, and hips. The primary contributing factors to these musculoskeletal issues include insufficient ergonomic knowledge, limited work experience, inattentiveness, and improper lifting postures. Workers are particularly vulnerable to such disorders during manual tasks such as lifting, lowering, pushing, pulling, and activities involving vibration exposure.[10]

Among Nipah leaf crafters, potential ergonomic hazards were predominantly categorized as requiring further observation, with 22 individuals (62.90%) falling into this group. Ten individuals (28.60%) were classified under the safe workplace condition category, while three individuals (8.60%) were identified as being in the dangerous category. Notably, the higher the ergonomic hazard score, the more severe the associated risk category.

Based on the results of a survey on musculoskeletal disorders among Nipah leaf crafters, several complaints were identified across different body parts. The most frequently reported issues were in the neck, right shoulder, and left shoulder, with 18 individuals (51.43%), 12 individuals (34.30%), and 12 individuals (34.30%), respectively, reporting symptoms that occurred often, although the severity was classified as "no problem." Complaints in the right elbow, left elbow, upper back, lower back, and right arm were reported with a frequency level of "sometimes" and a severity level of "discomfort," with nine individuals (25.71%), 11 individuals (31.43%), 13 individuals (37.14%), 12 individuals (34.28%), and 10 individuals (28.57%), respectively.

Additionally, the left arm, right hand, and left hand were noted with a severity level of "discomfort" by 14 individuals (40.00%), 13 individuals (37.14%), and 12 individuals (34.29%), although the frequency level was not clearly stated. The right and left hips were also commonly affected, reported as occurring "sometimes" and causing "discomfort" by 13 individuals (37.14%) and 12 individuals (34.28%), respectively.

Furthermore, discomfort was reported in the right thigh, left thigh, right knee, and left knee with a frequency of "often," though the severity level remained "no problem," as indicated by 16 individuals (45.71%) for both thighs, 13 individuals (37.14%) for the right knee, and 15 individuals (42.82%) for the left knee. In contrast, complaints involving the right and left calves, as well as the right and left feet, were mostly non-existent, with a frequency level of "never" and a severity level of "no problem," reported by 15 individuals (42.85%) for both calves, and 17 individuals (48.57%) and 17 individuals (48.85%) for the right and left feet, respectively.

Those mentioned above musculoskeletal disorders are primarily caused by occupational factors such as lifting Nipah leaves, bending the neck over the leaves, repetitive movements of the arms and hands, prolonged sitting without a backrest, extending the legs forward while dragging Nipah leaves, and the collection and lifting of sticks. Among handicraft workers, musculoskeletal disorders affecting the shoulders, back, and knees are more prominent than in other body parts.[11] Musculoskeletal disorders can lead to symptoms including pain, numbness, tingling, reduced work productivity, absenteeism, and even temporary or permanent disability.[12] Researchers have identified both physical and psychosocial workplace risk factors contributing to the development of these conditions. These include repetitive tasks, prolonged static sitting, fatigue, occupational stress, and the use of inappropriate tools or poorly designed work environments.[13] Such risk factors contribute to discomfort and pain in various body regions, particularly the lower back, neck, shoulders, wrists, and lower limbs. The manifestation of symptoms varies among individuals. In India, most handicraft workers report a high prevalence of musculoskeletal disorders, especially in the neck, lower back, and knees.[14] Among weavers, the annual prevalence was reported at 85% across all body parts, with 71% in the lower back, 41% in the shoulders, and 37% in the knees.[15]

Table 2 below shows the musculoskeletal disorders depending on the type of occupation.

Table 2: Musculoskeletal Disorders Vary Depending on The Type of Occupation

No	Description		n (%)
1.	Hydroelectric Power Plant Workers[16]	a. Lower back	103 (48)
		b. Wrists	88 (41)
		c. Knees	77 (36)
		d. Shoulders	61 (28.30)
2.	Car Repair Shops[17]	a. Shoulders	83 (84)
		b. Thighs	56 (57)
3.	ICU Nurses[18]	a. Lower Back	544 (80.10)
		b. Neck	534 (78.60)

No	Description	n (%)
	c. Shoulders	478 (70.40)
4. Rice Farmers[19]	a. Lower Back	135 (86.50)
	b. Neck	134 (85.90)
	c. Shoulders	126 (80.70)
5. Clay Brick Makers[20]	a. Shoulders	157 (47.87)
	b. Wrists	169 (51.52)
	c. Lower Back	164 (50)
6. Mango-Harvesting Farmers[23]	a. Lower Back	10 (71.43)
	b. Shoulders	14 (100)
	c. Neck	8 (57.14)

Brick kiln workers commonly report discomfort in the wrists, lower back, shoulders, fingers, upper arms, and knees, primarily due to repetitive tasks, prolonged physical exertion, and awkward postures such as twisting, bending, stooping, lateral body movements, kneeling, and squatting.[20] Pottery workers most often report back pain, neck pain, shoulder and hand-arm pain, as well as foot discomfort.[11] Handicraft workers most commonly report issues in the neck and shoulder regions.[21] Among e-waste workers, the back is the most affected area, followed by the shoulders, knees, lower legs, upper arms, and neck.[22]

Based on the results of the ANOVA test, a significant relationship was identified (p-value < 0.05) between the potential hazards of ergonomic factors and the occurrence of musculoskeletal disorders. A statistically significant difference was found in the mean score of potential ergonomic hazards between the category of safe workplace conditions and the category requiring further observation (p-value < 0.05). Likewise, a significant difference was observed between the mean score of potential ergonomic hazards in the safe workplace conditions category and that in the hazardous category (p-value < 0.05). However, the mean score of potential ergonomic hazards in the category requiring further observation did not differ significantly from the mean score in the hazardous category (p-value > 0.05).

Discussion

The findings of this study demonstrate that Nipah leaf crafters are exposed to significant potential ergonomic hazards, particularly affecting the upper body—such as awkward neck postures and repetitive arm movements—the back, and the lower body, which is subjected to bending, squatting, kneeling, and prolonged sitting for 5 to 9 hours per day. These physical stressors, when combined with demanding tasks like lifting and transporting Nipah leaves and sticks, contribute to the development of musculoskeletal disorders. These disorders manifest as pain in multiple regions of the body, including the neck, both shoulders, both elbows, upper and lower back, both arms, both hands, both hips, both thighs, and both knees.

There is a difference in the average score of potential ergonomic hazards, with the category of safe workplace conditions having a lower mean score than both the category requiring further observation and the category labeled as dangerous. This indicates that a lower average score of potential ergonomic hazards corresponds to safer workplace conditions and, consequently, a reduced risk of musculoskeletal disorders. Conversely, a higher average score reflects more hazardous workplace conditions and a greater risk of musculoskeletal disorders. This means there is a greater risk of musculoskeletal disorders. While there is no significant difference between the average scores of the "requiring further observation" and "dangerous" categories, both are higher than the average score in the safe category.

This suggests that workplaces classified under the "requiring further observation" and "dangerous" categories present similarly high risks of musculoskeletal disorders due to elevated ergonomic hazard levels.

Musculoskeletal disorders are serious injuries or impairments affecting muscles, bones, nerves, tendons, soft tissues, joints, cartilage, and spinal discs that develop during occupational tasks. These conditions arise from the interaction of multiple ergonomic risk factors encountered in various work environments.[12,24] Work-related musculoskeletal disorders are primarily linked to occupational factors such as physical overload, repetitive movements, and poor posture. Common symptoms include localized or radiating pain, discomfort, fatigue, a sense of heaviness, paresthesia (numbness and/or tingling), and decreased muscular strength.[25] These disorders often result from prolonged exposure to high-risk ergonomic conditions, including heavy lifting, awkward or sustained postures, and repetitive or monotonous tasks.[26]

Musculoskeletal disorders can develop gradually over time or manifest suddenly, and they are influenced by several contributing factors such as awkward postures, repetitive tasks, heavy lifting, exposure to vibration, fatigue, and extended working hours without sufficient rest.[27] These disorders are often chronic in nature and are primarily caused by repetitive movement patterns, physical overexertion, sustained awkward postures, and prolonged periods of sitting or standing.[28]

Globally, musculoskeletal disorders represent a major occupational health concern. Both industrialized and developing countries acknowledge work-related musculoskeletal disorders as significant public health issues. Epidemiological studies have established strong correlations between various workplace risk factors—such as repetitive tasks, awkward postures, physical exertion, prolonged exposure, environmental conditions, psychosocial stressors, and individual characteristics—and the development of musculoskeletal disorders.[29]

The challenges experienced by Nipah leaf crafters mirror those encountered by other handicraft workers. The handicraft industry typically involves minimal mechanization and is marked by exposure to numerous occupational risk factors, such as prolonged static sitting, high physical exertion, and repetitive upper limb movements, all of which significantly contribute to the prevalence of musculoskeletal disorders.[13]Similar observations have been reported among female workers in wool textile factories, where musculoskeletal complaints were associated with poor working posture, inadequate seating, and extended working hours.[11]

Although musculoskeletal disorders are not typically fatal, their long-term consequences can be severe. They often result in short-term and long-term work absences, decreased functional capacity, reduced productivity, a decline in quality of life, and increased healthcare costs.[18,30] Injuries resulting from work-related musculoskeletal disorders contribute to direct costs such as medical treatment, physician consultations, rehabilitation services, insurance claims, and compensation payments. Indirect costs include the training and replacement of workers, the loss of experienced labor, and increased administrative demands.[21]

Preventing work-related musculoskeletal disorders is a national priority in many countries, particularly within the informal sector and small-scale industries.[31] The prevention of these disorders is essential for workers, employers, and policymakers, given their significant impact on worker health and productivity.[2] Prevention strategies are generally categorized into three levels: primary prevention, aimed at averting the onset of work-related musculoskeletal disorders; secondary prevention, which focuses on the early detection of symptoms and the prevention of further progression; and tertiary prevention, intended to reduce the impact of already existing disorders.[32] Jobs with high ergonomic risks can be

identified through medical records, self-reported discomfort from workers, interviews, and expert assessments. Following identification, ergonomic interventions may include engineering controls (such as workstation redesign), administrative controls (including job rotation and scheduled rest periods), medical management (such as early diagnosis and treatment), and ergonomic modifications (e.g., the provision of armrests, footrests, lumbar support, and ergonomically designed hand tools).[32]

Conclusion

The potential ergonomic hazards factors among Nipah leaf crafters primarily affect the upper body and include awkward postures such as neck flexion, unsupported arms or elbows, repetitive forearm rotation, and intensive arm movements. These risks are further compounded by adverse environment conditions, such as inadequate lighting and heat exposure. In the back and lower body, ergonomic hazards are associated with prolonged sitting and awkward postures like bending and squatting. Moreover, the manual lifting and transportation of Nipah leaves and leaf sticks contribute additional ergonomic risks. The majority of these identified hazards were categorized as requiring further observation, involving 22 individuals (62.86%). Musculoskeletal disorders were reported in nearly every body region, including the neck, shoulders, elbows, back, arms, hands, hips, thighs, knees, calves, and feet. The severity and frequency of complaints varied, with most classified as low-risk, affecting 21 individuals (60.00%). A statistically significant relationship ($p < 0.05$) was found between potential ergonomic hazards and the occurrence of musculoskeletal disorders.

To reduce the risk of musculoskeletal disorders, it is recommended to improve work methods and body mechanics by promoting neutral postures and minimizing repetitive movements and prolonged postures. Scheduled breaks should align with workers' physical conditions and capabilities. Furthermore, mechanical aids, such as wheelbarrows, should be used to transport Nipah leaves and leaf sticks to reduce physical strain, reducing the risk of musculoskeletal disorders, and enhance worker safety.

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Original Article

Screening of tuberculosis among nurse clinicians: An analytical observational study at a tertiary care hospital in western Rajasthan

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ABSTRACT

Introduction: Healthcare workers (HCWs) face a significant risk of contracting tuberculosis (TB), especially in regions with a high incidence of the disease. In India, routine screening and surveillance data are scarce for TB among HCWs. Our objective was to conduct TB screening among nurse clinicians to address guidelines and policies in the health sector.

Methods: An analytical observational study was done in a tertiary care teaching hospital in western Rajasthan, India. Four hundred twenty-two nurse clinicians were recruited and screened for tuberculosis. The tuberculin skin test was conducted according to the latest recommendations and standards to obtain the results. Informed consent was obtained before the procedure was performed.

Results: 12.3% showed positive tuberculin test results, while 87.7% tested negative. Past positive history of tuberculosis and current signs and symptoms of tuberculosis are inversely correlated with the likelihood of having tuberculosis. In contrast, past contact with a tuberculosis patient is slightly positively associated with an increased risk of tuberculosis.

Conclusion: This study supports the prioritization of clinical nurses as a high-risk group for TB infection, underscoring the importance of considering demographic factors in TB screening and prevention efforts.

Keywords: Nurses, Screening test, Tuberculosis, Tuberculin test

Introduction

Tuberculosis (TB) is a common infectious disease and ranks among the top 10 causes of death globally.[1] It is caused by Mycobacterium tuberculosis and spreads easily through the air, often after prolonged exposure to an infected person.[2] In 2019, around 10 million people were diagnosed with TB, and 1.4 million deaths were reported worldwide. The incidence rate in India is approximately 193 cases per 100,000 people annually.[3] A study at Christian Medical College (CMC), Vellore, found 125 TB cases among healthcare workers (HCWs) over a 10-year period (1992–2001).[4] Additionally, the German Social Accident Insurance recorded 4,653 occupational TB cases between 2002 and 2017.[5] Health care workers are more vulnerable to getting hospital-associated transmission of tuberculosis because of deprived or non-existent infection control preventive measures. It's mainly the causes of transmission in low-resource settings.[6,7,8] Health care workers are closely working with patients who have active tuberculosis. They are at high risk

of contracting an infection due to ill-ventilated spaces and performing contaminated aerosol-generating procedures. For many years, health care workers have been at high risk of getting health hazard disorders, where tuberculosis is more common. The risk of exposure increased when they were exposed to a large number of (smear-positive) patients with TB. The risk of infection or its transmission can be minimized through effective infection control practices. HCWs who are working with an active case of a tuberculosis patient are recommended for screening of TB.[9]

Studies on infection risk show that many TB cases among staff nurses are work-related. For example, the Hamburg fingerprinting study revealed that 80% of TB cases in healthcare workers with known infection chains were linked to their occupation. A similar Dutch study reported this figure at 43%.10In Bengaluru, a descriptive longitudinal study conducted over 16 months among 600 healthcare workers in a tertiary care hospital showed that 120 (20.1%) initially had a positive Tuberculin Skin Test reaction. After one year, 345 of the 478 participants who initially tested negative were retested, and 67 (19.4%) showed a positive TST reaction.[11]

A cross-sectional study conducted in China reported a 33.6% prevalence of latent tuberculosis infection (LTBI) among healthcare workers (HCWs) using T-cell SPOTTB, highlighting the importance of strong infection control measures.[12] Globally, HCWs face a higher risk of both latent and active TB, even as overall TB prevalence declines.[13] In high-income countries, the annual incidence of TB among HCWs is below 10 per 100,000, with native-born HCWs at less than 25 per 100,000.[14] A review by Joshi et al. found that in low- and middle-income countries, 55% of HCWs have LTBI, with an annual LTBI risk of 0.5% to 14.3% and an annual TB incidence of 69 to 5,780 per 100,000.[15]

Nurses play vital roles in the care, management, and support of tuberculosis patients throughout treatment, despite facing various barriers. Makhado et al. highlight the challenges nurses face due to resource shortages, with limited investigation into their experiences and patient perspectives during treatment.[16] Healthcare workers, including nurses, are about three times more likely to contract TB compared to the general population, though this risk varies across studies. For example, in China and Taiwan, two studies reported active TB incidence rates of 78.3% and 61.1%, respectively.[17,18] There are no such criteria for tuberculosis screening before joining the institute. Therefore, this study will investigate the incidence of tuberculosis among staff nurses working in western Rajasthan, and it will also aid in the exploration of various clinical and demographic correlates associated with its causation. It is anticipated that the findings from this study will inform the development of necessary guidelines and policies related to occupational infections and preventive measures for staff nurses. We hope that the findings of this study can help to develop scientific infection control guidelines for nurses, contributing to a safer work environment and practices, ultimately reducing the risk of infectious diseases among staff nurses.

Methods

The analytical observational study was conducted in May-July 2023 in a tertiary care teaching hospital in western Rajasthan, India. Researchers used a simple random sampling technique to recruit the clinical nurses in this study. The nurses were provided with a consent form and questionnaires to participate in the study. Nursing

personnel working in a health care setting, i.e, clinical, for more than one year and who are willing to participate and share their clinical and health-related information related to this research study were included in the study.

Nursing professionals who have been previously diagnosed and treated for tuberculosis, pregnant or lactating female nursing personnel, individuals under care for HIV/AIDS, organ transplant recipients, and those who are immunosuppressed due to cytotoxic immunosuppressive agents such as cyclophosphamide or methotrexate are excluded from participation. Additionally, nurses undergoing long-term systemic corticosteroid therapy, individuals suffering from end-stage renal disease, and those diagnosed with leukemia are also excluded from the study.

The calculation of the sample size for the study was based on established statistical principles, using the formula Sample Size (n) = $(Z\ 1\text{-}\alpha/2)^2 * (p) * (q) / d^2$. Here, 'n' represents the desired sample size, 'Z 1-α/2' denotes the critical value corresponding to the level of confidence (1.96 for a 95% confidence interval), 'p' signifies the expected prevalence (considered as 0.5), 'q' represents the complementary probability of 'p', and 'd' indicates the margin of error or precision (set at 0.05). Drawing from a study by Christopher DJ et al[18]., where 'P' was considered as 0.5, 'q' as 0.5, and 'd' as 0.05, the calculated sample size was determined as $(1.96)^2 * 0.5 * 0.5 / (0.05)^2$, resulting in 384. To account for potential participant attrition, a 10% dropout rate was added, resulting in a final sample size of 422 nursing professionals. This rigorous calculation ensures adequate statistical power to detect meaningful associations and draw reliable conclusions from the study's findings.

Personal information consists of age in years, Gender, Educational qualification, Designation, Total working experience (Clinical), Area of living, and family history of tuberculosis. Clinical variables datasheet included the BCG scar, past history of tuberculin test, history of HIV testing, current signs and symptoms of tuberculosis, and previous contact with a tuberculosis patient.

A trained healthcare professional administered a tuberculin skin test, which was carried out according to the latest recommendations and standards of the Central TB Division, Ministry of Health and Family Welfare, Government of India. TST was performed on all nursing professionals who fulfilled the inclusion criteria.

The TB skin test involved injecting 0.1 ml of a solution containing 5 TU (tuberculin units) of purified protein derivative (PPD) into the intradermal skin on the lower arm. After 48–72 hours, the diameter of the raised area (induration) on the skin was measured to evaluate the result. The test was considered positive if the induration was 10 mm or more. Positive or active cases of tuberculosis was given further treatment as per hospital policy and protocols and proper follow-up was carried out for them till complete recovery.

Ethical clearance was granted by the Institutional Ethics Committee, as per letter number: /IEC/22/147 on dated 20 March 2023. All procedures adhered to pertinent ethical guidelines and regulations. Before obtaining informed consent, participants were provided with information about the research objectives and their involvement in the study. Privacy and confidentiality were maintained throughout all stages of the study. Each participant received a self-administered questionnaire to provide the necessary information on the study variables.

The information gathered through online surveys was exported as Excel data and imported into SPSS 26.0. Descriptive and inferential statistics were used for analysis. Statistical analysis was

conducted using SPSS Statistics 26.0. Quantitative data were presented as the mean with standard deviation. The relationship between demographic variables was analyzed using logistic regression.

Results

The demographic details of the 422 participants are presented in Table 1. Approximately 201 (47.7%) of the participants were aged between 26 and 30 years, while 15 (3.6%) were over 35 years old. Among the participants, 249 (59%) were male and 173 (41%) were female. Regarding educational qualifications, the majority, 323 (76.5%), held a B.Sc. in Nursing, and 6 (1.4%) held an M.Sc. in Nursing. A greater number of participants, 321 (76.1%), were nursing officers, followed by Senior Nursing Officers, 82(19.4%), and ANS, 19 (4.5%). Urban areas host the majority of the group 335(79.4%) compared to rural areas 87 (20.6%). Concerning clinical experience, a notable 177 (41.9%) possess over 5 years of experience, with 1-3 years and 3-5 years constituting 122 (28.9%) and 123 (29.14%), respectively.

A family history of tuberculosis is present in a small fraction, 5.9%, of the group. Overall, 43.1% of participants were working in emergencies with a smaller representation in IPD, 16.58%

Table 1: Frequency and percentage distribution of demographic variables (N=422)

Variables	Frequency (%)
Age in completed years	
18-25	93 (22)
26-30	201(47.6)
31-35	113 (26.8)
More than 35	15 (3.6)
Mean	28.80
Median	29
Range	21-42
Standard deviation	3.613
Gender	
Male	249 (59)
Female	173 (41)
Education qualification	
GNM	38 (9)
PB B.Sc.	55 (13)
B.Sc. Nursing	323 (76.5)
M. Sc. Nursing	6 (1.4)
Designation	
Nursing officer	321 (76.1)
Senior Nursing officer	82 (19.4)
ANS	19 (4.5)
Place of Living	
Rural	87 (20.6)
Urban	335 (79.4)
Working experience (Clinical)	
1-3 years	
3-5 years	122 (28.9)
More than 5 years	123 (29.14)
	177 (41.9)
Family history of tuberculosis (Yes)	
	25 (5.9)

Area of working	
IPD	7016.58)
Critical care	170 (40.3)
Emergency	182 (43.1)

Table 2 shows the clinical profile of the participant, where all 100% have a BCG scar on the upper part of the arm. Only a few participants, 5% had a past history of tuberculin test, among whom 23.7% tested positive. Similarly, past HIV testing history reveals that 35.3% have been tested, and among those tested, 35.3% have tested negative. Presently, a small fraction (2.6%) exhibits signs and symptoms suggestive of tuberculosis. Notably, a substantial proportion (43.1%) reports previous contact with tuberculosis patients

Table 2: Clinical Information of study participants **(N=422)**

Variables	Frequency (%)
BCG scar	
Present	422 (100)
Past history of tuberculin test	
Yes	21 (5)
No	401 (95)
If yes, then the result (n=21)	
Positive	5 (23.8)
Negative	16 (76.2)
Past history of HIV testing	
Yes	149 (35.3)
No	273 (64.7)
If Yes, then the result (n=149)	
Negative	149 (100)
Current signs and symptoms of tuberculosis	
Yes	11 (2.6)
No	411 (97.4)
Previous contact with a tuberculosis patient	
Yes	182 (43.1)
No	240 (56.9)

Table 3: Result of Tuberculosis among health professionals

Variables	Frequency (%)
Result of tuberculosis	52 (12.3)

Table 3 depicts the results of tuberculosis among participants, 12.3% showed positive tuberculin test results, while 87.7% tested negative. Table 4 suggests that past positive history of tuberculosis and current signs and symptoms of tuberculosis are inversely correlated with the likelihood of having tuberculosis, while past contact with a tuberculosis patient is very weakly positively correlated with tuberculosis. It is essential to note that correlation does not imply causation; further analysis is required to establish causal relationships.

Table 4 suggests that past positive history of tuberculosis and current signs and symptoms of tuberculosis are inversely correlated with the likelihood of having tuberculosis. In contrast, past

contact with a tuberculosis patient is very weakly positively correlated with tuberculosis. It is important to note that correlation does not imply causation, and further analysis would be needed to determine causal relationships.

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Table 4: Association between clinical profile and active case of tuberculosis

VARIABLES	CORRELATION COEFFICIENT	INFERENCE
Past positive history of tuberculosis	-0.061	Very weak negative
Current signs and symptoms of tuberculosis	-0.016	Very weak negative
Past contact with a tuberculosis patient	0.008	Very weak positive

The analysis of demographic variables related to tuberculosis testing outcomes (Table 5) reveals significant associations between various factors and the likelihood of testing positive for TB. Among age groups, individuals aged 21-28 exhibit 2.19 times higher odds of testing positive for TB compared to those aged 37 and above (95% CI: 0.09-0.04), and this association remains significant even after adjusting for other variables, with an adjusted odds ratio (aOR) of 10.64 (95% CI: 6.47-17.50). Similarly, individuals aged 29-36 show 4.58 times higher odds of TB positivity compared to the reference group (aged 37 and above), with an aOR of 5.08 (95% CI: 3.54-7.30). Gender-wise, females demonstrate 5.55 times higher odds of TB positivity than males (95% CI: 3.93-7.84). Regarding educational qualifications, those with GNM, Post Basic BSc Nursing, and BSc Nursing qualifications exhibit significantly elevated odds of TB positivity compared to MSc Nursing, with adjusted odds ratios (aORs) ranging from 5.33 to 7.5. Additionally, individuals residing in urban areas have 13.3 times higher odds of TB positivity than rural residents (95% CI: 5.81-30.56). Various other factors such as total working experience, previous contact with TB patients, and current signs and symptoms of TB also exhibit significant associations with TB testing outcomes. These results underscore the importance of considering demographic factors when developing TB screening and prevention strategies.

Table 5: Logistic regression analysis on participants variable with TST results

Demographic variables	TST Positive % (n/N)	TST negative % (n/N)	OR* (95% CI*)	AOR* (95% CI*)
Age				
21-28	4.8 (17/198)	95.2 (181/198)	2.19 (0.09-0.04)	10.64 (6.47-17.50)
29-36	16.4 (35/213)	83.6 (178/213)	4.58 (0.197-0.043)	5.08 (3.54-7.30)
37 and above	0 (0/11)	100 (11/11)	Reference	-
Gender				
Male	15.3 (38/249)	84.7 (211/249)	Reference	-
Female	8.1 (14/173)	91.9 (159/173)	5.55 (3.93-7.84)	-

Education Qualification				
GNM	15.8 (6/38)	84.2 (32/38)	5.33 (2.23-12.75)	-
Post Basic BSc Nursing	14.5 (8/55)	85.5 (47/55)	5.87 (2.77-12.43)	-
BSc Nursing	11.8 (38/323)	88.2 (285/323)	7.5 (5.34-10.52)	-
MSc Nursing	0 (0/6)	100 (6.6)	Reference	-
Designation				
Nursing Officer	11.5 (37/321)	88.5 (284/321)	7.67 (5.44-10.81)	-
Senior Nursing Officer	15.9 (13/82)	84.1 (69/82)	5.30 (2.93-9.6)	-
ANS	10.5 (2/19)	89.5 (17/19)	Reference	-
Place of living				
Rural	7 (6/86)	93 (80/86)	Reference	-
Urban	13.7 (46/336)	86.3 (290/336)	13.3 (5.81-30.56)	-
Total working experience				
1-3 years	9.8 (12/122)	90.2 (110/122)	9.16 (5.05-16.63)	-
3-5 years	12.2 (15/123)	87.8 (108/123)	7.2 (4.19-12.35)	-
More than 5 years	14.1 (25/177)	85.9 (152/177)	Reference	-
Family history of Tuberculosis				
Yes	20.0 (5/25)	80.0 (20/25)	4 (1.50-10.65)	-
No	11.8 (47/397)	88.2 (350/397)	Reference	-
Area of working				**-**
IPD	5.9 (4/68)	94.1 (64/68)	16.0 (5.82-43.93)	
OPD	0 (0/2)	100 (2/2)	-	-
Critical Care	21.2 (36/170)	78.8 (134/170)	3.72 (2.57-5.37)	
Emergency	6.6 (12/182)	93.4 (170/182)	Reference	
BCG Scar				
Present	12.3 (52/422)	87.7 (370/422)	2.66 (2.30-3.08)	
Past history of Tuberculin test				
Yes	4.8 (1/21)	95.2 (20/21)	20 (2.68-149.02)	
No	12.7 (51/401)	87.3 (350/401)	Reference	-
If yes, what was the result				
Positive	0 (0/11)	100 (11/11)	Reference	
Negative	2.7 (11/411)	97.3 (400/411)	2.67 (2.30-3.09)	
Past history of HIV testing				
Yes	13.4 (20/149)	86.6 (129/149)	Reference	

No	11.7 (32/273)	88.3 (241/273)	6.45 (4.02-10.33)	
If yes, what was the result				
Negative	12.3 (52/422)	87.7 (370/422)	2.66 (2.30-3.08)	
Current signs and symptoms of TB				
Yes	0.2 (1/52)	12.4 (51/370)	Reference	
No	2.4 (10/411)	87.6 (360/411)	10 (1.28-78.11)	
Previous contact with tuberculosis patient				
Yes	12.6 (23/182)	87.4 (159/182)	Reference	
No	12.1 (29/240)	87.9 (211/420)	6.91 (4.46-10.7)	

Discussion

The 422 nurse clinicians screened for tuberculosis who were working in a tertiary care centre in western Rajasthan. The majority of study participants were aged between 26 and 30 years, with a median age of 29 years. This age distribution is similar to the findings of a study that was conducted among nursing professionals in a hospital setting.[18]

The current study found that only 59% of males and 41% of females participated in screening. These findings contrast with prior work by Mogan et al., who found that 78.7% of males and 21.3% of females were screened for tuberculosis.[19] Interestingly, the present study discovered that 35.3% of participants had a history of HIV testing. These results are comparable to a study by Mogan et al., which found that 30% of participants had previously undergone HIV testing.19The results are highly favourable and reassuring, as none of the patients tested positive.

The current study findings suggested that the majority of participants, 76.1% were nursing officers, which is in line with a previous study conducted by wang et. al, where subjects completed a bachelor's degree in the medical profession, 72.9%.[20] Our study found that 12.3% of participants tested positive for the tuberculin test, which is lower than the LTBI prevalence of 20% reported in public tertiary care hospitals in India and 40% in Pakistan.[21,22] Previous studies have shown a significant link between increasing age and TST positivity. In our study, we also observed a moderate positive association with previous contact tuberculosis patients.[22,23] A study by Main S highlighted a significant connection between TBI and factors such as being male, working in the hospital, and older age, which was unexpected.[24] Our analysis also revealed a statistically significant relationship between increasing age and TST positivity, aligning with findings from other studies.[23,24] In the hospitals included in the study, most healthcare workers began their careers between the ages of 26 and 30. Therefore, the increased risk of TST positivity with age is likely due to prolonged exposure from both work-related and non-work-related sources.[25] Specific work areas, such as inpatient TB services, general medicine wards, emergency rooms, and laboratories, have been associated with a higher risk of TB exposure compared to outpatient or surgical services, as well as the general population. This matches our study's findings. The study's key strength lies in its focus on nurse clinicians, a high-risk group for tuberculosis, providing valuable insights into occupational exposure in a real-world clinical setting. Conducted at a tertiary

care hospital using validated screening tools, the study ensures reliability and relevance to similar healthcare environments. A key limitation of the study is that it was conducted at a single center, which may limit the generalizability of the findings. Furthermore, issues like symptom underreporting and the potential impact of prior BCG vaccination on test outcomes could influence the accuracy of the results.

Conclusion

In conclusion, this study found a significant number of clinical nurses tested positive for the TST. This study marks an initial effort to assess the risk of TB exposure and TST outcomes among clinical nurses in public tertiary care hospitals in India. Our analysis also warrants the immediate implementation of an occupational infection preventive policy in tertiary care teaching hospitals. The findings of this study highlight the need for hospital authorities to develop scientific infection control guidelines for nurses, which would promote a safer work environment and practices, ultimately helping to prevent infectious diseases among staff nurses.

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Disclosure statement

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Original Article

Work-related stress and mental well-being among police personnel at Mangalore jurisdiction

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ABSTRACT

Introduction: Stress is the physiological response to anything that requires focus or movement. Police officers are responsible for enforcing laws in their jurisdiction, as there is a rise in the personal risk of verbal and physical assaults, as well as ongoing involvement in a range of unpleasant situations, the duties of law enforcement officers tend to become fundamentally stressful. This research aims to assess the work related stress and mental wellbeing among police personnel at Mangalore jurisdiction.

Methods: Descriptive study was conducted with 220 police personnel from Mangalore Jurisdiction from 3rd March 2023 to 31st March 2023. Operational Police Stress Questionnaire and Warwick Edinburgh Mental Wellbeing Scales were used to gather data from participants selected through a disproportionate stratified random sampling technique. To determine the relationship between police officers' mental wellness and their level of work-related stress, Karl Pearson's Correlation Coefficient was calculated.

Results: Most 87.3% of the police personnel had high stress followed by 10.5% of police personnel had medium stress and 2.2% of police personnel had low stress. Majority 59.6% of police personnel had medium mental wellbeing, 35.9% had high mental wellbeing and 4.5% had low mental wellbeing. The results also showed that there was no significant correlation (r=0.034) between work related stress and mental wellbeing among police personnel.

Conclusion: This study concluded that there is high work-related stress among police personnel at Mangalore jurisdiction which is directly or indirectly affecting their mental wellbeing.

Keywords: Mangalore jurisdiction, mental wellbeing, police personnel, work related stress

Introduction

Stress is the physiological response to anything that requires focus or movement.[1] Both positive and negative circumstances can cause stress, and it manifests itself when the body reacts to any form of excessive demand.[2] Stress increases the risk of physical and mental illness as well as impacting intellectual and physical fitness, decreasing quality of life.[3] Workplace stress can occur in a wide range of contexts.[4]

Police officers are responsible for enforcing laws in their jurisdiction.[5] Due to the personal risk of verbal and physical assault and exposure to unpleasant situations, their duties tend to become fundamentally stressful.[6] Stress can cause poor judgment, increased mood swings, and an increased risk of mental illnesses like anxiety or

depression. The memory, attentiveness, and emotional management of a police officer can be significantly impacted by long-term or chronic stress.[7]

Mental health is a state of well-being in which a person is aware of their own potential, capable of coping with life's regular stresses, able to work creatively and productively, and able to contribute to their community.[8] Police officers' mental health statistics suggest that, on average, 15% of American cops suffer from Post-traumatic stress disorder symptoms.[9] Maintaining mental well-being is essential for sustaining good mental health, just as physical fitness is vital for maintaining physical strength.[10] Workplace stress may contribute to the emergence of mental health issues among police personnel.[11]

There is evidence to support the idea that police forces experience mental health difficulties differently from other professional groups. A variety of disorders, including stress, depressive disorders, post-traumatic stress disorder, anxiety, burnout and familial issues have been documented in studies on the mental health challenges faced by police officers. If police officers lack support systems (friends, family, classmates, and the confidence of co-workers and superiors), or if they lack characteristics that make them manageable, they can be particularly vulnerable to poor mental health[12]. So this study aimed at assessing the relationship between work-related stress and mental well-being among police personnel.

Methods

A descriptive research design was used to conduct a study among police personnel in selected police stations in the northern and southern regions of the Mangalore Jurisdiction. Data collection was scheduled from March 3, 2023, to March 31, 2023. Ethical clearance was obtained from the Institutional Ethical Committees. Permission was secured from the Deputy Commissioner of Police, Mangalore, and various police stations in the Mangalore jurisdiction. Twenty-one police stations cover both regions under the Mangalore jurisdiction. The northern region of Mangalore jurisdiction comprises 11 police stations, from which the investigator randomly selected 5, while the southern region has 10 police stations, from which 5 were also randomly selected for the study. Each police stations was considered as a stratum.

With 95% confidence interval and 80% power, the sample size calculated to be 212, but the researcher chose to include 220 participants in the present study[21]. The sample consisted of police personnel, including Constables, Head Constables, Assistant Sub Inspectors, Sub Inspectors and Inspectors at the selected police stations within Mangalore jurisdiction.

The method of sampling that was used was a disproportionate stratified random sampling technique in which the different stations of the north and south regions of Mangalore Jurisdiction were considered as 10 strata and a disproportional distribution was used to determine the individuals selected from every stratum. At the level of stratum, a list of police personnel was collected from each police station, and a lottery method of simple random sampling was used to select the 22 participants from each police station.

A pre-tested, 14-item demographic proforma was developed and used to acquire the background information of police personnel. Operational Police Stress Questionnaire (OPSQ), a 7-point standardized scale with 20 items, was used to assess the work-related stress, and Warwick Edinburgh mental well-being scale (WEMWBS), a 5-point standardized tool with 14 items, was used to assess the mental well-being among police personnel. A reliability test (Cronbach's alpha) was done to check the reliability of the tools. The reliability quotient obtained for the Kannada version of the questionnaire for work-related stress was 0.84, and for mental well-being, it was 0.74.

All police personnel were cooperative during the data collection process. The gathered data were compiled in preparation for data analysis. Descriptive analysis was conducted using Frequency, Percentage, Mean and Standard

deviation. Karl Pearson's Correlation Coefficient were computed to determine the relationship between work-related stress and mental wellbeing among police personnel. Chi-square tests were used to find the association between work related stress and mental wellbeing among police personnel with selected demographic variables.

Results

Table1: Distribution of samples according to the demographic variables.

S. No.	Demographical variables	Frequency &Percentage
1.	Age (in years)	
	a) 20-30	90 (40.9%)
	b) 31-40	57 (25.9%)
	c) 41-50	47 (21.4%)
	d) 51-60	26 (11.8%)
2.	Gender	
	a) Male	173 (78.6%)
	b) Female	47 (21.4%)
3.	Educational status	
	a) SSLC	16 (7.3%)
	b) PUC	60 (27.3%)
	c) Diploma	8 (3.6%)
	d) Graduate	120 (54.5%)
	e) Postgraduate	16 (7.3%)
4.	Marital status	
	a) Married	153 (69.5%)
	b) Unmarried	67 (30.5%)
5.	Type of the family	
	a) Nuclear family	60 (27.3%)
	b) Joint family	157 (71.4%)
	c) Extended family	3 (1.3%)
6.	Duration of work experience as police (in years)	
	a) 0 to 10	119 (54.1%)
	b) 11 to 20	45 (20.5%)
	c) 21 to 30	49 (22.3%)
	d) 31 to 40	7 (3.1%)

The level of work-related stress among police personnel was assessed using the Operational Police Stress Questionnaire and graded as follows: < 2.0 = low stress; 2.1-3.4 = medium stress; > 3.5 = high stress.

The grading of the stress level is determined by taking the average of total stress score divided by the total number of items in the Operational Police Stress Questionnaire.

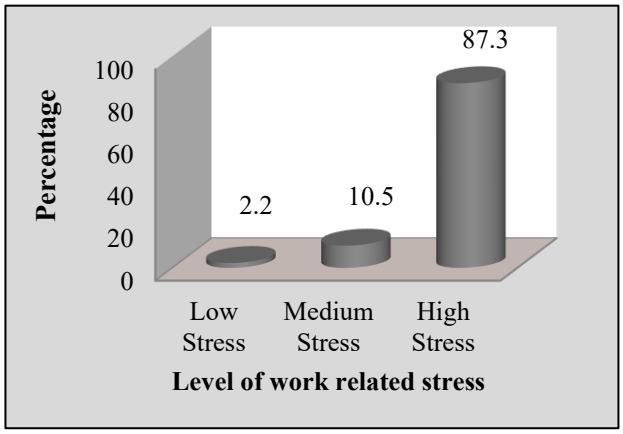

Figure 1: Distribution of police personnel according to the work related stress.

The level of mental wellbeing among police personnel was assessed using Warwick Edinburg Mental Wellbeing Questionnaire and graded as follows: 14–42 = low mental wellbeing, 43–60 = medium mental wellbeing and 61–70 = high mental wellbeing and depicted in Figure 2.

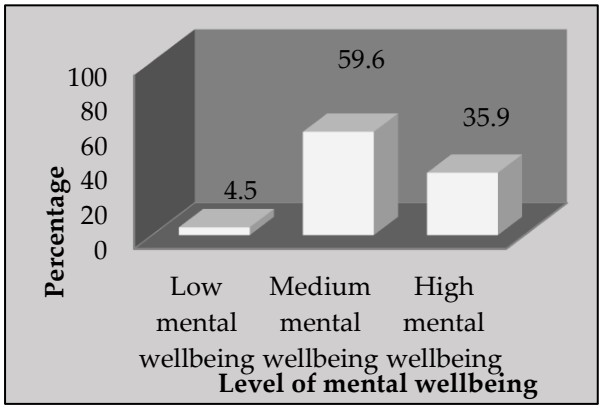

Figure 2: Distribution of police personnel according to the mental wellbeing

The obtained 'r' value (0.034) is less than the table value (0.138) at the 0.05 level of significance. Hence, the null hypothesis H_{01} was accepted and it was concluded that there is no significant relationship between work-related stress and mental wellbeing scores among police personnel as shown in the scattered diagram.

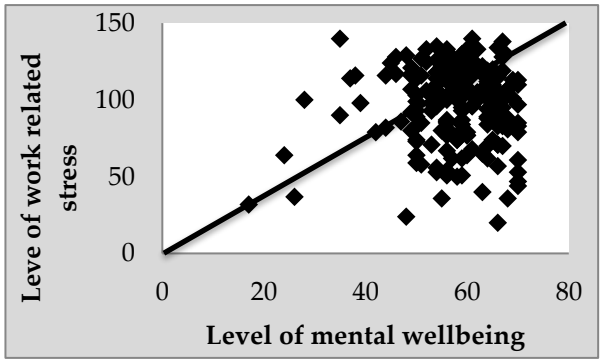

Figure 3: The correlation between work-related stress and mental wellbeing among police personnel.

Table 2: Association of work-related stress and mental wellbeing among police personnel with selected demographical variables. **n=220**

SL NO	Demographical variables	Work related stress		Mental wellbeing	
		x^2 value	p value	x^2 value	p value
1	Age	7.717	0.052	3.543	0.315
2	Gender	3.718	0.054	3.302	0.069
3	Educational status	23.087	0	2.047	0.727
4	Marital status	1.807	0.179	1.22	0.269
5	Type of family	1.244	0.537	4.322	0.115
6	Duration of work experience as police	4.576	0.206	5.783	0.123
7	Rank of job at present	6.885	0.142	8.729	0.068
8	Type of work demand	6.842	0.033	1.361	0.506
9	Duration of work per day	0.578	0.447	0.164	0.686
10	Nature of work	12.375	0.054	5.171	0.522
11	Any illness	2.086	0.149	0.012	0.911
12	Routine medical check-up	12.817	0	4.717	0.03
13	Attending any mental wellness programme from organization	5.198	0.023	3.237	0.072
14	Practice any stress reduction techniques	1.092	0.296	9.353	0.002

*Significant at ≤0.05 level of significance S- Significant, NS- Not Significant

The data presented in Table 2 indicates that there is a significant association between the level of work-related stress among police personnel of Mangalore jurisdiction and selected demographic variables such as educational status (p<0.00), routine medical check-up (p<0.00) and attending any mental wellness programme from organization (p<0.023). Since the calculated chi-square value is greater than the table value at the 0.05 level of significance, the null hypothesis (H_{02}) was rejected, and the research hypothesis was accepted.

The data presented in Table 2 indicates that there is a significant association between the level of mental wellbeing among police personnel of Mangalore jurisdiction and selected demographic variables such as routine medical check-up ($p<0.03$) and attending any mental wellness programme from organization ($p<0.002$). Since the calculated chi-square value is greater than the table value at the 0.05 level of significance, the null hypothesis (H_{03}) was rejected and the research hypothesis was accepted.

Discussion

This study assessed work related stress and mental wellbeing among police personnel, so that preventive interventions may be recommended.

The findings related to demographic variables of the present study were supported by research conducted by John-Akinola YO, et al., which indicated that the age of the respondents ranged from 22 to 59 years with a mean age of 42.1 ± 14.4. More than two fifths 138 (40.6%) of the respondents were within the age range of 22 to 32 years, and a smaller number 78 (22.9%) were in the 33 to 43 years age group. Thirty-four (10.0%) were within the age range of 44 to 54 years, while 90 (26.5%) were aged over 55 years. There were more males 187 (58.1%) than females 135 (41.9%); more than a third 108 (33.5%) of the respondents held a National Diploma qualification, 96 (28.9%) secondary education, while few 58 (18.0%) of the respondents were degree holders More than two fifths 141 (41.5%) of the respondents had been in the police force for 11 to 20 years, while only 27 (7.9%) had practiced for over 30 years[13].

This study revealed that 87.3% of police personnel were experiencing high work-related stress, 10.5% had medium stress and 2.2% police personnel had low stress. This result is marginally more than that found in another study by Queirós C, et al., in Portugal, which revealed that 88.4% of police personnel had high stress, 9% of subjects had moderate stress and only 2.6% suffered from low level of stress.[14] However, a study by Saya G K, et al., in Puducherry showed that 32.8% of police personnel had high stress, 51% were suffering from very high stress, 11.5% had average stress and 4.7% had low stress.[15]

This study revealed that 59.6% of police personnel had medium mental wellbeing, 35.9% had high mental wellbeing and 4.5% had low mental wellbeing. This finding was marginally higher than that of a study by Marshall R E, et al., in Sydney, which revealed 84.1% had low levels of mental health symptoms, 73.8% had moderate levels, and 70.3% had low levels of mental health symptoms.[16] The results of this investigation were corroborated by a cross-sectional study by Weiner C in Wisconsin, which showed the symptoms of anxiety among police personnel were 73.75%, depression 83.44% and behavioral control 90.31%.[17]

With regard to the relationship between work-related stress and mental wellbeing among police personnel, the calculated coefficient of correlation 'r' value was found to be 0.034 with 218 degrees of freedom. The correlation of the present study is supported by a study conducted by Demou E, et al., Makurdi. The study results show that there was a significant negative influence of work stress on dimensions of psychological wellbeing, with a calculated 'r' value was 0.223.[18]

The association of work-related stress among police personnel in this study is supported by a study performed by Ummaru A in Nigeria. The results showed that occupational stress had a significant association with Age ($p<2.310$), Gender ($p<51.55$), Marital status ($p<9.80$), Educational qualification ($p<20.687$), Rank ($p<255.102$), Working experience ($p<17.223$), and Income ($p<56.822$). Therefore, the null hypothesis was rejected and the research hypothesis accepted.[19]

The association of mental wellbeing among police personnel in this study is supported by a research conducted to examine the association of work-related stress with mental health problems in a special police force unit in Italy. Results showed that the Depression Inventory scores had a significant association with length of employment ($p<0.12$). Therefore, the null hypothesis was rejected.[11]

Limitations

The study included only the police personnel of law and order department. The study was limited to a survey of work-related stress and mental wellbeing and no interventions were provided to the police personnel. No follow-up was conducted after assessing their work-related stress and mental wellbeing.

Conclusion

Police personnel are the executive civil force, responsible for upholding laws for prevention and detection of crime and maintaining public order. They carry significant responsibilities due to ongoing development, democracy, and public welfare, as well as the complexities of life and social relationships. The importance of policing has grown, especially in light of advancement in technology, which have both beneficial and harmful effects on society.[20] Policing is one of the most mentally taxing jobs, contending with long and often rotating shifts, threats of violence, increased need for hyper-vigilance, and a lack of public support, all of which create chronic stress.[1] There is a need to manage work related stress to maintain the mental health[22]. Hence, this study aimed to assess work related stress and mental wellbeing among police personnel at Mangalore jurisdiction.

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Review Article

Occupational Health and Safety in the Mahabharata: An Ethical and Historical Perspective

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ABSTRACT

This paper examines how the guidelines of the Mahabharat, an epic, help to enrich Occupational Health and Safety (OHS) mechanisms in the modern context. This research examines the types of works and core ideas of OHS, including duty of care, prevention, and moral responsibility, as mentioned in the text. The study analyses risk factors and clear rules for safety and conduct. The paper answers how the work practices, safety systems, and moral laws in the Mahabharata can help improve OHS today. It explores the epic's lessons on hazard prevention, mental resilience, and medical care, and examines their relevance in modern safety culture.

The research compares the Mahabharata with current OHS concepts, focusing on safe work practices, preventive healthcare, mental readiness, and the role of moral duty (dharma). It also reveals safety principles found in the text that can be applied to enhance modern safety systems. It examines how the leaders in the workplace discharge their role and responsibilities to protect their team members. It focuses on how one can correlate one's duty with safety and mental strength to obtain success at work. It integrates ancient wisdom with modern science to support modern safety mechanisms. It also highlights the importance of moral values in improving safety culture, offering a more comprehensive approach to protecting health and dignity at work.

Keywords: Dharma, Hazard Prevention, Medical Readiness, Mental Resilience, Occupational Health and Safety, Safety Culture

Introduction

Occupational Health and Safety (OHS) focuses on physical well-being, mental resilience, and ethical responsibility to achieve success in every field of work. Industrial-era reform and legislative progress have influenced the development of OHS; however, its core principles—such as duty of care, hazard awareness, and preventive discipline—are derived from ancient cultural traditions. The traditional values have long acknowledged the moral and practical necessity of protecting individuals in hazardous occupations.

The scripture emphasizes the crucial role of human duty (dharma) in safeguarding workers in complex and often hazardous situations. The text portrays a diverse range of occupational roles, including warriors, healers, charioteers, artisans, and messengers. Each of them faces distinct risks and is guided by specific codes of conduct. Their different occupational roles also resonate with the core aims of contemporary safety practice: minimizing harm, promoting preparedness, and integrating ethical considerations into operational decision-making.

This study examines how the epic serves as both a cultural document and a framework for OHS principles. By reviewing the epic's occupational structures, safety protocols, mental resilience strategies, and medical ethics, it examines how

ancient wisdom can contribute to promoting a present-day safety culture. The research examines how moral and procedural guidance contribute to the development of conceptual foundations for modern occupational health. In doing so, it demonstrates that the technical requirements of the workplace alone cannot safeguard human well-being in the absence of ethical practices.

Research on Occupational Health and Safety (OHS) encompasses a broad range of disciplines, including literary analysis, historical studies, and modern safety theory. Scholars assemble around a few recurring themes that connect the epic's narratives with contemporary safety concepts. Several critics emphasize the Mahabharata's moral framework (dharma) as a foundation for hazard prevention and responsible conduct. Alf Hiltebeitel highlights the scripture's sustained focus on moral duty under dangerous conditions, presenting dharma as a safeguard for individuals and communities.[1] J. L. Brockington and Bibek Debroy focus on it by noting the rules of war that enshrine the principles of prohibiting attacks on the unarmed, mandating time-bound combat, and protecting noncombatants to control hazards.[2,3] These policies parallel modern ethical guidelines in workplace safety. Kisari Mohan Ganguly's accounts of charioteers' stress discipline, trust, and adherence to code.[4] Similarly, Eknath Easwaran and W. J. Johnson draw connections between Krishna's teachings and moral decision-making in moments of occupational stress.[5,6] These works assert that ethics is both a protective and guiding force in high-risk environments.

A second group of critics highlights the epic's focus on structural developments for safety measures and hazard-control practices. P. V. Kane identifies ancient prescriptions for tool quality, fortifications, and structural design as early equivalents of engineering controls.[7] K. K. Bhishagratna and Dominik Wujastyk examine battlefield medical readiness, emphasizing triage, sanitation, and immediate intervention as preventive measures.[8,9] Modern OHS scholars such as Ashutosh Tewari and Antonio R. Paiva advocate for probabilistic safety assessment. Yang Wang and colleagues highlight communication efficiency in safety-critical situations.[10] Both reflect practices visible in the Mahabharata's coordinated battlefield strategies. These works collectively suggest that hazard management in the epic anticipates layered safety systems in modern industry.

Another body of literature connects the epic's moral and spiritual guidance to mental health resilience in occupational contexts. Easwaran interprets Arjuna's battlefield paralysis as a form of stress injury that is addressed through cognitive reframing.[5] W.J. Johnson emphasizes detachment (vairāgya) and disciplined action (karma-yoga) as coping mechanisms.[6] J.L. Brockington notes that emotional discipline is required across all high-risk roles, not only for warriors.[2] Bhishagratna and Wujastyk both underscore the importance of mental composure for precision work.[8,9] James Reason and Sidney Dekker relate psychological safety to trust, adaptability, and open communication.[3,11] C. Shamasundar's modern perspective on resilience as a cultivated, adaptive state reinforces the enduring value of the epic's mental-strength teachings.[12]

A group of scholars links the scripture's medical narratives to ethical healthcare and occupational well-being. Kaviraj Kunja Lal Bhishagratna's translations of the Sushruta Samhita and Wujastyk's studies of Ayurveda reveal classifications of occupational diseases, surgical procedures, and preventive protocols.[8,9] Pandurang Vaman Kane underscores the healer's obligation to treat even enemies, showing a universal duty of care.[7] Modern critic P. Saik, in his article "Cultural Dimensions in Hazard-Risk Assessment Methodology," upholds hazard-assessment frameworks in the current safety literature, aligning with this focus on prevention, readiness, and leadership responsibility.[13] The combined work of these scholars shows that the epic embeds a preventive safety culture centuries before it became formalized in modern OHS practice.

Finally, several critics explicitly connect ancient narrative ethics with modern safety science. James Reason's systems approach and Sidney Dekker's human-error analysis provide frameworks for understanding the epic as a multi-layered safety model.[3,11] Sasmita Samanta and Jyotiranjan Gochhayat's critique of India's construction sector14 and G. Ramachandran and Panneer Sigamani's warnings about unregulated occupational expansion illustrate modern risks that parallel the epic's cautionary episodes.15 Michael M. J. Fischer and Iavicoli et al. explore the role of ethical decision-making under uncertainty, echoing the text's portrayal of leaders who choose safety over expedience.16,17 These convergences demonstrate that the scripture can serve as a living case study

Methods

This study employs a qualitative research methodology that treats the epic as a cultural and occupational document, in addition to a literary masterpiece. The research is based on close textual analysis, focusing on narrative episodes that depict occupational roles, hazard-prevention measures, ethical obligations, and medical practices. These depictions are examined within their historical and cultural context. They are then systematically compared with the conceptual foundations of contemporary Occupational Health and Safety (OHS). The aim is to uncover resonances between ancient narrative ethics and modern safety science. It demonstrates that the safeguarding of human well-being is both a timeless and cross-cultural phenomenon. It examines authoritative English translations of the Mahabharata by Bibek Debroy, Kisari Mohan Ganguly, Alf Hiltebeitel, Eknath Easwaran, and W. J. Johnson as primary sources. These translations serve as the textual foundation for identifying occupational categories, role-specific hazards, and safety protocols in the epic. Findings are compared with secondary scholarship from history, ancient Indian law and medicine, safety engineering, occupational risk management, and resilience research. This dual focus preserves both the historical accuracy of the epic's practices and their modern relevance. A comparative lens shapes the research, aligning ancient ethics with today's OHS standards, including hazard identification, risk control, preventive care, leadership duty, and psychological safety. The aim is not merely to draw an analogy, but to explore how principles such as integrating dharma with safety recur across time and cultures. This method highlights universal safety values while respecting the distinct contexts of ancient and modern work.

The scripture has been extensively studied for its philosophical, ethical, and political insights; however, its systematic portrayal of occupational roles and safety practices remains largely unexplored. Existing literature often isolates specific aspects such as the rules of war and the moral teachings of the Bhagavad Gita. It fails to recognize the broader, integrated safety culture present throughout the epic. At the same time, contemporary OHS scholarship rarely engages with pre-industrial literary sources as legitimate frameworks for hazard prevention, ethical leadership, and occupational well-being. This absence creates a gap at the intersection of literary studies, history, and occupational health. The present research addresses this lacuna by offering a comprehensive, interdisciplinary analysis that connects the ancient occupational wisdom of the epic with modern OHS theory, positioning workplace safety as both a technical discipline and an enduring ethical mandate. Industrialization, labor rights movements, and contemporary regulations continue to shape Occupational Health and Safety (OHS) standards, often disregarding moral and social norms and values. However, the epic shows that moral, procedural, and social codes contribute to protecting workers. It comprises various occupational roles, ranging from warriors and charioteers to healers, artisans, diplomats, and ascetics. It asserts that explicit duties (svadharma) and implicit safety measures govern each role. Its narratives focus on an understanding of role-specific hazards, the necessity of preventive measures, and the interdependence of ethical duty and operational safety. Examining these depictions alongside contemporary OHS theory offers a rare opportunity, drawing on the insights from a pre-industrial context. The rationale for this study is that combining ancient wisdom with modern practice can enhance occupational health and safety. For literary studies, it unveils the epic's role in occupational ethics and hazard management. For OHS, it urges to go beyond industry and rules to lasting human values and cultural safety principles. The study presents a framework that links technical skills with ethical duty, demonstrating that workplace safety reflects moral values deeply rooted in human history.

Results

The epic portrays a diverse range of occupational roles, each with its own distinct hazards and responsibilities. Battle codes (yuddha-dharma) govern Warriors (kṣatriyas) by prohibiting them from striking the unarmed, restricting combat after sunset, and mandating the inspection of weapons and armour. Charioteers (sārathis) ensure safety through route selection, equipment checks, horse management, and battlefield communication, emphasizing their interdependent role with warriors.

Healers (vaidyas) perform surgical interventions, wound care, and sanitation in hazardous conditions. They adhere to ethical duty by treating all the wounded, including enemies. Artisans and craftsmen manufacture weapons, erect fortifications, and maintain war equipment, paying attention to the proper use of tools, quality workmanship, and the reliability of structures.

Messengers and diplomats undertake perilous journeys across hostile territories, confronting risks of ambush and volatile negotiations.

The text also depicts that ascetics and sages are involved in war. However, they encounter environmental and psychological challenges, such as extreme weather, resource scarcity, isolation, and mental fatigue. Their reliance on discipline, austerity, and resilience illustrates an awareness of occupational strain beyond the battlefield.

Across all roles, the epic highlights preventive safety measures, including fortification design, signaling systems, inspections of chariots and weapons, and provision of healing spaces. Psychological readiness is also emphasized, with Arjuna's battlefield paralysis and Krishna's counsel serving as a narrative example of mental strain and recovery. The epic links occupational responsibilities with safeguards against physical and psychological risks. These results illustrate that the epic incorporates safety awareness into the very structure of occupational duties. It also presents a spectrum of physical, ethical, and psychological safeguards. The following discussion interprets these findings in relation to contemporary Occupational Health and Safety (OHS) principles, highlighting their enduring relevance.

Discussion

The scripture presents even hazardous occupations as a part of an individual's moral duties (svadharma). Every individual is assigned role-specific responsibilities and provided with safeguards to protect them. Alf Hiltebeitel, in Rethinking the Mahabharata, emphasizes that the epic's occupational diversity allows it to explore risk from multiple social perspectives, including martial, diplomatic, artisanal, and medical spheres.[1] Warriors (kṣatriyas) face a high risk, engaging in combat under strict ethical rules. J. L. Brockington, in The Sacred Thread, explains that these rules—such as prohibitions against attacking an unarmed opponent or fighting after sunset are forms of hazard minimization that maintain a balance between valor and safety.[2] Similarly, Bibek Debroy, in The Mahabharata, points out that battlefield discipline extended to weapon maintenance, armor inspection, and pre-combat drills, all of which align with modern preventive safety measures.[18]

The charioteers (sārathis) play a crucial safety role for both themselves and the warriors they transport. Kisari Mohan Ganguly, in The Mahabharata of Krishna-Dwaipayana Vyasa, notes that charioteers have various responsibilities like route planning, equipment checks, and managing horses under extreme stress. They take essential safety measures to prevent accidents during battle.[4] The relationship between warriors and charioteers often depends on their mutual trust. Their relationship reflects the modern concept of safety interdependence among co-workers in high-risk environments. The healers (vaidyas) play an equally crucial role on the battlefield, managing medicine and ensuring post-injury recovery. K. K. Bhishagratna, in The Sushruta Samhita, documents the surgical techniques, wound classification, and sanitation practices of healers, which echo the depiction of their medical care.[8] Dominik Wujastyk in The Roots of Ayurveda underscores that these healers work under hazardous conditions, often in proximity to ongoing combat. They perform their duties with technical expertise and situational awareness.[9] The charioteers and healers in the epic adhere to their workplace ethical guidelines, which protect them from potential accidents and hazards.

Artisans and craftsmen manufacture weapons, build fortifications, and maintain war equipment, even as they face hazards associated with metalwork, carpentry, and construction. P. V. Kane, in History of Dharmaśāstra, points out that the Mahabharat recognizes the dangers of such work and prescribes guidelines for quality control, proper tools, and safe working environments.[7] These preventive measures resemble modern industrial safety standards for manufacturing sectors. Sasmita Samanta and Jyotiranjan Gochhayat, in Health and Safety Practices in Indian Construction Sector, highlight that poor training, unsafe ergonomics, lack of personal protective equipment, and weak safety culture increase risks in the Indian construction sector.[14] Likewise, G. Ramachandran and Panneer Sigamani, in Occupational Health in India: Present Scenario and Future Challenges, warn that rapid industrial growth without integrated OHS reform often puts worker protection at risk.[15] In the epic, Warriors follow battle ethics to reduce unnecessary harm, charioteers choose safe routes to prevent accidents, and craftsmen use proper tools to avoid injury. By linking safety to both rules and job responsibilities, the epic has created a structured way to prevent harm in every occupation. V. Mhalshekar, in Occupational Health: A Foundation for Sustainable Development, emphasizes that occupational health is foundational to sustainable development, mirroring the Mahabharata's holistic integration

of safety within societal well-being.[19] Beyond the battlefield, messengers and diplomats undertake perilous journeys to deliver communications or negotiate peace. Alf Hiltebeitel notes that the messengers and diplomats navigate hostile territories, encounter the threats of ambush, and deal with political volatility.[1] These duties parallel modern high-risk roles in security, peacekeeping, and crisis negotiation, where individuals confront danger and protect lives skillfully and strategically.

In the epic, ascetics and sages face environmental hazards, including extreme weather, scarcity of food and water, and encounters with wild animals in remote forests. They also endure significant psychological strain, such as long periods of isolation, rigorous self-denial, and mental fatigue. These conditions require discipline, mental resilience, and physical endurance. Eknath Easwaran, in The Bhagavad Gita, highlights the importance of discipline, mindfulness, and self-regulation as key roles to maintain workplace safety. He further asserts that their roles help them prevent mental strain and physical harm during prolonged austerities.[5] The scripture focuses on an awareness of job-specific hazards and role-based safety measures to create a proper ambience in the workplace. James Reason, in Managing the Risks of Organizational Accidents, argues that effective safety management requires context-specific protocols rather than one-size-fits-all rules.[11] The epic mirrors this principle, showing that safety practices are adapted to the unique risks of each profession. Sidney Dekker in The Field Guide to Understanding 'Human Error' suggests that such narrative case studies offer valuable training material for cultivating adaptive thinking in hazardous environments.[3] The epic blends tales of valor with rules and customs that serve as safety protocols. Alf Hiltebeitel points out that the epic's code of war (yuddha-dharma) operates as a regulatory framework designed to limit unnecessary harm and maintain a degree of safety even in lethal contexts.[1] One of the most explicit protocols is the bar against attacking an unarmed opponent. J. L. Brockington, in The Sacred Thread, explains that this rule reduces the likelihood of enemies exploiting weaknesses and helps prevent avoidable battlefield accidents.[2] Likewise, Bibek Debroy observes that time-bound combat—ending at sunset—functions as a rest and recovery mechanism, reducing fatigue-related mishaps.[18] The epic stresses that regular supervision and monitoring of weapons and armor are mandatory for their safety purpose. Such activities ensure regular inspection, repairs, and proper storage, guaranteeing the reliability of their work in battle and preventing accidents. Kisari Mohan Ganguly notes that before each day's battle, warriors inspect and test their equipment to ensure reliability, much like modern preventive maintenance protocols in hazardous industries.[4] The epic highlights the importance of the regular maintenance of chariots, as poorly maintained chariots endanger both the user and the allies in close formation. In the epic, the charioteer makes continuous risk assessments. They perform pre-run checks and select safe routes. They also control speed and balance and protect against missiles. Likewise, they maintain communication and rehearse emergency drills.

Ganguly records that skilled sārathis (charioteers) select terrain routes to reduce the risk of overturning, avoiding muddy or uneven ground that could trap wheels.[4] These approaches parallel modern vehicle safety inspections and route risk assessments in logistics and military operations. K. K. Bhishagratna connects battlefield safety to medical readiness. He highlights the need for immediate triage areas to treat injuries before they become fatal.[8] This principle mirrors the modern requirement of first-aid stations and rapid response teams in high-risk workplaces. Dominik Wujastyk, in The Roots of Ayurveda, adds that preventive health measures, such as proper hydration and a balanced diet, are recommended for those in physically demanding roles.[9] Trained personnel can maintain safety skillfully and reduce the risk of accidents in the workplace.

In the text, fortifications and defensive structures play a crucial role in hazard management, as they protect against enemy attacks and mitigate battlefield risks. P. V. Kane asserts that ancient prescriptions for wall strength, gate security, and watchtower placement are meant to protect inhabitants and defenders from surprise attacks.[7] These architectural safeguards can be compared to contemporary occupational safety barriers and engineering controls, which are designed to prevent harm before it occurs. In Modeling and Mitigation of Occupational Safety Risks in Dynamic Industrial Environments, Ashutosh Tewari and Antonio R. Paiva argue for probabilistic, data-driven safety assessments in dynamic environments, reflecting the epic's emphasis on vigilance and readiness.[20] Similarly, Yang Wang et al. highlight the necessity of clear, rapid communication in safety-critical contexts, akin to the Mahabharata's signaling systems.[10] From a design perspective, the modern idea of Prevention through Design (PtD)—incorporating

safety into processes from the very beginning—mirrors the epic's focus on pre-emptive battle planning and thorough infrastructure checks.

In the epic, warriors follow strict codes of honor in one-on-one duels. Both must give consent before they fight. They use equal weapons and begin only when both are ready. They avoid striking an opponent who is unarmed, injured, or distracted. These rules uphold the epic's ideal that even in warfare, combat should be guided by fairness, discipline, and respect for one's opponent. Easwaran emphasizes Krishna's insistence on aligning warfare with moral law, specifically avoiding the use of prohibited weapons and deceptive tactics during war.[5] This ethic resonates with modern regulatory bans on unsafe tools in the workplace. James Reason, in "Managing the Risks of Organizational Accidents," argues that such layered safety defenses—rules, training, equipment checks, and environmental controls—are key to preventing incidents.[11] The Mahabharata's approach, as Sidney Dekker suggests, shows an early understanding that safety is achieved through multiple reinforcing systems rather than a single precaution.[3] Multiple approaches are required to retain safety in the workplace. Every party should follow certain norms for maintaining safety mechanisms.

The epic offers profound insight into the mental dimension of occupational health, particularly the emotional and psychological strain experienced in high-risk roles. Alf Hiltebeitel notes that the epic consistently addresses the inner turmoil of its characters. It reveals how mental resilience is as critical as physical readiness in hazardous occupations.[1] The most crucial case of psychological strain occurs when Arjuna, facing his kin on the battlefield, experiences acute emotional paralysis. Easwaran interprets this moment as a form of stress reaction. The overwhelming moral and emotional weight impairs operational capacity. Krishna's response, Easwaran explains, acts as a form of cognitive reframing, helping Arjuna reconnect with his sense of purpose and duty.[5] W. J. Johnson in The Bhagavad Gita points out that Krishna's teachings include mindfulness (smṛiti), detachment (vairāgya), and disciplined action (karma-yoga), aligning with modern occupational stress management techniques.[6] Arjuna overcomes his mental confusion through Krishna's cognitive reframing.

J. L. Brockington, in The Sacred Thread, emphasizes that mental preparedness should be reserved for warriors, messengers, charioteers, and healers, enabling them to function calmly and effectively amid danger.[2] The training for such roles often includes moral instruction, reflective practices, and the cultivation of inner calm. K. K. Bhishagratna underlines the importance of emotional equilibrium for physicians to enhance diagnostic accuracy and surgical performance.[8] Dominik Wujastyk, in The Roots of Ayurveda, adds that mental health cannot be separated from physical well-being. A proper dietary balance, effective breathing practices, and a meditative focus are essential for maintaining psychological resilience.[9] P. V. Kane notes that leaders in the epic demonstrate composure under duress, modeling stability for their followers.[7] This model teaches modern organizational leaders to act as role models to boost the morale of the team and their performance. James Reason asserts that psychological safety means speaking up about concerns fearlessly for reliable operations.[11] The epic shows that the warriors and charioteers discuss openly the risks they face, having developed mutual trust with each other. Sidney Dekker explains that resilience is not just about enduring hardship. It is also about adapting when situations change.[3] The epic reflects such capability of the characters who change strategies during battle and adjust plans to deal with new dangers, maintaining equanimity of mind even under heavy pressure.

In the story, even ascetics who stay away from battle face mental challenges, passing through loneliness, exhaustion from strict living, and resisting temptation. Easwaran observes that they remain strong through discipline and a clear sense of purpose.[5] These lessons also apply to stressful modern jobs. C. Shamasundar in Resilience as an Adaptive Capacity in Indian Psychology shares a similar view, stating that mental health is an adaptive state built through planned coping methods and strong moral values. Arjuna shows this when he changes and grows under Krishna's guidance.[12] The epic shows that maintaining safety is possible only by integrating both ethical duty (dharma) and physical precautions. In Rethinking the Mahabharata, Alf Hiltebeitel emphasizes that moral responsibility serves as a guiding principle for human conduct in dangerous situations. This ensures that power is used with care to protect life.[1] P. V. Kane explains that leaders and warriors in the epic adhere to their duty to safeguard both their allies and their adversaries by refraining from attacking the wounded or unarmed.[7] This ethic parallels modern occupational safety laws that require employers to protect all workers in the workplace,

regardless of rank or status. L. Brockington observes that the code of conduct covers all jobs, from artisans to healers.[2] Each job has its own safety rules, which act like informal laws, making people responsible and stopping harm before it happens. Bibek Debroy, in The Mahabharata, notes that adherence to these moral duties often supersedes immediate tactical advantage, as seen in instances where combatants spare opponents who have lost their weapons.[18] This focus on ethics mirrors the modern rule that no task is too urgent to do safely. Eknath Easwaran interprets Krishna's counsel to Arjuna as an insistence on right action (karma) - acting in alignment with one's duty while avoiding harm wherever possible.[5] W. J. Johnson highlights Krishna's repeated emphasis on self-control and integrity. He notes that these virtues prevent reckless or negligent behavior that could endanger others.[6] Ethical discipline thus becomes a protective mechanism in hazardous occupations. K. K. Bhishagratna links professional ethics directly to patient safety, stating that a physician who acts with compassion and diligence reduces the likelihood of medical errors.[8] Dominik Wujastyk reinforces this point, noting that ancient Indian medical codes place moral integrity on par with technical skill for ensuring treatment safety.[9]

James Reason argues that a strong just culture, where fairness and accountability coexist, is the foundation for a robust safety environment.[11] The Mahabharata reflects this in its insistence on proportional responses to harm and in its condemnation of treachery in combat. Sidney Dekker observes that ethics shape safety decisions in moments of uncertainty, guiding individuals to choose protective actions even when immediate rules are unclear.[3] Proper response to harm and ethics are required to sustain safety.

These ancient principles find echoes in modern OHS scholarship. In "Ethical Considerations in Healthcare Practice under Conditions of Uncertainty," Michael M. J. Fischer identifies weaknesses in contemporary healthcare ethics, such as fragmented moral engagement and tolerance of uncertainty, underscoring the need for personal accountability—qualities that the epic models consistently exhibit.[16] Similarly, Iavicoli et al. explore the ethical dilemmas faced by occupational health professionals as they balance stakeholder interests, confidentiality, and transparency. They also emphasize that a strong moral core is essential for safety decision-making.[17] In Balancing Duty, Utility, and Virtue in Safety-Monitoring Technologies, Ajslev et al. have proposed the Duty-Utility-Virtue (DUV) framework for evaluating safety-monitoring technologies. The framework reinforces the enduring value of integrating moral virtues into safety governance, a practice deeply embedded in the Mahabharata's warfare and occupational conduct.[2]

The epic devotes considerable attention to medical care, disease prevention, and the healer's ethical duty to preserve life. Alf Hiltebeitel points out that the presence of physicians on the battlefield and the repeated emphasis on healing reflect a broader cultural commitment to sustaining health even amidst war.[1] K. K. Bhishagratna, giving detailed surgical methods, wound classification, and sanitation practices, explains that such procedures align with the Mahabharata's accounts of battlefield care. Injuries are treated quickly, and healers follow strict guidelines to protect life and uphold their duty.[8] These include cleansing wounds with herbal decoctions, using surgical instruments for the extraction of embedded arrows, and applying antiseptic pastes to prevent infection. Dominik Wujastyk emphasizes that preventive measures are as necessary as curative ones. He recommends regulating diet, maintaining hydration, and getting adequate rest to maintain resilience under strenuous conditions.[9] These instructions parallel modern occupational health programs that address fatigue management and nutrition for workers in physically demanding roles. Bibek Debroy explains the role of the Ashvins, divine physicians, who were invited to restore critically injured warriors and return them to battle.[18] Their interventions, often combined with surgical skill and restorative tonics, symbolize the integration of emergency care and rehabilitation. P. V. Kane, in History of Dharmaśāstra, observes that ancient Indian legal and moral codes hold healers to strict ethical standards, including the obligation to treat even the wounded enemy.[7]

J. L. Brockington explains that healers in the epic are active participants in the operational safety network. They ensure that injury does not escalate into fatality so that fighters can return to their duties with minimal long-term impairment.[2] Eknath Easwaranb interprets Krishna's emphasis on balance and self-care as equally applicable to physical health. He suggests that sustaining the body is essential for fulfilling one's duty effectively.[5] Similarly, W. J. Johnson, in The Bhagavad Gita, notes that disciplined living, moderation in diet, and regulated rest are presented as prerequisites for both mental clarity

and physical readiness.6 James Reason argues that preventive systems—such as regular health monitoring, safety drills, and protective equipment—are more effective than relying solely on reactive measures.[11] The Mahabharata reflects this logic in its insistence on preparation and readiness long before conflict begins. Sidney Dekker adds that medical readiness is part of a larger safety culture, where the health of individuals is seen as a collective responsibility.[3] Such a culture fosters both physical and mental capability to meet challenges, mutual trust, and resilience. In both epic narrative and modern safety science, readiness is not a reactive measure but an ongoing embedded practice that strengthens collective approaches before crises emerge. During their exile years, they hone their martial skills, maintain physical fitness, and cultivate mental fortitude. Their overall growth exemplifies how preparedness is built into the very fabric of survival and eventual success. This case mirrors the preventative ethos found in contemporary safety and health systems.

Conclusion

The Mahabharata emphasizes holistic approaches to maintaining occupational health and safety. It integrates both technical, moral, and psychological aspects to ensure workplace safety. Role-specific safeguards are implemented to protect warriors, charioteers, healers, artisans, and others. It stresses hazard prevention, medical readiness, and leadership responsibility. Thus, the scripture explains that the real workplace safety results from the integration of technical measures, moral responsibility, and mental resilience.

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Review Article

Occupational safety and health in Ecuador: legal frameworks, labor inspectorate challenges and insights

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ABSTRACT

Introduction: Occupational Safety and Health (OSH) is crucial to the well-being and productivity of workers, necessitating robust legal frameworks and effective enforcement. In Ecuador, despite comprehensive legislation, challenges persist in ensuring compliance and protecting workers from occupational risks. This study aims to examine the existing legal framework of OSH in Ecuador, highlight the challenges faced by the labor inspectorate, and provide insights into improving worker protection, with a specific focus on the province of Cañar.

Methods: This research employed a qualitative approach, utilizing inductive, analytical, synthetic, and deductive methods. The study applied a bibliographic review and documentary analysis to synthesize existing knowledge and critically examine the legal framework of OSH in Ecuador. It specifically investigated the practices of the labor inspectorate in the province of Cañar, including the types of documents requested during inspections.

Results: The findings indicate that while Ecuador possesses an extensive legal framework for OSH, its enforcement is significantly hindered by an acute shortage of labor inspectors (0.04 inspectors per 10,000 workers) and inconsistent inspection procedures. Specifically, in Cañar, labor inspectors often fail to request crucial documentation related to workplace safety and health, leaving employers unchecked. It leads to inadequate supervision of occupational risks, contributing to a high incidence of workplace accidents and diseases, as evidenced by 301 reported accidents in Cañar in 2021. This situation constitutes a violation of constitutional principles and the fundamental rights of workers.

Conclusion: The study concludes that there is an urgent need to strengthen Ecuador's labor inspection system. Recommendations include increasing the number of labor inspectors, standardizing inspection procedures to ensure consistent review of all relevant OSH documents, improving training and awareness for both employers and workers, enhancing state oversight and accountability of inspectors, and imposing stricter penalties for non-compliance. Implementing these measures is crucial to ensure adherence to OSH regulations, protect workers' rights, and foster safer working environments in Ecuador.

Keywords: Labor inspection, Labor law, Occupational risks, Working conditions, Workplace safety

Introduction

Workers are exposed to various occupational risks while performing their duties,[1] which may harm their fundamental rights (health, life, and integrity). These rights are recognized and protected by both national and international regulations. Occupational risks are "the physical, psychological, chemical, environmental, social, and cultural factors acting upon the individual".[2] Similarly, the Andean Instrument on Occupational Safety and Health (2004), in subsection (e) of Article 1, describes occupational risks as "the likelihood that exposure to a hazardous environmental factor at work causes illness or injury".[3]

The Ecuadorian Labor Code considers occupational risks as "(...) the harmful events to which a worker is exposed during or as a result of their activity. For employer liability, occupational risks include professional diseases and accidents".[4] Moreover, occupational risks comprise factors or events, including chemical, physical, social, and psychological hazards, that may harm individuals during their work activities, potentially leading to accidents or occupational diseases. Employers bear responsibility for inadequate risk management.[5]

These occupational risk factors result in two harmful events: workplace accidents and occupational diseases. First, a workplace accident is defined as " any unforeseen and sudden event causing bodily harm or functional disturbance to the worker as a result of or during the work performed for someone else".[4] Similarly, Ecuador's National Court of Justice (2013), in ruling 0272-2013-SL, declares that, legally and doctrinally, a workplace accident is a harmful event that occurs during or as a result of work, entitling the affected worker to compensation or reparation.

There is significant debate about the scope of OSH. One perspective sees these as inseparable concepts, while another argues they are distinct sciences with independent applications. Proponents of the first perspective assert that occupational safety and health are an indivisible pairing with mutual influence, aiming to protect workers.[6–8] Meanwhile, the second view regards workplace safety as encompassing actions within production processes, machinery use, workplace settings, or worker habits aimed at preventing workplace accidents.[9] In contrast, occupational health focuses on preserving health by identifying and controlling factors that cause harm[10]. Furthermore, OSH is defined as "a multidisciplinary field concerning the protection, safety, health, and well-being of people involved in work."[2] Therefore, safety focuses on the work environment, while health emphasizes the well-being of the worker.

Historically, occupational safety and health were studied and considered independent sciences with autonomous applications. However, it is now recognized that they share a common purpose: protecting workers during their activities. As such, these fields complement each other to such an extent that they form a unified field of study. Health cannot be ensured without proper safety measures, and vice versa. Thus, implementing occupational safety and health as an integrated field is essential for achieving its objectives.

Identifying the two fields of action is necessary to establish the indivisibility of occupational safety and health. Occupational safety encompasses non-medical prevention methods to combat workplace accidents[11]. According to World Health Organization (WHO), occupational health involves activities that define measures to protect workers' health. The distinction between these areas is presented in Table 1.[8]

Throughout its history, the International Labor Organization (ILO) has issued several international conventions on OSH, which aim to protect workers through actions by member states. Table 2 provides a timeline of these conventions.

Table 1: Action fields in Industrial Safety and Occupational Health[7]

Industrial Safety	Occupational Health
Ergonomics	Industrial Hygiene
Environmental Analysis	Occupational Medicine
	Occupational Mental Health

Table 2: ILO conventions timeline[12]

Year	Convention
1964	The Hygiene (Commerce and Offices)
1979	The Occupational Safety and Health
1981	The Occupational Safety and Health
1985	The Occupational Health Services
1988	The Safety and Health in Construction
1995	The Safety and Health in Mines Convention
2001	The Safety and Health in Agriculture
2006	The Promotional Framework for Occupational Safety and Health

Considering this historical reality, it is notable that Ecuador, like many Latin American countries, experienced delays in developing labor law. During the early republic, the economy was primarily agricultural and artisanal. However, the exploitation of oil and the move from rural to urban living necessitated the regulation of labor relations. In 1916, the workday was regulated; in 1921, workplace risks were addressed; and in 1938, the Labor Code was enacted.[13]

Within this context, the 1938 Labor Code established foundational principles, including individual contracts, workday duration, rest periods, and occupational risk prevention[14]. In 1975, the Regulations on Workplace Safety and Hygiene came into force to prevent occupational risks.[15] These regulations were repealed in 1986 by Executive Decree No. 2393, which enacted the Regulations on Workplace Safety and Health and Environmental Improvements at Work. This decree established the State's role as a guarantor of worker safety and remains in effect today.[16]

Subsequently, the 1990 General Regulations on Occupational Risks Insurance were issued, followed by the 1998 Regulations on Safety for Construction and Public Works. In 2001, the Social Security Act was enacted, and in 2011, the General Regulations on Occupational Risks Insurance were issued. These regulations were replaced in 2016 by updated regulations. Collectively, these provide broad legal coverage within Ecuador's domestic legal framework.

OSH initially emerged as a dual discipline focused on preventing risks to which workers are exposed during their activities. However, this subject transcends such a simple concept. Occupational safety and health are fundamental rights for workers and are integral to the concept of decent work proposed and developed by the ILO.

Despite multiple legal frameworks governing Occupational Safety and Health (OSH) in Ecuador, there is a lack of comprehensive studies that compile and analyze national and international regulations in a single, structured manner.[17] Previous research has primarily focused on isolated aspects of OSH, such as specific laws, compliance issues, or enforcement mechanisms, without offering a holistic view of the regulatory landscape.[18] Therefore, this study aimed to fill that gap by consolidating and critically analyzing Ecuador's legal framework on OSH, including constitutional provisions, labor laws, international treaties, and government responsibilities such as

those of the Ecuadorian Ministry of Labor. This research provides an exhaustive and detailed overview, serving as a valuable resource for policymakers, labor authorities, employers, and researchers seeking to navigate and improve OSH regulations and enforcement. It also highlights gaps in labor inspections, using the case study of the labor inspectorate in the province of Cañar as an example, and proposes reforms to enhance compliance and worker protection.

Ecuador: Legal Framework for OSH Protection

In Ecuador, the right to OSH is regulated and protected by the legal framework, which includes the Constitution, international instruments, regional agreements, conventions, the Labor Code, and other relevant laws.[16]

National Legislation

The Constitution of the Republic of Ecuador (CRE) is the supreme legal norm of the Ecuadorian legal framework. Article 33 declares that work is both a right and a social duty, and it must be performed under healthy conditions, respecting the dignity, life, and other rights of workers. Similarly, Article 32 establishes the State as the principal guarantor of the right to health, which is closely connected to other rights, such as the right to labor.[19]

The right to work is also supported by principles outlined in Article 326 of the Constitution. Paragraph 5 states: "Every individual has the right to carry out their work in an appropriate and conducive environment that guarantees their health, integrity, safety, hygiene, and well-being."

At a sub-constitutional level, there is also extensive regulation. For example:

• Article 42, paragraphs 2 and 3 of the Labor Code stipulates that employers must comply with preventive measures concerning workplace safety and hygiene. Additionally, employers must compensate the affected worker if an occupational accident or disease occurs.[4]

• The Social Security Act (2001) includes provisions for occupational risks and diseases under its social security framework, aiming to protect employers and employees. The law emphasizes prevention and rehabilitation, offering support for physical, mental, and professional reintegration in the event of incidents.

• The General Regulations on Occupational Risks Insurance (2016) define the scope of insurance coverage for injuries or illnesses resulting from work. They also regulate benefits for damage caused by workplace accidents or occupational diseases that impede work activities.

• Executive Decree No. 2393 of 1986 issued the Regulations on Workplace Safety and Health and Environmental Improvements at Work. These regulations, still in effect today, emphasize the implementation of minimum measures to prevent, mitigate, or eliminate occupational risks and improve the work environment. Article 1 states:

"The provisions of these Regulations shall apply to all work activities and workplaces. Their objective is preventing, reducing, or eliminating occupational risks and improving the work environment".[20]

International Legislation

Ecuador has also ratified international agreements on OSH:

• The country has ratified 32 ILO conventions, including those related to OSH.

• Ecuador has adopted regulations from the Andean Community of Nations (CAN), such as Decision 584: Andean Instrument on Occupational Safety and Health, later regulated by Resolution 957. This decision aims to reduce, prevent, or eliminate workplace risks across member countries.[3] Table 3 offers a comprehensive list of the OSH legislation in Ecuador.

Table 3: OSH Legislation in Ecuador

International Agreements	National Laws	Executive Decrees	Ministerial Agreements	ILO Conventions
- Decision 584 - Resolution 957	- Labor Code - Social Security - Education Act - Judicial Act - Public Safety	- Decree 860 - Decree 2393	- AM-Nro-MDT-2020-001 - AM 13 - AM 82 - AM 135 - AM174	- CVN 024 - CVN 029 - CVN 077 - CVN 078 - CVN 113 - CVN 148 - CVN 162

Source: Ministry of Labor Ecuador; adapted by the authors

The Importance of OSH in Labor Law

Labor law regulates wage-based labor relationships, both individual and collective, between employers and workers. These regulations impose obligations on employers, such as providing wages and meeting legal requirements.[21] Under existing laws, labor law governs contractual relationships between employers and workers, emphasizing key components such as mutual consent and bilateral obligations.[22] In Ecuador, the Labor Code aims to guarantee and protect workers' rights. It regulates the relationship between employees and employers and imposes sanctions for non-compliance.[23] Thus, the Labor Code reflects the balance of power between capital and wage labor.[24]

Furthermore, OSH is a right and a duty. For employers, it is an obligation. For workers, it is a right and a responsibility. Employers must inform workers about the risks inherent in their work and take action to prevent, mitigate, or eliminate them. They must protect the integrity, health, and safety of their employees and others in the workplace.[25,26] Additionally, workers have the right to a safe and healthy workplace, supported by the protective principle of labor law. The State and employers must ensure working conditions that uphold workers' dignity and personal development.[26]

It is fundamental to analyze both perspectives to understand how OSH benefits both parties in the labor relationship:

• Employers benefit by reducing liability for occupational accidents or diseases and potential financial consequences. Employer liability arises when employers fail to provide optimal working conditions, leading to workplace accidents or illnesses. Employer liability includes compensating workers when the Ecuadorian Institute of Social Security (IESS) is unable to grant the benefits to which they are entitled or has denied such claims. If employer liability is established, the employer must provide compensation as specified in Article 15 of the Regulations on Employer Liability (2016). Additionally, when a worker is not registered with IESS, the Ministry of Labor is responsible for investigating and enforcing compliance, as stated in Article 353 of the Labor Code. In cases where workers are not affiliated with IESS, employers must still provide compensation for workplace accidents or diseases, as mandated by international agreements such as ILO Convention 121, which Ecuador has ratified.

• Workers are exposed to occupational risks that can affect their health and job performance. Implementing occupational safety and health measures reduces accidents and professional illnesses by preventing, mitigating, and eliminating risks.[27] It is essential to understand that receiving wages does not justify exposing oneself to avoidable risks. Risk management ensures safe and healthy workplaces.[17] Additionally, OSH measures extend beyond the workers, benefiting their families, collaborators, and society. Effective management prevents occupational diseases, creates healthier work environments, and reduces costs associated with

workplace accidents.[18]

The Ministry of Labor as a Regulatory Body for OSH

While employers are legally obligated to ensure occupational safety and health, this is insufficient to guarantee compliance. Therefore, the State plays a critical role in enforcing these obligations through its relevant authorities, primarily the Ministry of Labor. The Ministry of Labor oversees the enforcement of labor rights, ensuring compliance with legal obligations related to occupational safety and health in both the public and private sectors. Its role is essential in upholding social justice in the workplace, promoting equality, and ensuring dignified labor opportunities.[28]

Historical Evolution

The Ministry of Labor has undergone several transformations since its inception in 1925, following the Juliana Revolution. Initially established as the Ministry of Labor and Employment, it later adopted additional roles.[28]

- In 1928, it became the Ministry of Labor and Human Resources, focusing on protecting the rights and duties of employers and employees.
- In 2009, through Executive Decree No. 10, it was renamed the Ministry of Labor Relations after merging with the National Technical Secretariat for Human Resources and Public Sector Remuneration Development. This merger expanded its authority to include responsibilities outlined in the Organic Law on Civil Service and Administrative Careers and the Labor Code.
- In 2014, Executive Decree No. 500 renamed it the Ministry of Labor, emphasizing the human dimension of labor over economic concerns.

The Ministry is the central authority for public policies related to work, employment, and public sector human resources. Among its many functions, it oversees the regulation and enforcement of labor obligations, including those on occupational safety and health.[28]

The Ministry of Labor derives its mandate from the Ecuadorian Labor Code, which grants it extensive authority, including:

- Regulating and enforcing compliance in occupational safety and health,
- Imposing sanctions and collecting fines for violations,
- Conducting comprehensive inspections to ensure compliance with labor laws concerning wages, social benefits, safety and health, and other rights.

To fulfill its duties, the Ministry has established regional offices across the country, which address:

- Inquiries regarding labor laws and regulations,
- Administrative jurisprudence unification,
- Fines and penalties,
- Complaints and collective labor mediation,
- Approval of internal workplace regulations and safety and health protocols.

Labor inspectorates operate under these regional offices, ensuring compliance with national legal mandates.

Article 539 of the Labor Code outlines the Ministry's powers, including labor regulation, monitoring compliance, and leading initiatives on workplace safety and risk prevention. The Ministry works collaboratively with other key institutions, such as the Ecuadorian Institute of Social Security (IESS) and the Ministry of Public Health, as part of the Inter-institutional Committee on Workplace Safety and Hygiene. The Committee's primary role is to coordinate public sector risk prevention efforts and fulfill legislative and regulatory mandates.[29] These actions aim to improve working conditions, encourage preventive measures, reduce workplace injuries and illnesses, and enhance productivity through proactive management.[28] The Ministry's powers mentioned above are carried out through the Labor Inspectorates.

Labor Inspectors: Their Functions and Obligations

Labor inspectorates are public services ensuring compliance with labor regulations, including occupational safety and health standards. These inspectorates provide guidance and conciliation on labor matters following the framework established by ILO Convention No. 81.[30] Labor inspectors who represent these bodies follow the directives of the Ministry of Labor.[31] The ILO describes labor inspections as state institutions that provide services to employers and workers, ensuring the proper functioning of workplaces. Inspectors address workplace safety and health, wages, labor relations, child labor, and forced labor.[32]

In Ecuador, labor inspectorates are administrative authorities responsible for monitoring compliance with labor laws in public and private sectors. Their jurisdiction is provincial, as established by Article 544 of the Labor Code (2005).

Labor inspectors are professional officials responsible for enforcing labor laws and social standards. They act as agents, supervisors, and advisors tasked with improving workplace conditions and ensuring compliance with legal provisions.[33] Their primary objective is to enforce labor laws and protect workers through various legal measures. Inspectors advise employers and employees on improving workplace conditions and oversee wage compliance, occupational safety and health, and child labor.[34]

Powers and Obligations of Labor Inspectors

Labor inspectors are endowed with significant authority under both international and national law.

1. International Powers

The ILO's Convention No. 81 grants labor inspectors the following powers:

- Free access to workplaces without prior notification,
- Authority to investigate compliance with legal provisions,
- Power to interview employers or workers to verify compliance,
- Ability to request documents required by national legislation,
- Permission to take samples of substances or materials for analysis (with prior notice to the employer).

Inspectors must present their credentials to exercise thesepowers.[35]

2. International Obligations

Labor inspectors must:

- Act with independence, impartiality, and integrity,
- Maintain confidentiality, including the origins of complaints,
- Uphold professional competence[33].

These obligations stem from Article 15 of Convention No. 81, which prohibits inspectors from having an interest in the entities being inspected and mandates confidentiality regarding trade secrets or production methods encountered during inspections.

3. National Powers

In Ecuador, labor inspectors enforce compliance with legal obligations by both employers and workers. Article 545 of the Labor Code grants inspectors authority to:

- Monitor occupational safety and hygiene compliance,
- Ensure that employers and workers meet their legal obligations,
- Conduct labor inspections,
- Resolve disputes related to labor violations,
- Impose fines and sanctions,
- Oversee workplace harassment cases and order public apologies, if necessary.

Inspectors must observe workplace conditions, including ventilation, lighting, machinery safety, and sanitation facilities, as well as worker protections such as social security registration and provision of personal protective equipment. These responsibilities are outlined in Article 412 of the Labor Code.[4]

Accountability of Labor Inspectors

The Labor Code holds labor inspectors accountable for any misconduct:

- Article 546 establishes civil and criminal liability for the malicious disclosure of trade secrets that may be encountered during inspections.
- Article 547 provides for sanctions, including dismissal, for inspectors acting with malice or partiality.

Inspectors must adhere to national and international regulations to ensure compliance and enhance workplace conditions.

OSH in Labor Inspections

Labor inspections are a vital mechanism through which the State ensures that workplaces meet the required safety and health standards. Labor inspectors conduct these inspections and verify compliance with occupational safety and health laws. Additionally, they aim to raise awareness among employers and workers about the minimum standards necessary for safe working conditions.

Labor inspections serve as a verification tool to check compliance with labor regulations, particularly those related to occupational safety and health. Inspections involve visiting workplaces to assess compliance with safety measures and identify potential risks and hazards that could impact the health and safety of workers.

In Ecuador, labor inspections are crucial for identifying and addressing violations of occupational safety and health regulations. These inspections are also crucial for identifying any breaches of workers' rights and ensuring that the working environment meets national and international standards.

Labor inspections also provide the opportunity to educate employers and workers on best practices, safety protocols, and regulations that ensure the well-being of workers. The primary goals of labor inspections in this area include:

1. Ensuring that workplaces comply with health and safety standards,
2. Promoting awareness of occupational safety measures,
3. Reducing workplace accidents and diseases by identifying risks and preventing hazards,
4. Verifying that workers are provided with appropriate safety equipment and training,
5. Providing a mechanism to report unsafe practices and conditions.

Labor inspections aim to identify violations, prevent accidents, and improve the working conditions in which employees perform their duties. It aligns with ILO Convention No. 81, which promotes the establishment of labor inspection systems to safeguard workers' rights, safety, and health.[35]

Legal Framework for Labor Inspections in Ecuador

In Ecuador, the Labor Code provides the legal foundation for labor inspections, specifying the roles and powers of labor inspectors, as well as their responsibilities regarding occupational safety and health compliance. The Regulation on Occupational Safety and Health (Decree 2393, 1986) also outlines the obligations of employers regarding workplace safety and the conduct of labor inspections.

Article 412 of the Labor Code requires employers to comply with specific safety standards, including ensuring proper lighting, ventilation, cleanliness, regular inspection of machinery, and provision of adequate hygiene facilities. The code also mandates that workers be registered with Social Security and supplied with appropriate protective equipment. These obligations are subject to inspection by labor authorities.

Types of Inspections

Various types of labor inspections focus on ensuring occupational safety and health compliance:

1. Comprehensive Inspections: These inspections are thorough checks to assess compliance with labor regulations, including workplace safety.

Inspectors evaluate various aspects of the working environment, from structural safety to worker protection.

2. Focused Inspections: These are inspections conducted when specific issues or complaints have been raised regarding safety or health risks at a particular workplace. These inspections focus on a limited set of concerns but aim to address them comprehensively.

3. Random Inspections: These inspections occur without prior notice and focus on randomly selected workplaces. They ensure that employers consistently maintain compliance with labor laws across the board.

Labor inspections may be triggered by complaints, audits, or routine checks to ensure compliance with legal standards.

The Role of Labor Inspectors in OSH

Labor inspectors are critical in ensuring workplaces meet OSH standards. Their duties include:

- Conducting inspections to identify workplace hazards and ensure compliance with safety protocols,
- Recommending improvements in safety measures and guiding employers on best practices,
- Imposing fines and penalties for non-compliance,
- Providing reports on inspection findings and following up to ensure corrective measures are implemented.

The Ministry of Labor ensures that labor inspectors conduct thorough inspections and that businesses adhere to safety regulations. Additionally, the Ecuadorian Institute of Social Security (IESS) and the Ministry of Public Health coordinate with the Ministry of Labor to address occupational risks, promote preventive health measures, and provide resources for the rehabilitation of injured workers.

International Framework and Best Practices in Occupational Safety and Health Inspections

On an international level, the ILO's Convention No. 81 (1947) on labor inspections requires member states to establish labor inspection systems to protect workers' rights and improve workplace safety.

The ILO Convention No. 81 outlines the responsibilities of labor inspectors, which include:

- Ensuring that workplaces meet safety and hygiene standards,
- Providing assistance and advice to employers and workers on labor law compliance,
- Maintaining impartiality and independence in inspections,
- Ensuring that inspections are conducted to promote compliance through persuasion rather than punitive measures.

In Ecuador, labor inspectors are empowered to carry out their duties by the provisions outlined in the Labor Code, and they must follow strict guidelines to ensure fairness and transparency in their inspections. The Ministry of Labor coordinates these efforts to prioritize workplace safety and health in labor law enforcement.

Labor inspections are vital for maintaining a safe and healthy working environment. They ensure employers comply with legal obligations to protect workers from hazards and risks that could lead to accidents or occupational diseases. Labor inspectors play an essential role in this process by identifying potential risks, advising employers, and enforcing penalties for non-compliance.

In Ecuador, the comprehensive legal framework governing labor inspections, supported by national and international laws, guarantees that occupational safety and health are prioritized in all sectors. Continued efforts to strengthen labor inspections will improve working conditions, reduce workplace accidents, and protect workers' rights.

Methods

The research adopted a qualitative approach, which focuses on in-depth insights into the characteristics of the phenomenon by exploring complex issues in a natural setting. It emphasized the exploration and interpretation of data to gain a deep understanding of OSH legal frameworks in Ecuador. It utilized a combination of inductive reasoning to identify patterns and generate insights, analytical methods to deconstruct complex information, synthetic techniques to integrate diverse perspectives, and a dogmatic approach to examine established doctrines and principles. It focused on synthesizing existing knowledge by critically analyzing and summarizing findings from relevant sources. The research involved meticulous bibliographic note-taking and employed a structured review process to organize and evaluate the selected materials. As a result, thematic trends, gaps in the literature, and opportunities for further inquiry were identified. It provided a cohesive and comprehensive understanding of the Ecuadorian OSH legal frameworks, specifically labor inspections, which are valuable for OSH decision-making and serve as a guideline for navigating labor law in Ecuador and Latin American countries.

Case Study: Cañar Labor Inspectorate

As previously discussed, labor inspectors have significant authority to oversee compliance with labor regulations, particularly those related to OSH. One of the critical issues observed in Cañar is that labor inspectors often fail to request the necessary documentation from employers during inspections that would verify compliance with occupational safety and health regulations. According to official notices from labor inspectors, required documentation may include:

- The worker roster,
- Copies of the employer's tax registration (RUC),
- Entry notifications to the Ecuadorian Social Security Institute (IESS),
- Payroll statements for social security contributions,
- Certificates of compliance with obligations,
- Attendance records,
- Evidence of payment for overtime, night shifts, and bonuses,
- Employment contracts registered in the Unified Labor System, among others.

However, in practice, some documents related to safety regulations, such as the internal workplace safety and health rules or worker protective equipment, are often not requested. This situation leaves the issue of workplace safety and health largely unchecked, making it easy for employers to neglect these fundamental rights.

The inspectors' discretion in determining which documents to request creates inconsistencies in how inspections are conducted and fails to prioritize safety and health measures. This lack of standardized and thorough inspection violates constitutional principles and international labor standards.

Failure to perform comprehensive inspections undermines the objectives of the Ministry of Labor and violates the workers' constitutional right to a safe and healthy work environment. This issue is compounded by the shortage of labor inspectors in Ecuador, as there are only 0.04 inspectors per 10,000 workers in the country[36]. This significant imbalance between the number of inspectors and workers further exacerbates the problem of non-compliance.

Discussion

The lack of enforcement of OSH regulations in Ecuador contributes to a high incidence of workplace accidents and diseases. According to statistics from the General Occupational Risk Insurance (2022), 301 workplace accidents were reported in Cañar in 2021 alone. These incidents are indicative of the ineffective oversight mechanisms currently in place.

While it cannot be claimed that accidents will disappear solely through more inspections, there is a clear connection between the regular

implementation of safety checks and a reduction in workplace incidents. Ensuring that safety measures are adequately enforced would allow for better prevention and the establishment of policies to reduce the occurrence of accidents.

Therefore, this failure to enforce safety regulations constitutes a violation of constitutional principles and workers' fundamental rights. It also demonstrates the State's shortcomings in its duty to ensure the safety and well-being of its citizens, particularly those in vulnerable labor positions.

The constitutional state paradigm places the responsibility on the State to uphold the rights of its citizens. One of the key features of the constitutional State is the rule of law, which requires that laws be applied equally and consistently to protect individuals. In this case, the State's failure to adequately enforce labor laws related to safety and health reveals a breach of the constitutional guarantees of equality and protection against harm.

The lack of proper oversight also weakens the relationship between workers and employers. Workers in a more vulnerable position in this relationship are left without sufficient protection from workplace hazards. Employers may neglect their duties to maintain safe workplaces without effective enforcement, further exacerbating the power imbalance between the parties.

This situation not only affects the safety of workers but also impacts the overall quality of work and the working environment. When workers are exposed to unnecessary risks, the workplace becomes less productive, less secure, and less supportive of personal development.

The failure of the Provincial Labor Delegation of Cañar to enforce occupational safety and health laws illustrates a significant gap in the implementation of Ecuador's labor regulations. This lack of enforcement results in a direct violation of workers' rights and a failure to adhere to constitutional principles, such as effectiveness and efficiency in public administration.

For the State to fulfill its constitutional role, it must ensure the proper functioning of labor inspection systems and enforce safety regulations that protect workers from harm. Strengthening the labor inspection system, increasing the number of inspectors, and prioritizing safety and health regulations are essential steps to rectify these issues and protect workers' fundamental rights.

The analysis presented throughout this research highlights critical gaps in enforcing OSH regulations, particularly within the Provincial Labor Delegation of Cañar. These gaps undermine the constitutional framework and international standards, putting workers at risk and perpetuating inequalities within the labor relationship.

The current situation, in which safety and health regulations are poorly enforced, is a pressing issue that demands immediate attention from the State and the relevant authorities. Given the limited number of labor inspectors and the lack of consistency in safety inspections, it is clear that improvements are necessary to ensure that workplaces are safe and that workers' rights are upheld.

Recommendations for Improvement

1. Increase the Number of Labor Inspectors

To address the labor shortage, it is essential that Ecuador significantly increase the number of labor inspectors. The recruitment and training of additional labor inspectors should be prioritized to allow for more frequent and thorough inspections.

2. Standardize Inspection Procedures

A standardized and transparent inspection procedure should ensure that all relevant occupational safety and health documents are consistently requested and reviewed consistently. Hence, it would prevent the current discretionary practices, where certain safety aspects may be overlooked.

3. Improve Training and Awareness

Both employers and workers must be better informed about occupational safety standards and

their rights and obligations under the law. Training programs should be established to increase awareness of safety procedures, risk mitigation strategies, and the importance of compliance with legal requirements.

4. Strengthen State Oversight and Accountability

The Ministry of Labor must enhance its oversight mechanisms and hold labor inspectors accountable for their actions. Ensuring inspectors adhere strictly to their legal responsibilities and guidelines will help create a more transparent and efficient inspection system. Regular audits of inspection practices could be a means to monitor the effectiveness of these measures.

5. Enforce Penalties for Non-Compliance

Employers who violate occupational safety and health laws should face stricter penalties. Ensuring that there are significant consequences for non-compliance would incentivize employers to invest in safety measures and comply with regulations. Imposing fines and sanctions for violations should be vital in improving workplace safety standards.

Conclusions

Ecuador's legislation includes a broad scope of protection for the right to occupational safety and health. This protection is enforced through the legal framework, which comprises the Constitution of the Republic of Ecuador, international treaties and conventions, laws, executive decrees, and ministerial agreements. These regulations establish the mandatory observance of this right, with the State acting as guarantor through its respective entities.

The importance of implementing OSH lies in the obligation of employers to comply with this duty, while workers have the right to be informed about the occupational risks they face. Furthermore, by adhering to preventive measures, employers avoid incurring liability. On the other hand, workers must recognize that salary is not the only significant factor in a labor relationship; their activities must also be carried out under optimal conditions of dignity and safety.

Labor compliance is enforced through workplace inspections, which are governed by various national and international regulatory frameworks. Labor inspectors must be highly trained professionals to fulfill their duties and responsibilities outlined in national and international regulations. At the national level, particularly in the province of Cañar, it has been observed that the Labor Inspectorate does not fulfill its role as a guarantor of workers' labor rights concerning OSH. For instance, inspectors fail to request documentation or evidence demonstrating employer compliance with OSH obligations during on-site inspections. This neglect violates various constitutional principles and rights, undermines the proper functioning of public administration, and fails to protect workers from the discretion of competent authorities.

Under the fundamental principles recognized in Article 11, numeral 8 of the Constitution, developing the right to OSH through laws, jurisprudence, and public policies is necessary. It aims to provide proper protection for this right through competent agencies. Consequently, it is essential to reform the Labor Code, which dates back to 1938, to issue or amend ministerial agreements related to labor inspections and to provide training on the importance of OSH to all parties involved in the labor relationship. Additionally, administrative labor authorities must update their oversight processes.

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