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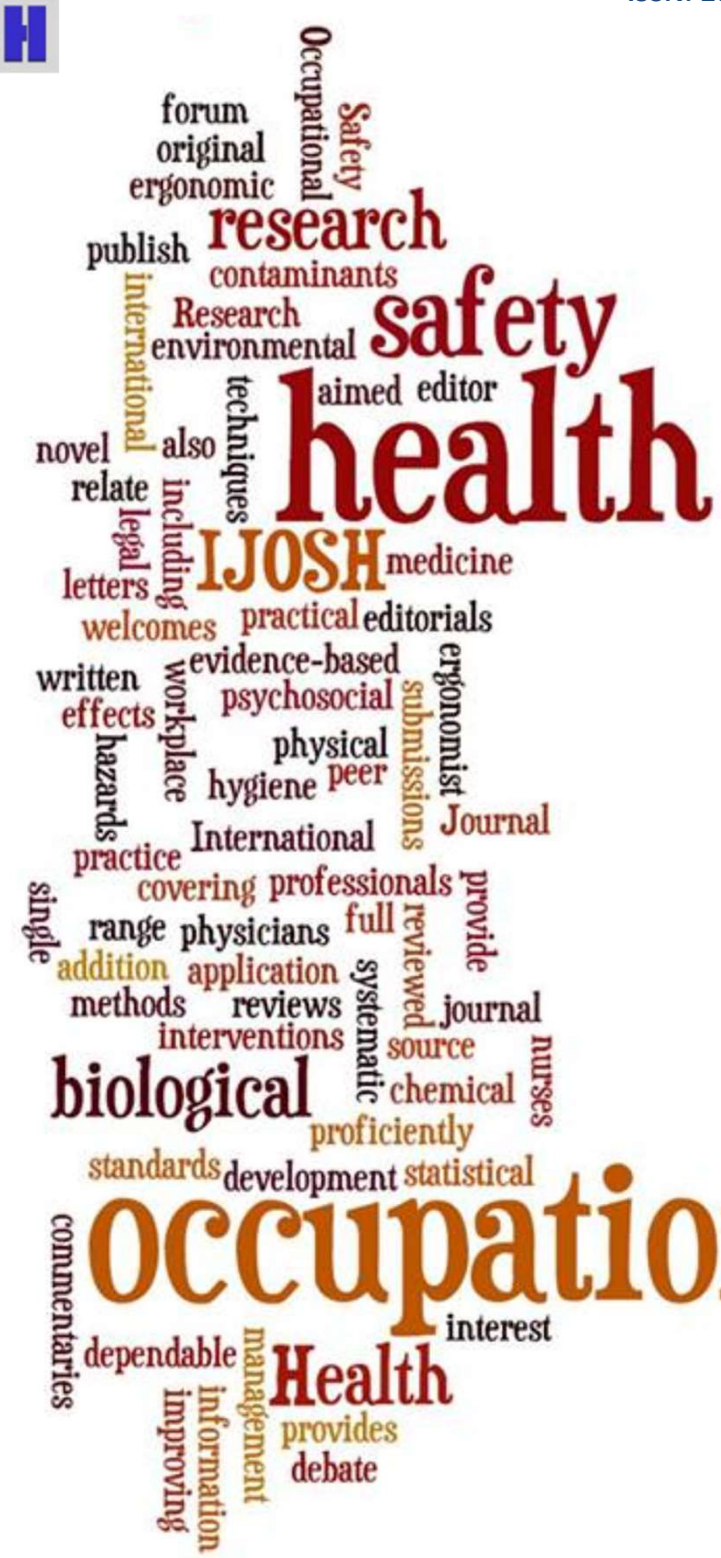

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Original Article

Assessment of self-perceived risk and risk rating among chemical sprayers in selected tea plantations in South India

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ABSTRACT

Introduction: Chemical sprayers of the tea plantation industry perceive various degrees of risk involved in their daily work. The objective of the study was to assess self-perceived risk and to rate these risks among the pesticide sprayers working in selected tea plantations in South India.

Methods: A cross-sectional study was conducted among 290 chemical sprayers in six selected tea plantations in South India from September to October 2018 after approval from the Institutional Ethics Committee and permission from the plantations. Data was collected by structured interview schedule with the chemical sprayers and key informant interviews were conducted with their supervisors. The risks perceived by the sprayers were rated and expressed using the Risk Rating Matrix.

Results: The mean age of the participants was 45.6±8.5 years and all of them were males. The most common risks encountered were leech bites (76%), other insect bites (58%) and bruises (46%). Chemical spills, splashes, slips, falls and backaches were considered as minor hazards in risk rating. Animal attacks and falls from trees were assigned the highest risk rating scores.

Conclusion: Insect bite was the most common risk perceived and animal attacks attained the highest risk score. Regular supervision and monitoring of work-related risk factors can help in the reduction of common injuries thereby ensuring safety at the workplace.

Keywords: Chemical sprayer, Risk rating, Tea plantation

Introduction

The idea of risk assessment dates back its history to over 2400 years ago with the Athenians assessing risk before making important decisions.[1,2] The concept of risk assessment in occupational settings is recently gaining importance. It is the first step towards systematic and successful health, safety and environment (HSE) management. It refers to careful examination of the work to identify the possibilities of harm to people so that enough precautions can be taken to prevent this harm. Unknown, hidden, undetected, or unrelated risks cause more uneasiness. The information arising from risk assessment must be shared with the right persons. Good risk assessment can help users to choose the most appropriate preventive measures.[3]

The Occupational Health and Safety (OHS) risk assessment matrix is a part of any general risk assessment form and helps workers put a numerical value on the hazard and risk identification process. In this hazard risk analysis

matrix, every consequence and the probability surrounding it are given a numerical value. When multiplied together they result in a number that correlates with a certain level of risk.[4,5]

'A tool for risk assessment' written by Dejan Ristic explains the various types of risk assessment matrices.[6] There are two ways to evaluate the matrices of consequences and likelihood: qualitative and quantitative. The first type is used for qualitative assessment of likelihood and consequences, while the second type is used for quantitative assessment of likelihood and qualitative assessment of consequences. Both matrices classify the consequences by using the following terms: death, major permanent disability, minor permanent disability, and temporary disability. In the qualitative matrix, likelihood is represented through the following categories: frequent, likely (probable), accidental, unlikely, and improbable.

India is also the world's largest consumer of tea with three-fourths of its total production consumed locally. The tea exports reached 837 million dollars in 2017-2018 and contributed to five percent of the national income in agriculture.[7,8]

The plantation industry is composed of a complex chain of workers whose functions often overlap. The main workforce in the plantation industry includes people involved in various activities like pesticide spraying; weeding (removal of unwanted/weeds that grow among the tea plants); shade lopping/tree cutting (either branch which is causing too much share or the dead branches of the trees in between the tea plants are chopped by a person climbing up the tree); pruning (mainly involves trimming of the tea bushes to maintain the height at the same time expanding the width of the tea bush) and plucking of tea leaves.[9]

While there are a few studies done among plantation workers, very few are done to date on the sprayers of tea plantations; hence there is scope to explore this area of work further. This study was done to assess self-perceived risk and to rate these risks among the pesticide sprayers working in selected tea plantations in South India.

Methods

A cross-sectional study was conducted among 290 sprayers in selected tea plantations in South India during the period of two months [September – October 2018]. Approval was obtained from the Institutional Ethics Committee (IEC No. 272/2017) and all the six tea estates who consented to be part of this study.

The calculated sample size was 354 using the formula [$n = \{z^2(pq) / d^2\}$] and using the finite population correction using the formula [$(\sqrt{N-n}/N-1) \times$ Calculated sample size] the final sample size was estimated to be 255 employees.

However, in this study, we were able to interview all the sprayers who attended the annual health appraisals on the days of data collection. In total, 290 sprayers were included in our study.

Written informed consent was taken and the sprayers were interviewed either in the muster or at the Estate Hospital after their working hours. A structured interview schedule was administered by face–to–face interviews with the sprayers.

Risk rating was done based on the workers' opinion of the hazards they come across. They were first asked to list the most common hazards they came across. After obtaining the list of hazards, sprayers were asked to rate the hazards based on the severity of the hazards outcome and exposure was rated based on the frequency of exposure. Hazards were rated as 1 = no treatment/first aid at home, 2 = minor treatment like dressing at the hospital, 3 = major treatment like suturing, 4 = severe treatment such as surgeries, and 5 = fatal/death. Frequency was rated as 1 = rarely, 2 = unlikely, 3 = possible, 4 = likely, 5 = certain.

The risk rating matrix was applied to the commonly reported hazards to identify the various high-risk factors and the ranking of the risks was done according to the matrix. The results were represented in the form of a color-coded risk rating matrix table.

Results

The mean age of the participants was 45.6±8.5 years and all of them were males. In this study, 132(45.5%) had completed high school and 86 (29.7%) had middle school education. The

majority of them were married 282 (97.2%) and 52 (18%) of them were migrants coming mostly from the Northeastern parts of India. Half the study population 141 (48.6%) belonged to class 3 of B G Prasad socioeconomic classification for the year 2018. In this study, modified B G Prasad's scale for socio-economic status classification was used taking Consumer Price Index= 307.[10] [Table 1].

Table 1: Socio-demography of the study population (n = 290)

Age group (Years)	**Number of respondents (%)**
<21	4 (1.4)
21-30	17 (5.9)
31-40	50 (17.2)
41-50	138 (47.6)
51-60	79 (27.2)
≥61	2 (0.7)
Education	
No formal education	19 (6.6)
Primary school	38 (13.1)
Middle school	86 (29.7)
High school	132 (45.5)
PUC	14 (4.8)
Degree	1 (0.3)
Marital status	
Married	282 (97.2)
Unmarried	8 (2.8)
Socioeconomic class (Modified BG Prasad)	
Upper	4 (1.4)
Upper middle	73 (25.2)
Middle	141 (48.6)
Lower middle	70 (24.1)
Lower	2 (0.7)
Total	290 (100)

Table 2: Work profile of the study population (n = 290)

Duration of work as sprayer [Years]	**Frequency (%)**
0-10	46 [15.9%]
11-20	69 [23.8%]
21-30	129 [44.5%]
≥31	46 [15.9%]
Total	290
Methods of spraying	**Frequency [%]**
High Volume Sprayer	113 [39%]
Knapsack [manually operated] sprayers	106 [36.6%]
Power machine [operated by petrol]	71 [24.5%]
Other activities done by sprayers	**Frequency [%]**
Pruning	104 [35.9%]
Weeding	151 [52.1%]
Plucking	214 [73.8%]
Shade lopping [tree cutting]	35 [12.1%]

More than half of the study population 175 [60.3%] had worked for over 20 years as sprayers in the plantation. More than one-third of the devices used for spraying were high-volume sprayers (brand name Lu-shyong) by 113 [39%] and the knapsack sprayer by 106 [36.6%] of the sprayers. Apart from spraying, the sprayers were rotated in other work on the estate like weeding, pruning, shade lopping and plucking tea leaves. [Table 2]

More than two-thirds of the sprayers listed leech bite, 210 (72.4%) as the most common problem at their workplace. Steep climbing (46.6%), insect bites (25.5%), long walks (24.1%) and the need to carry a machine on their back (24.1%) were the most common occupation-related problems faced by the study participants. The sprayers adopted indigenous methods to prevent leech bites [Table 3].

Table 3: Main problems faced at work by the sprayers

Main problems faced	Leech bites	210 (72.4%)
	Other insect bites	74 (25.5%)
	Climbing steep	135 (46.6%)
	Weight of machine	70 (24.1%)
	Long walks	70 (24.1%)
	Injuries	38 (13.1%)
Solution for leech bites as listed by the participants	Application of snuff	79 (27.2%)
	Work carefully	56 (19.3%)
	Use of PPE	43 (14.8%)
	Chloroxylenol (Dettol)	7 (2.4%)
	Application of salt	8 (2.8%)

The risk was categorized based on severity and frequency as per the study participants. Leech bites, other insect bites and bruises were certain and likely to happen respectively and as a hazard, both did not need any treatment. Cuts/injuries, chemical spills and splashes were certain to happen during their course of work and were considered minor hazards. Slips, falls and backache were also possible and were considered minor hazards. Fractures and eye injuries were also likely to happen and were considered moderate hazards. Fall from a tree (while involved in shade looping) and snake bites, were considered major risk groups and this exposure was possible. Attacks by animals (elephants and Indian Gaur/bison) were considered major to severe hazards and were possible to unlikely to happen at their workplace.

Figure 1: Categorization of injuries in the Risk rating matrix as perceived by the sprayers

		Frequency of exposure				
Severity of hazards		Certain	Likely	Possible	Unlikely	Rare
	No treatment	Leech bite, Insect bite	Bruise			
	Minor	Cuts/Injuries, spills, Splashes		Slips and falls, Backache		
	Moderate		Fractures, Eye injuries			
	Major			Fall from trees, Snake bites	Bison attack	
	Severe			Elephant attacks		

Very Low risk Low risk Moderate risk High risk

Discussion

Among the 290 sprayers in the study, the finding that all the sprayers in this study were males was obviously due to the selection of only males for the activity of spraying, considering it strenuous and exhaustive. During the discussion with the employers, they mentioned that women do not prefer this job because of exposure to chemicals. Similarities were seen in other studies conducted in Lucknow among pesticide sprayers which reported that only male sprayers were included in the study which could be obviously due to the employment of predominantly males for this activity in those areas also. However the employment in tea plantations as such do not have any gender preferences and females are usually employed more and involved in activities like plucking, weeding, transportation, pruning, and nursing of young plants.[11,12]

According to the risk rating matrix, elephant and bison attacks were assigned the highest risk rating scores in this study. This finding is mainly due to the study setting which is close to the forest region. The wild animals are often reported to come down to the valleys in search of food and water in the areas where tea plantation and inhabitation is present. The most common problem faced by 72.4% of the sprayers was the leech bite and the insect bites. They also use remedies like 'application of snuff powder, antiseptics/chloroxylenol (brand name Dettol) and salt' for the same. The climatic condition and crop favours the growth of these insects in this region. A similar study done in order to assess the risk rating in the tea plantation industry in South India showed that the most common morbidities were small cuts and abrasions. Backaches and insect bites attained the highest risk rating score in that study.[13] These differences could be because this study included only chemical sprayers whereas the other study also had workers from the factory and also women involved in tea plucking were included in the study group. Musculoskeletal disorders among these chemical sprayers have been presented elsewhere.[14]

Injuries, spills and splashes from the chemicals were also reported to be the second most common issue at the tea plantations. Bruises are also frequently affecting these workers.

These data point to the fact that occupational injuries and issues need to be addressed and recorded so that necessary steps can be taken to prevent them and hence improve the working conditions and in turn productivity. The risk rating matrix is an easy tool that can be used for such periodical assessment.

Conclusions

Insect bites were the most common issue faced by the sprayers in tea plantations. Attacks by animals like elephants and Indian gaur attained the highest risk rating scores in this study.

Continuous risk assessment among the plantation workers is vital to understand their perceived health risks at the workplace and to do the needful rectification to prevent accidents at the workplace and to alleviate health risks perceived by the workers.

Acknowledgments

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Original Article

Biosafety knowledge and perception among medical laboratory students: a cross-sectional study at a medical university in Vietnam

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ABSTRACT

Introduction: Medical students have to deal with biohazards in laboratories during undergraduate studies and intensive practice in hospitals. Unsafe operators can result in an outbreak of biohazardous pathogens to healthcare workers, the community, and the environment. However, the most common risk factors for laboratory accidents are a lack of perception and knowledge of biosafety and laboratory safety management. This study aimed to assess knowledge and factors influencing the biosafety practices of medical students at Hanoi Public Health University, Vietnam

Methods: A cross-sectional study was conducted to assess the biosafety knowledge of all 286 students majoring in a medical laboratory at HUPH from December 2021 to February 2022. Ethical clearance was obtained from the Ethics Committee of Hanoi University of Public Health. The questionnaire has been created based on WHO biosafety guidelines with some modifications according to the local context. The data were collected by face-to-face interviews.

Results: Out of the 286 students invited to complete a biosafety questionnaire, 68.6% of students recognized the fundamental principles of biosafety. Additionally, 76.2% and 91% of students correctly identified risk factors and danger signs in the laboratory, respectively. Furthermore, 79.8% of students provided accurate answers to biosafety laboratory troubleshooting questions. Notably, academic performance, students' year of study, and average scores in biosafety courses had significantly related to the biosafety knowledge. Gender factors and academic performance were related to the rate of obtaining precise knowledge about incident handling and preventing risk factors in the laboratory.

Conclusion: The passed rate of biosafety knowledge among medical laboratory students at the University of Public Health was 68.6%. Factors such as the student's school year, academic performance, average score in the biosafety course number of internships in hospitals significantly affected their biosafety and troubleshooting knowledge in the laboratory.

Keywords: Biosafety, Biosafety education; Hanoi University of Public Health, Vietnam, Medical student

Introduction

Clinical laboratories are indispensable units in hospitals and medical universities. Laboratory scientists are integral parts of healthcare teams. They analyze biological specimens (cells, blood, bodily fluids, specimens…) to support doctors' decisions in diagnosis.[1] In the laboratory environment, risk factors such as pathogens infections, fire, explosion, or toxic chemicals are always exposed to medical staff.[2] Students in medical laboratory programs undertake various

practical sessions, including biochemistry, microbiology, hematology, histology, and parasitology. Therefore, students undertaking such specialties are in direct contact with various hazards, which increases the likelihood of exposure to chemicals or infectious agents, including blood-borne infections, if substantial safety measures are not accurately followed.[3] Biosafety is essential knowledge and skills that should be provided to medical students to learn and become familiar with the professional work.

A compilation of research on laboratory-related infections from 1930 to 2004 showed that there were 5,527 laboratory-associated infections, including 204 deaths.[1] The Belgium Institute of Technology and Biosafety reported 67-82 cases of related laboratory infection from 2007 to 2012.[1] Bio risk and biosafety are realities that cannot be ignored by medical students or medical laboratory workers.[4]

It is estimated that there are 2.5 accidents per week in academic laboratories. A surveillance study, conducted by the CDC, ranked laboratory incidents in educational institutions second among the industries studied, and a large number of injuries were those among students. Studies about safety practices in chemistry, biology, and medical laboratories, in academic institutions worldwide and in the Middle East, indicate a lack of knowledge, and a misunderstanding of safety concepts, emphasizing increasing safety awareness through lectures, training, and other activities.[3] To ensure that medical laboratory students are adequately trained about biological risks and laboratory risks they are likely to face, it is essential to include and emphasize biosafety training as part of the educational curriculum. According to the data collected from 82 medical students and 12 teachers at Oswaldo Cruz Foundation courses in Rio de Janeiro, biosafety in healthcare working environments is in discrepancy with school environment. The research pointed out the necessity of improvement in the teaching processes of biosafety in secondary courses in the health area.[3] Knowledge about biosafety increases according to academic evolution in graduation.[5]

The basic biosafety course is a mandatory subject for medical laboratory students at Hanoi University of Public Health (HUPH). The students must take this course in the first year before continuing their clinical laboratory core subjects such as microbiology, biochemistry, hematology, and clinical practice in hospitals. However, gaining insight into biosafety knowledge requires real-life experience in laboratory situations. This experience is not yet available to first-year medical students and will be added throughout their studies and hospital internship experience. Therefore, it is necessary to evaluate the basic knowledge, knowledge about handling biosafety situations, and factors related to the development of the biosafety capacity of medical students to improve training programs related to biosafety. This study aims to assess biosafety knowledge and analyze some related factors of students majoring in Medical Laboratory Technology at Hanoi University of Public Health, Vietnam.

Methods

A cross-sectional study was carried out from December 2021 to February 2022. The target group of this study included medical laboratory students in HUPH.

The sample size was calculated using the Cochrane formula for estimation of proportion, $n=z^2pq/ d^2$, using a past prevalence of passed biosafety knowledge among medical laboratory students of 68.6%, at a 95% confidence interval (CI) and a 1% margin of error.

The sample size was estimated at 181 students, which was optimized to a total population of 286 undergraduate students. All students who were studying in the medical laboratory program at HUPH were taken for research. Among them, 98 students were in the 1st year (34%), 88 students in the 2nd year (31%), 80 students in the 3rd year (28%), and 20 students in the 4th year (7%). Eight instructors who directly supervised students in hospital practice courses were interviewed to make the findings more comprehensive and objective about knowledge and factors influencing

biosafety.

The questionnaire was generated to survey the participants' information, knowledge, and skills regarding biosafety problems in medical laboratory students. Face-to-face interviews were conducted to collect data. Discussions and short interviews helped to collect information regarding factors influencing students' ability to handle biosafety situations in hospitals. The questionnaire consisted of three sections. Section 1 focused on general information, while sections 2 and 3 evaluated knowledge about biosafety according to Biosafety guidelines of WHO.[6] The survey of biosafety knowledge included recognizing hazards, restricted activities, and knowledge about biosafety troubleshooting in the laboratory. The scoring was done by giving 1 point for each correct answer and 0 points neither for wrong answers nor skipping the questions. Individuals with a knowledge score >=7/10 were considered to pass, while <7/10 were considered to fail.[5]

The data were entered into Epidata 3.1 and analyzed using STATA 15.0 software. Descriptive statistical tools such as frequency, percentage, median, and interquartile range were used to express the results. The Pearson chi-square test was used for bivariate analysis to determine the presence of an association between dependent and independent variables. All tests were performed with a significance level of 5% (p-value <0.05).

The study was ethically approved by the Ethics Committee, Hanoi University of Public Health under decision No 212/2021/YTCC-HD3. The study was conducted with the consent of the University of Public Health's leadership. Research participants were fully explained about the study, assured of confidential information, and could refuse to participate in the study without giving any reason.

Results

A total of 286 students took part in the study. Among them, there were 98 freshmen (34%), followed by sophomores, juniors, and senior students with 31%, 28%, and 7% respectively. Female students accounted for a majority of 223 (78%), while their male counterparts were 63 (22%). All the students have completed the biosafety course and have been involved in medical laboratory practices. Additionally, 3rd and 4th year- students have participated in internship courses in hospitals whereas 1st and 2nd year students have not undergone any internship.

General knowledge of biosafety was assessed based on students' recognition of basic concepts and laboratory risk factors. The assessment of biosafety knowledge is shown in Figure 1. The average rate of students recognizing basic concepts was 68.6%. Most students demonstrated awareness of concepts related to laboratory biosafety knowledge on infectious pathogens, accounting for 81.1% (Figure 1).

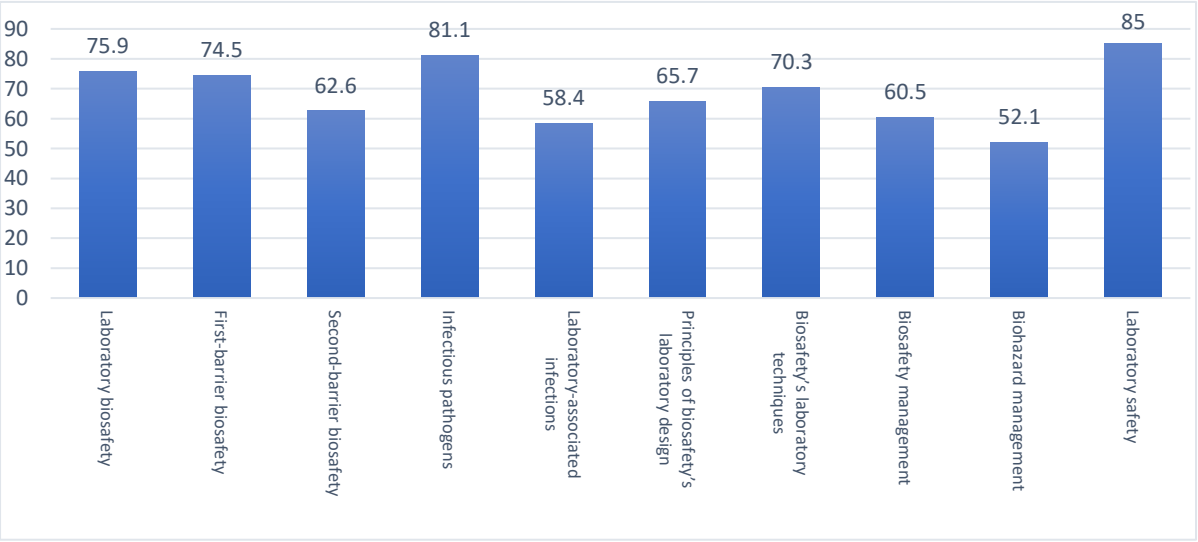

Figure 1: General biosafety knowledge prevalence of the respondents (%)

Risk factors are prevalent in laboratories, and recognizing these factors and assessing their level of danger are important skills for students to protect themselves while working in a laboratory. The assessment of students' identification of laboratory hazards is shown in Table 1. The two most commonly recognized risks were exposure to pathogenic microorganisms (95.1% answered correctly) and exposure to chemicals (91.6%).

Table 1. Students' perceptions of laboratory hazards (n=286)

Laboratory hazard	Correct answer students	Passing rate (%)
Exposure to pathogenic microorganisms	272	95.1
Exposure to chemicals	262	91.6
Exposure to hazards such as fire, electricity, etc	195	68.2
Injuries from dangerous objects	219	76.6

As risks in the laboratory always exist, laboratory workers need to follow safety principles and be able to recognize danger signs to protect themselves during work. Students' perception of common laboratory safety procedures was also evaluated through a questionnaire that assessed their awareness of restricted activities and identification of hazard signs. Appropriate knowledge about prohibited activities in the laboratory ranged from 83.2% to 99.7% (with an average of 94.5%). Nearly all students recognized that playing/eating is prohibited in the laboratory (99.7%). Students' accurate awareness of other prohibited activities in the laboratory was also high (> 90%). The survey findings are presented in Table 2.

Table 2. Student's perceptions about restricted activities and hazard signs (n=286).

Student's perceptions about biosafety practice	Correct answer students	Rate of correct answer (%)
Restricted activities in the laboratory		
Sucking pipette by mouth	278	98.2
Using saliva to attach the tube's barcode	280	97.9
Touching mouth, eyes, phone screening… after exposing to samples	282	98.6
Directly discharge the contaminated solution into the public sewer system	281	98.3
Wearing personal protective clothing out of the laboratory	295	90.6
Wearing lab slippers outside the laboratory	262	91.6
Using shoes, open-toed sandals, and heels in the laboratory	281	98.3
Hanging protective clothing with casual clothes	282	98.6
Reusing medical masks	250	87.4
Playing/eating at the lab	285	99.7
Holding specimen samples without gloves	267	93.4
Storing gloves and masks in a pocket to reuse	273	95.5
Using a pair of gloves for multiple patients	238	83.2
After contact with a patient, still wearing gloves and touching surrounding surfaces	264	92.3
Signs recognition		
Biohazards sign	259	91.2
Radioactive substances sign	241	85.4
Flammable substances sign	277	98.2
Cytotoxicity sign	251	89.1

Incidents in the laboratory pose potential dangers that every student and medical personnel working in laboratory environments must be prepared to face. Being fully equipped with troubleshooting knowledge helps students or laboratory workers confidently and calmly handle incidents, ensuring safety for themselves, equipment, facilities, laboratory materials, and the overall environment. The results of assessing students' knowledge of troubleshooting in biosafety laboratories for common situations are presented in Figure 2. Notably, the majority of students (87.8%-89.2%) had knowledge about cleaning spilled pathogenic solutions in safety cabinets, handling centrifuge incidents, and informing colleagues when being stabbed by a needle. However, for more complicated incidents such as spilling pathogenic solutions outside the safety cabinet; flammable chemical spill incidents, and self-troubleshoot of being stabbed by a needle, only 52.8% - 69.6% of students knew to properly handle.

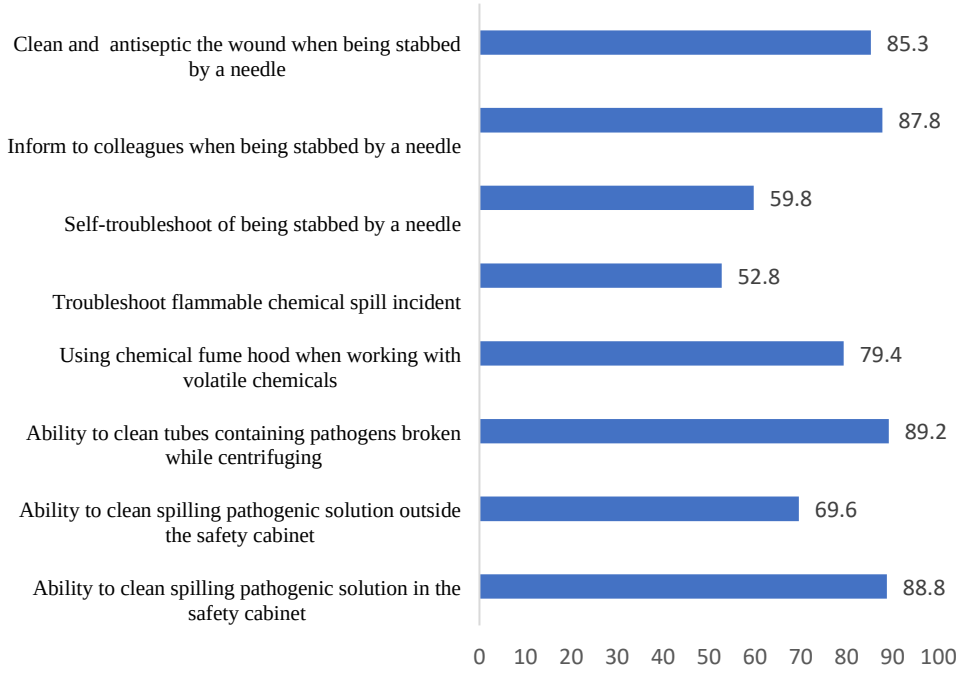

Figure 2: Biosafety troubleshooting knowledge level of the respondents (%)

The percentages of students with basic biosafety knowledge in the 1styear, 2ndyear, 3rdyear, and 4thyear were 70.4%, 58%, 70%, and 90%, respectively ($p<0.05$). In which, students with good and very good academic performance were 71.8% and 88.9%, which was significantly higher than those with average and poor academic performance (50.7%). Gender factors, previous biosafety incidents, and participation in an internship program at the hospital also influenced students' general awareness of biosafety. (Table 3).

Regarding troubleshooting knowledge in the laboratory, gender and academic ability were factors related to the rate of gaining such knowledge. Accordingly, female students demonstrated a higher level of knowledge (82.1%) compared to their male counterparts (69.8%), $p<0.05$. Additionally, 82.1% and 88.9% of students with good and distinction academic performance, respectively, demonstrated proficiency in troubleshooting knowledge, whereas the average group accounted for 67.8%,$p<0.05$. (Table 4).

Table 3. Factors influencing knowledge of biosafety

Student's characteristic		**Basic knowledge of biosafety**	
		Pass (%)	**p-value**
Gender	Male	58.7	p >0.05
	Female	70.4	

Year of Study	1st	70.4	**p <0.05**
	2nd	58.0	
	3rd	70.0	
	4th	90.0	
Academic performance	Below good	50.7	**p <0.05**
	Good	71.6	
	Very good	88.9	
Used to get biosafety trouble	Yes	76.4	p >0.05
	No	65.8	
Average biosafety score	Above 7	65.1	**p <0.001**
	Below 7	32.4	
Number of internship courses at the hospital	1	0.0	**p <0.005**
	2	33.3	
	3	72.5	
	4	60.0	
	5	87.5	

Table 4. Factors influencing knowledge of troubleshooting in the laboratory

Student's characteristic		**Knowledge about troubleshooting in the laboratory**	
		Passed (%)	**P**
Gender	Male	69.8	**p <0.05**
	Female	82.1	
Year of Study	1st	77.6	p >0.05
	2nd	80.7	
	3rd	75.0	
	4th	100.0	
Academic performance	Below good	68.7	**p <0.05**
	Good	82.1	
	Distinction or above	88.9	
Used to get biosafety trouble	Yes	85.5	p >0.05
	No	77.9	
Average biosafety score	Above 7	79.4	p >0.05
	Below 7	73.5	
Number of internship courses at the hospital	1	0.0	p >0.05
	2	66.7	
	3	76.3	
	4	100.0	
	5	100.0	

Discussion

Research results show that the general knowledge of biosafety and identification of risk factors among medical laboratory students has a passing rate of 68.6%. This rate is higher than the findings of Nguyen Dinh Minh Man's survey of medical students at Hue University of Medicine and Pharmacy in 2019, which scored 24.1% [5], and the research conducted by Nazia Chaudry and Sania Arif on undergraduate and postgraduate medical students in Pakistan, which scored 59.5%.[7] The difference may be attributed to the fact that the research subjects in this study specifically focused on medical laboratory students who were being trained to work in medical laboratories in the future. According to research conducted by Withanage N.D. on 229 students at universities in Sri Lanka in 2016, there was a statistically significant difference related to laboratory safety knowledge between study programs, but no significant difference was observed among students in the same study program.[8] The aforementioned differences can be attributed to variations in the educational environment and

educational background across different countries.

The ability to recognize danger signs is an important knowledge in biosafety. In this study, we recorded the ability of students to recognize hazard signs as 98.2%, 89.1%, and 85.3%. These percentages are higher than those reported in Nguyen Dinh Minh Man's survey at Hue University of Medicine and Pharmacy on identifying signs of flammable, cytotoxic, and radioactive substances, which recorded pass rates of 81.8%, 60.6%, and 47.7% respectively.[5] This could be the difference between the group of medical laboratory students that we surveyed and other groups of medical students such as nurses, doctors, and orthodontists in their study at Hue University of Medicine and Pharmacy. These (HUPH) students have to gain biosafety courses in 1st year. The corresponding differences in biosafety perceptions between groups of healthcare workers have also been noted in many studies.[4]

Medical laboratory students will become clinical technicians at healthcare facilities. According to research conducted in 2011, the general biosafety knowledge of healthcare workers in Vietnam was 60%[9], which was lower than in Nigeria (73.15 %).[4] This phenomenon can be explained by the fact that biosafety course was introduced relatively late in medical schools. Many barriers to biosafety and biosecurity training in health-related organizations in Africa, the Middle East, and Central Asia have been reported, including inadequate dissemination of guidelines, lack of financial resources, insufficient personnel, lack of equipped laboratories, and lack of instructional material.[10]

In 2021, our study showed a slight improvement in the biosafety knowledge of medical students at HUPH, reaching 68.6%. Most of the prohibited activities were correctly recognized (>90%). However, there were still some improper activities such as reusing medical masks (87.4%) and using a pair of gloves for multiple patients (83.2%). Records from some instructors have shown that when knowledge is incorrect will likely lead to wrong practices: "Many errors occur such as reused gloves, reused masks, wear gloves to touch phone screening after contacting the samples or patients". This may be due to students' limited awareness of risk factors. Consequently, these improper habits can pose potential risks, which are eventually difficult to deter from. Such actions can escalate the risk of laboratory-acquired infections(LAIs) in medical laboratories[11]. This may be the result of students' poor awareness of biohazard management and laboratory-associated infections (52.1%, 58.4%). Over the years, lab safety education has been diminishing as many instructors are not properly trained in its implementation. This can result in students who are not well-educated in safety, nor understand the importance of safety guidelines existence, potentially placing them in dangerous situations.[12] The risks of exposure to biosafety incidents are mostly related to patient specimens from collection to completion of testing in the laboratory, also referred as "the specimen management chain".[13]

The influence of gender, year of study; academic performance, previous experience with biosafety incidents, average biosafety score, and the number of internship courses at hospitals on basic biosafety knowledge and troubleshooting skills were assessed. Factors such as year of study, average biosafety score, and the number of internship courses at hospitals were found to be correlated with the level of basic biosafety knowledge. A similar trend was also observed in medical students at the Hue Medicine and Pharmacy University, Vietnam in 2019 and UPSJB dentistry students in 2023.[5,14] However, in our study, the pass rate of the HUPH students was higher compared to that of Hue Medicine and Pharmacy. The results of our study differ from those of other authors, such as the study by Nazia Chaudry and Sania Arif in 2013 on undergraduate and graduate students, where no significant difference was found between the results of our study and those of undergraduate and graduate students.[7]

There is a statistically significant difference between student performance and biosafety

knowledge. Students with good and very good academic performance were 71.8% and 88.9%, respectively, which were much higher than students with average and poor academic performance. Students who achieved an average score in a biosafety course >7 had better general knowledge about biosafety than students with an average course score of <7. Similarly, Nguyen Dinh Minh Man's results conducted in 2019 have shown that the percentage of students with lower academic achievement was 8.8% and the percentage of students with good or higher was 29.2%. From the above results, it can be seen that students with good academic performance seem to have more interest, investment, and attention in learning, thereby improving grades and cognitive abilities. Statistically significant differences were not found when examining the relationship between gender, previous biosafety incidents, and biosafety knowledge.

The majority of students knew about handling troubleshooting, with an average rate of 76.6%. About 87.8%-89.2% of students exhibit knowledge about handling simple accidents in laboratories, such as cleaning spilled pathogenic solutions in a safety cabinet or centrifuge, and informing colleagues when being stabbed by a needle. However, only 52.8% - 69.6% of students knew how to handle more complicated incidents, such as clean spilled pathogenic solutions outside the safety cabinet, or a flammable chemical spill incident. This indicates that the students might not be adequately prepared to deal with high-risk situations. The gender factor is related to the rate of gaining knowledge about troubleshooting in the laboratory, with female students (82.1%) outperforming male students (69.8%). Medical laboratory students' knowledge of troubleshooting is also affected by academic performance: students who have good and very good academic performance demonstrate higher percentages of knowledge regarding troubleshooting (82.1% and 88.9%), compared to the average group with 68.7%.

Even though the study revealed significant findings, it is not free from limitations. The study's limitations include a small sample size of participants. The questionnaire only focused on knowledge of general biosafety, laboratory-restricted activities, hazard signs, and biosafety troubleshooting. Finally, the current study only assessed knowledge gain and not the impact of the education module on students' actual practices. Evaluating the effectiveness of the training would require a follow-up study so that medical schools can come up with appropriate interventions.

In medical education universities, laboratory biosafety should be designed as a compulsory course. The institutions should survey the factors in promoting the perception and practice of biohazardous handling to minimize the risk of personal, community, and environmental exposure. Practical training, continuous education, and intensive laboratory practice during undergraduate studies play a significant role in developing a biosafety culture, biosafety knowledge, and practice among students. Therefore, students should be trained throughout their academic careers, given their potential future roles as laboratory workers and researchers. These considerations should be critically considered by medical education institutions.

Conclusions

This study has initially assessed the current status of biosafety knowledge in the laboratory among Medical laboratory students at the University of Public Health. Out of 286 participants who took part in the study, 68.6% of them provided correct answers to the questionnaire. This pass rate is notably higher compared to other medical students in Vietnam.

Several factors have been identified as influencing basic biosafety knowledge, including the student's school year; Academic performance; Average score of biosafety; and the number of internship courses completed in hospitals. Additionally, gender and academic performance are also linked to the rate of gaining knowledge about troubleshooting in the laboratory.

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Original Article

Ergonomic Risk Assessment and Fatigue Analysis During Manual Lifting Tasks in Farming Activities

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ABSTRACT

Introduction: Farming is a physically demanding occupation that puts farmers at risk of musculoskeletal disorders, particularly when frequently performing activities like heavy lifting, which strains the lower back muscles. The present study is aimed to assess the ergonomic risk and fatigue during manual lifting tasks of farming activities.

Methods: A study was performed on 20 farmers to analyse the ergonomic risks associated with load lifting by estimating the Recommended Weight Limit and Lifting Index using the revised NIOSH lifting equation. The low back compression forces of the participants were estimated using the 3DSSPP software. Surface electromyography was employed to analyse the onset of muscle fatigue during the lifting activity.

Results: The results of the study showed a 111.12% increase in the recommended weight limit, a 52.77% reduction in lifting index, and a 28.15% reduction in the low back compression forces for the redesigned lifting technique. The average low-back compression force for the redesigned technique was observed to be well below the back compression design limit of 770 lb. A reduction in the slope of the RMS voltage regression line by 60% and a reduction of 50.23% in the peak spectral power of the sEMG signal, accompanied by a shift in the peak spectral power towards higher frequency region indicated delayed onset of fatigue for the redesigned technique.

Conclusion: The outcomes of the study indicated that the ergonomic redesign of the lifting task could significantly reduce the lifting index and alleviate the spinal compression forces well within the back-compression design limit. The redesign was also found to delay the onset of fatigue in the erector spinal muscles.

Keywords: Ergonomic risk, Manual lifting, Muscle fatigue, sEMG, Spinal compression force

Introduction

Agriculture is one of the most practised professions and is a vital source of revenue for developing countries. It is also the primary source of food, money, and employment for rural populations. More than half of the working population in India is involved in agriculture and allied activities.[1] However, farming is a physically demanding occupation with a potential risk of musculoskeletal disorders (MSDs). Each activity in agriculture brings about a certain level of stress on the muscles and bones leading to work-related MSDs.[2] Such problems represent a major cause of absence from work and may ensue considerable financial liability to the worker. Particularly, low back pain arising from frequent lifting and lowering loads, improper postures, and heavyweight handling is regarded as the most predominant form of MSDs in farming occupation.[3] Farmers generally accept pain as a normal element of their work and only seek medical attention when the problem becomes incapacitating.

Appropriate analysis and ergonomic interventions are required to alleviate MSD-related health issues and increase work efficiency. Several techniques have been proposed for assessing the manual lifting tasks that may lead to MSDs. Among these, the revised National Institute for Occupational Safety and Health (NIOSH) lifting equation and the University of Michigan 3-dimensional static strength prediction program (3DSSPP), have gained wide acceptance owing to their simplicity and quantitative nature.[4,5]

The revised NIOSH lifting equation can be used to evaluate the possible ergonomic risks from two important measurands viz; the Recommended Weight Limit (RWL) and Lifting Index (LI). RWL is defined as the weight of the load that can be lifted over a while for a certain set of conditions with minimal risk of occurrence of MSDs. Whereas, the Lifting Index (LI) compares the load to be lifted with the RWL and offers a relative estimate of the physical stress associated with a manual lifting job. Reduced injury risk is indicated by lower values of LI, preferably less than 1, and vice versa. Meepradit et al,[6] utilised the revised NIOSH lifting equation to identify the risks associated with lifting a box containing auto parts and found the LI to be greater than 1, implying a high risk of MSDs. LI was brought down by redesigning the task with the help of recommendations as per the NIOSH standards.

In the present work, a comprehensive analysis of the manual lifting techniques associated with farming activities has been performed using the revised NIOSH Lifting Equation, 3DSSPP, and sEMG. The measurements obtained were analysed for possible ergonomic risks to the farmers. The effect of redesigning the lifting task on the physical stress associated with the task, compressive force in the lower back, and muscle fatigue characteristics were also determined.

Methods

The study was designed for the farmers of Udaipur, Rajasthan, India. A group of twenty farmers having an age of 25.2 ± 3.18 years with a height of 163 ± 7.06 cm volunteered for the activity. The sampling technique is the condition that, the farmers have neither undergone any spinal surgery nor been clinically diagnosed with chronic low back pain. All the farmers signed a written consent form for performing the lifting task. The data required for the study was collected for 20 days. The data collection technique followed for the study is described below.

The data was collected in two stages, the first being the selection of farmers, identifying the history of back injury, and collecting their anthropometric data. In the second stage, each farmer was asked to lift the loaded container filled with 20 kg of wheat from the ground level to their head. Figure 1 shows the task sequence, which comprises grasping the container, lifting it, and placing the container on the head. During this stage, the data variables such as horizontal distance of load, vertical distance of load, height through which the load was lifted, and the frequency of the lifting task were measured.

The Recommended Weight Limit (RWL) and Lifting Index (LI) were determined using the revised NIOSH Lifting Equation. RWL is given by the following equation.

$$RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM \quad (1)$$

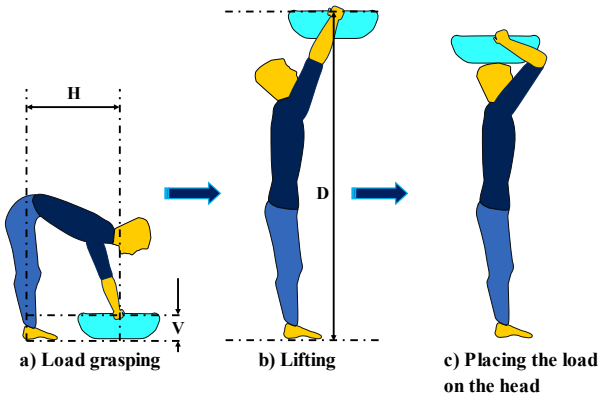

Figure 1: Sequence of Lifting

In the Equation (1), LC is the load constant, taken to be 23 kg. The multipliers such as Horizontal Multiplier (HM), Vertical Multiplier (VM), Distance Multiplier (DM), Asymmetric Multiplier (AM), Frequency Multiplier (FM), and Coupling Multiplier (CM) were calculated with the help of the equations given in Table 1.[7] The variables in Table 1, viz; H, V and D, corresponding to HM,

VM and DM respectively are represented in Figure1. Here, H represents the horizontal distance of the object from the individual, V represents the vertical distance of the palm from the ground during load grasping and D represents the distance travelled by the object vertically before being placed on the individual's head. Psychophysical and biomechanical studies show reduced maximum weight limits and isometric lifting strength for asymmetric lifting tasks compared to symmetric ones.[8,9] In this study, no twisting occurred, resulting in an asymmetry angle approximation of zero and an AM value of 1. The frequency multiplier came out as 0.84 for a lifting frequency of 2 lifts/min and work duration between 1 and 2 hours, from the frequency multiplier table of the revised NIOSH lifting equation.[7] The value of the Coupling Multiplier (CM) can be 0.90, 0.95 and 1.00. The selection of value depends on vertical height and coupling quality. Loads with proper couplings or handles are easier to lift and lessen the risk of the load falling.[9] The CM in the present study is obtained as 0.95 for a vertical height of the object from the ground below 30 inches with a container of fair gripping quality.

Table 1. Calculation of multipliers used in NIOSH Lifting Equation.[10]

Multiplier	Formula Used	Variable	Variable Description
Horizontal Multiplier (HM)	HM=(25/H)	H	Horizontal location of the load from the subject
Vertical Multiplier (VM)	VM=(1-0.003|V-75|)	V	Vertical Location of the load from the floor
Distance Multiplier (DM)	DM=(0.82+(4.5/D))	D	The distance the object moved vertically
Asymmetric multiplier (AM)	AM=(1-(0.0032A))	A	Asymmetry Angle
Frequency Multiplier (FM)	NIOSH frequency multiplier table	F	Frequency and duration of lifting activity
Coupling Multiplier (CM)	NIOSH coupling multiplier table	C	Quality of grip on the object (poor, good, fair)

The lifting index (LI) was estimated from the following equation:

$$LI = \frac{load\ Weight}{RWL} \quad (2)$$

Where, 'load weight' is the weight of the object to be lifted, which is 20 kg of wheat in the present study. According to the NIOSH guidelines, lifting tasks with an LI>1 is likely to aggravate the risk of lower back pain. Hence, it is desirable to achieve an LI value of 1 or less.

While performing any lifting activities, the spine region is subjected to back compression force and this is caused by ground reaction force, gravity, and muscular/ligament contractions, with the L4/L5 disc being the most vulnerable site for instability.[11,12,13] To study the risk of low back instability in different applications, 3DSSPP software has been widely used to assess the posture and suggest appropriate corrections for performing the tasks.[14] The tool has been widely used to predict the spinal compressive force acting at the L4/L5 intervertebral disc using anthropometric, hand load, and posture data of the worker. Don B Chaffin and Muzaffer Erig[15] performed a detailed empirical comparison of a 3D static strength prediction model with a set of strength performance data and observed that with good postural data, the model was capable of predicting the mean static strength of a given population. Beyrami et al.,[16] adopted this method to estimate the forces exerted on the lower back in young workers during manual lifting tasks. Around 40% of the workers were found at high risk of suffering low back pain. Silvetti et al.,[17] used 3DSSPP to analyse the lumbar disc compression

force at L4/L5 in a group of sea fishermen and predicted a lower to medium level of risk of injury for the lower back. Despite several kinds of research on the application of the above techniques for various industrial activities, the use of 3DSSPP in assessing the ergonomic risks associated with farming activities remains largely unexplored. To calculate the lower back compression force using 3DSSPP, the anthropometric data of the participants were recorded first. Following this, the photograph of the worker performing the lifting task was captured and the 3D model generated by the software was processed to estimate the low back compression force.

It is also important to understand that, during any manual lifting activity, the required extensor force is provided by the erector spinae muscle group, which spans almost all along the spine. During lifting tasks, the erector spinae muscles gradually undergo fatigue and hinder voluntary task performance. The fatigue experienced by these muscles increases with the increase in the duration of the lifting activity, especially for the muscles located near the L4-L5 disc interspace. Fatigue accumulation, if not resolved, leads to overwork, chronic fatigue syndrome, and even a threat to human life.[18] Hence, estimating the muscle activity and fatigue behaviour due to repetitive loads is essential to prevent musculoskeletal injuries in workers. Various methods are available to assess muscle fatigue characteristics among which, acquiring muscle signals by surface electromyography (sEMG) is the most commonly used non-invasive technique and has been well-reported by many researchers.[19] sEMG records the variation in myoelectric signals as a manifestation of the biochemical and physiological changes in muscles during fatigue. For this, sEMG uses several fatigue indices such as the root mean square (RMS) voltage and the power spectral density (PSD).[20] Over the past decade, sEMG has gained wide acceptance in predicting the fatigue levels of various muscle groups for applications such as sports, ergonomics, occupational and medical, etc.[21]

To estimate muscle fatigue in the present work, surface electromyography (sEMG) equipment (Make: Delsys® Model: Trigno™ Wireless Biofeedback System) was used. Before attaching the sensors to the participant, the subjects had their skin shaved, scrubbed, and wiped with alcohol. The sensor input range was fixed to 11 mV. The location of the sensors on the erector spinae muscles was identified by referring to the guidelines put forth by SENIAM.[22] Accordingly, the sensors were positioned on the participants at the Thoracolumbar Fascia at the level of their L4-L5 interspace, and 2 cm lateral to the midline using hypoallergenic adhesives. The placement of sensors for one of the participants is shown in Figure 2. The sensor electrodes were spaced 1 cm apart and aligned parallel to the muscle fibres. The raw EMG data of the muscle activity was recorded using the data acquisition software (DELSYS EMGworks® Acquisition Software) at a sampling rate of 2148 Hz. The raw EMG signal was first filtered using a bandpass filter of 10-450 Hz. Then, the EMG signal was converted to the RMS value using a moving RMS calculation procedure. The time window length considered was 0.125 seconds and the window overlap was 0.0625 seconds. In order to manifest the fatigue characteristics of the muscle group, the raw EMG data was post-processed to obtain the RMS voltage regression line and the power spectral density curve.[23,24]

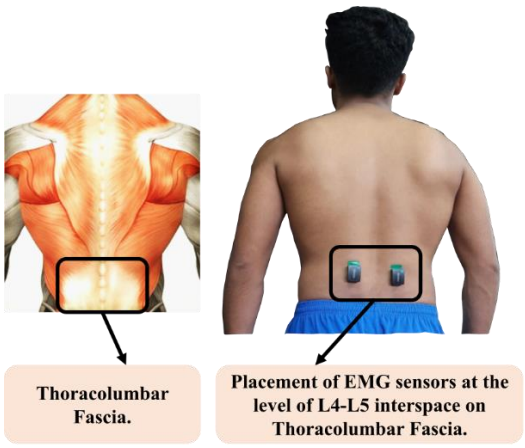

Figure 2: Depiction of the muscles corresponding to L4/L5 interspace (left) and Placement of EMG sensors (right)

Results

After the completion of data collection, the RWL

and LI were calculated with the help of the multipliers provided in Table 1. The frequency multiplier and coupling multiplier were obtained from the standard tables provided in the application manual for the NIOSH Lifting Equation.[7] The asymmetric multiplier was estimated to be "1" as calculated using the equation given in Table 1. The RWL and LI values calculated for all 20 farmers are given in Table 2. The 3DSSPP postural model of one of the volunteers performing the lifting task is shown in Figure 3.

The low back compression force estimated from the 3DSSPP analysis is also presented in Table 2.

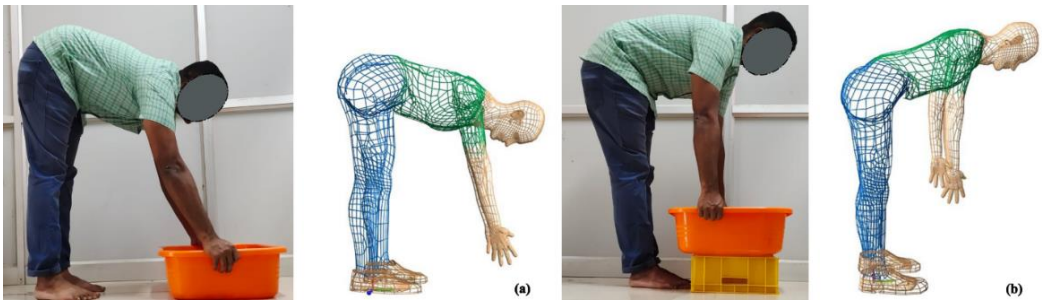

Figure 3: 3DSSPP Postural model of the volunteer during flexion for load grasping - (a) before redesign and (b) after redesign.

Table 2. Statistics of variables, multipliers RWL, LI, and back compression force for the lifting task before redesign

Subject	Height (in cm)	Age (Years)	Hand Location (Initial)		Distance Travelled (D_1) (cm)	HM	VM	DM	RWL (kg)	LI	3D Back Compression Force (N)
			Horizontal Distance (H_1)(cm)	Vertical Distance (V_1) (cm)							
1	157	22	46	12	168	0.543	0.811	0.847	6.846	2.921	3981.156
2	170	28	53	13	175	0.472	0.814	0.846	5.966	3.352	3918.880
3	157	28	48	12	161	0.521	0.811	0.848	6.576	3.041	3558.575
4	155	32	57	12	158	0.439	0.811	0.848	5.541	3.609	4648.389
5	170	27	57	13	175	0.439	0.814	0.846	5.549	3.604	4354.806
6	165	22	48	12	171	0.521	0.811	0.846	6.561	3.048	4016.742
7	168	25	44	12	169	0.568	0.811	0.847	7.161	2.793	5933.924
8	160	21	48	12	166	0.521	0.811	0.847	6.569	3.045	5208.864
9	160	29	54	13	162	0.463	0.814	0.848	5.866	3.409	4114.602
10	171	23	55	12	168	0.455	0.811	0.847	5.736	3.487	3224.959
11	145	22	52	12	166	0.481	0.811	0.847	6.064	3.298	3598.609
12	168	23	58	12	178	0.431	0.811	0.845	5.421	3.689	4274.738
13	160	31	48	13	172	0.521	0.814	0.846	6.585	3.037	3545.230
14	161	27	47	12	168	0.532	0.811	0.847	6.707	2.982	4670.630
15	158	25	50	12	169	0.5	0.811	0.847	6.304	3.173	3754.297
16	170	24	48	12	170	0.521	0.811	0.846	6.561	3.048	4279.1867
17	172	24	55	12	172	0.455	0.811	0.846	5.73	3.49	4123.499
18	172	25	53	12	173	0.472	0.811	0.846	5.944	3.365	3580.816
19	163	22	51	12	166	0.49	0.811	0.847	6.178	3.237	3732.0557
20	160	23	51	13	165	0.49	0.814	0.847	6.201	3.225	4314.772
Average	163.1	25.15	51.15	12.25	168.6	0.491	0.812	0.8467	6.203	3.242	4141.737

From Table 2, the average RWL, LI, and low back compression force were found to be 6.20 kg, 3.24, and 4141.737 N respectively. The mean LI being greater than 3 indicates that the lifting task is highly stressful. Continued adoption of this lifting technique may thus lead to muscle fatigue and eventually musculoskeletal disorders (MSDs).[7,25]

Table 2 also indicates that the mean back compression force at L4/L5 was higher than the Back-Compression Design Limit BCDL of 770 pounds[26], which is approximately 3425.129 N implying a substantial risk of lower back pain. Hence, it becomes necessary to redesign this

lifting task to reduce the risk of MSDs. Accordingly, the lifting tasks were modified by following the recommendations put forth by Waters et al.[7] An artistic impression of the lifting before and after the redesign is presented in Figure 4.

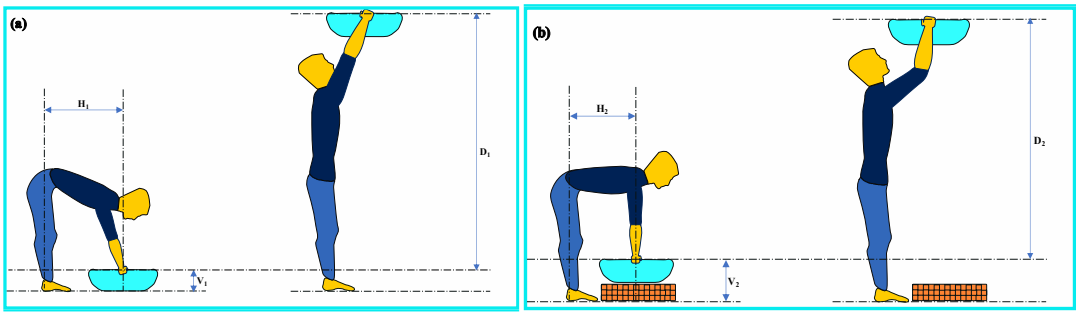

Figure 4: Artistic impression of the lifting task - (a) before redesign and (b) after redesign. Here $H_2<H_1$, $V_2>V_1$ and $D_2<D_1$

The following modifications were carried out for the ergonomic redesign of the lifting task.

1. The initial lifting position of the hand was changed by reducing the horizontal distance between the hand and the body by keeping the load closer to the body (i.e. from H_1 to H_2, where $H_2<H_1$) and by raising the vertical height of the load by keeping the load on a platform and lifting it from that position (i.e. from V_1 to V_2, where $V_2<V_1$).
2. The height through which the load was lifted beyond the head level was also reduced to minimise the distance moved by the hands (i.e. from D_1 to D_2, where $D_2<D_1$).
3. The coupling multiplier is influenced by the grip of the hand on the object and the vertical distance of the hand from the ground during load grasping. The greater the coupling multiplier, the better the handling capabilities. To improve this multiplier, the farmers were instructed to apply a strong grip and hold the container while lifting. By doing this, the coupling multiplier was increased from 0.95 to 1.

Here, V_1 is the height at which the load is gripped, measured from the ground before the task redesign, and measured as 17 cm. V_2 is the height at which the load is gripped, after adding an extra platform and is increased to 31 cm. Here, the platform height is 14 cm, maintained the same for all the participants of the study.

Similarly, H_1 and H_2 are horizontal distances of the load grasping measured from the individual's coronal axis, in the case before modification and after modification respectively. These distances were fixed at 60 cm and 30 cm respectively, with a difference of 30 cm. D_1 and D_2 are the vertical distances traveled by the load, before and after the modification. In the initial task, the participants lifted the load with the arms completely stretched atop the head. While in the modified tasks, the participants lifted the load from the platform to the tip of their head, without completely stretching the arm. These distances vary concerning the heights of the participating individuals.

After the modifications in the lifting task, the RWL and LI values were re-estimated, and the data is presented in Table 3. Figure 3(b) depicts the 3DSSPP postural model after the ergonomic redesign of the task. The back-compression force estimated from the analysis is also presented in Table 3.

The average RWL, LI, and back compression force after the redesign of the task were 13.09kg, 1.53, and 2975.64 N, respectively, when compared to the corresponding values of 6.20 kg, 3.24, and 4141.74 N obtained from the previous lifting technique. There was a 111.12% increase in RWL, a 52.78 % reduction in LI, and a 28.25% reduction in back compression force after the modification in the lifting task. An increase in RWL implies that a farmer who was earlier recommended to lift a maximum load of 6.20 kg is now capable of lifting a load of nearly 13.09 kg without any risks of MSDs.

After obtaining the results of RWL, LI, and back compression forces, the analysis was further extended to study the fatigue behaviour of the erector spinal muscle. For this, the surface electromyography voltage signals of the target muscle group were captured and post-processed to obtain the RMS voltage regression lines and the power spectral density curves.

A total of 10 cycles, with 1-minute rest interval between cycles, consisting of erector spinae flexion (for grasping the load) and extension (for lifting the load) activities, were performed by each volunteer before and after the task redesign.

Table 3. Statistics of variables, multipliers RWL, LI, and back compression force for the lifting task after redesign

Subject	Height (in cm)	Age (Years)	Hand Location (Initial)		Distance Travelled (D_2) (cm)	HM	VM	DM	RWL (kg)	LI	3D Back Compression Force (N)
			Horizontal Distance (H_2)(cm)	Vertical Distance (V_2) (cm)							
1	157	22	29	30	140	0.862	0.865	0.852	13.735	1.456	3349.509
2	170	28	30	28	156	0.833	0.859	0.849	13.134	1.523	2886.894
3	157	28	32	33	137	0.781	0.874	0.853	12.588	1.589	3091.512
4	155	32	32	33	136	0.781	0.874	0.853	12.588	1.589	3118.201
5	170	27	28	30	153	0.893	0.865	0.849	14.179	1.411	2602.208
6	165	22	29	30	150	0.862	0.865	0.85	13.702	1.46	2464.313
7	168	25	27	29	150	0.926	0.862	0.85	14.669	1.363	3220.51
8	160	21	30	32	141	0.833	0.871	0.852	13.365	1.496	3087.064
9	160	29	33	30	145	0.758	0.865	0.851	12.063	1.658	3300.578
10	171	23	34	34	148	0.735	0.877	0.85	11.846	1.688	2820.171
11	145	22	27	29	130	0.926	0.862	0.855	14.755	1.355	2548.829
12	168	23	34	35	146	0.735	0.88	0.851	11.9	1.681	3496.3
13	160	31	33	30	144	0.758	0.865	0.851	12.063	1.658	2731.206
14	161	27	28	30	144	0.893	0.865	0.851	14.212	1.407	3336.164
15	158	25	32	31	138	0.781	0.868	0.853	12.502	1.6	2793.481
16	170	24	31	31	151	0.806	0.868	0.85	12.857	1.556	2606.656
17	172	24	32	34	150	0.781	0.877	0.85	12.587	1.589	3167.132
18	172	25	31	28	156	0.806	0.859	0.849	12.708	1.574	3158.235
19	163	22	29	33	143	0.862	0.874	0.851	13.861	1.443	2660.035
20	160	23	32	31	141	0.781	0.868	0.852	12.487	1.602	3073.719
Average	163.1	25.15	30.65	31.05	144.95	0.819	0.868	0.851	13.090	1.534	2975.636

A rest time of 30 minutes was given between the original activity and the redesigned activity, to avoid data discrepancy. Figure 5 shows EMG voltage data for a volunteer's left Thoracolumbar Fascia muscle during pre and post-redesign lifting tasks, indicating a significant reduction in EMG voltage potential after the redesign. An expanded image of the EMG graph of the same data is presented in Figure 6 to clearly show the variation in EMG voltage potential between conventional and redesigned lifting techniques.

To further understand the effect of task redesign on muscle activation and the onset of muscle fatigue, the RMS voltage regression graph and the power spectral density distribution of the EMG signal of the volunteers were obtained. The RMS voltage regression line for one of the volunteers before and after the task redesign is shown in Figure 7(a). Figure 7(b) shows the power spectral density distribution of the volunteers before and after task redesign.

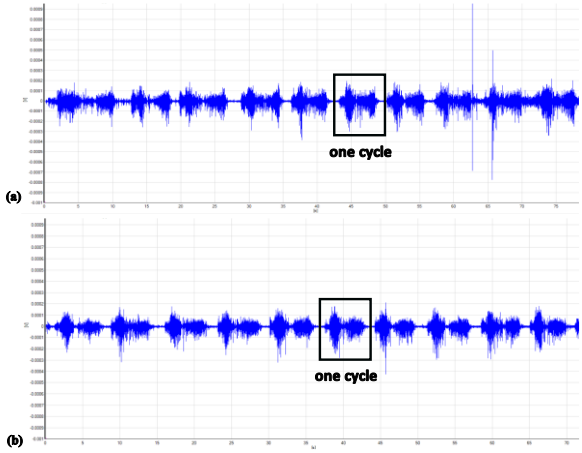

Figure 5: EMG data of a participant (a) before the redesign and (b) after the redesign

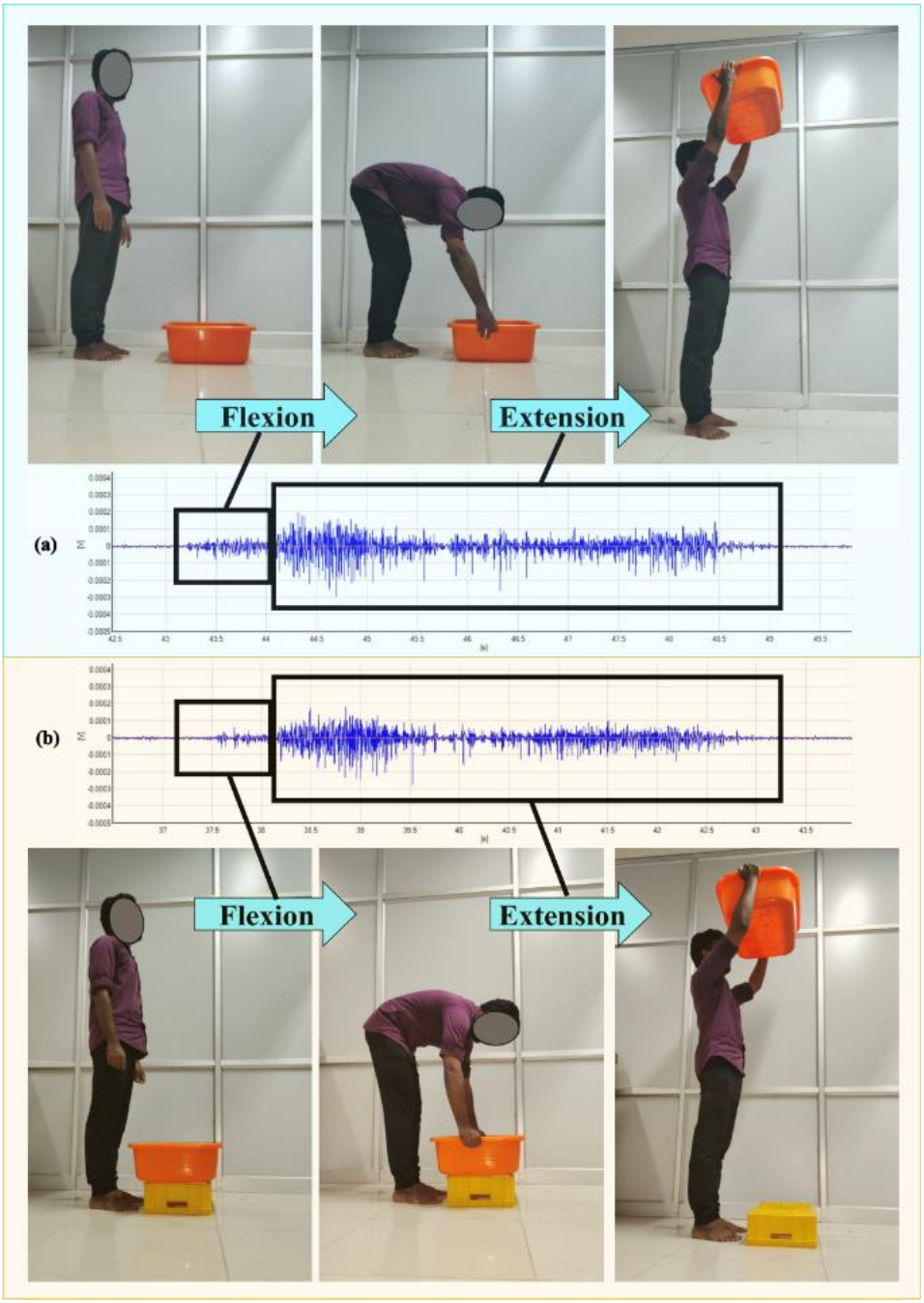

Figure 6: Sequence depicting the tasks and EMG data of lifting operation (a) Before task redesign and (b) After task redesign.

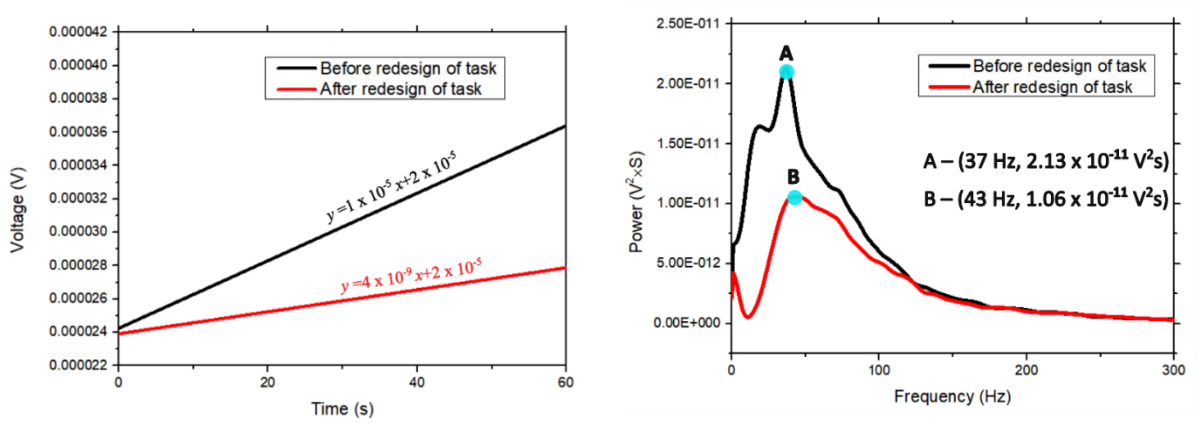

Figure 7: **(a)**RMS voltage regression lines before and after task redesign
(b) Power spectral density curves before and after task redesign

Table 4. RMS voltage regression slopes and power spectral density points for different volunteers.

	RMS voltage regression line slope		Power spectral density data points			
Subject	Before redesign	After redesign	Before redesign		After redesign	
			Power (V^2 s)	Frequency (Hz)	Power (V^2 s)	Frequency (Hz)
1	3.00×10^{-08}	1.20×10^{-08}	5.00×10^{-11}	53	4.00×10^{-11}	60
2	2.00×10^{-08}	8.00×10^{-09}	4.28×10^{-11}	47	2.78×10^{-11}	53
3	1.50×10^{-08}	6.00×10^{-09}	3.28×10^{-11}	39	1.28×10^{-11}	47
4	2.25×10^{-08}	9.00×10^{-09}	4.90×10^{-11}	51	3.60×10^{-11}	58
5	1.30×10^{-08}	5.20×10^{-09}	2.20×10^{-11}	43	1.20×10^{-11}	48
6	3.20×10^{-08}	1.28E-08	5.10×10^{-11}	51	3.10×10^{-11}	59
7	1.60×10^{-08}	6.40×10^{-09}	4.10×10^{-11}	43	2.60×10^{-11}	50
8	2.00×10^{-08}	8.00×10^{-09}	3.10×10^{-11}	48	1.80×10^{-11}	54
9	1.00×10^{-08}	4.00×10^{-09}	2.13×10^{-11}	37	1.06×10^{-11}	43
10	2.50×10^{-08}	1.00×10^{-08}	4.70×10^{-11}	51	3.70×10^{-11}	58
11	1.00×10^{-08}	4.00×10^{-09}	2.13×10^{-11}	36	6.30×10^{-12}	42
12	1.90×10^{-08}	7.60×10^{-09}	4.10×10^{-11}	46	3.10×10^{-11}	51
13	2.60×10^{-08}	1.04×10^{-08}	4.80×10^{-11}	48	2.80×10^{-11}	55
14	2.20×10^{-08}	8.80×10^{-09}	3.10×10^{-11}	45	2.10×10^{-11}	53
15	1.80×10^{-08}	7.20×10^{-09}	2.32×10^{-11}	41	1.32×10^{-11}	47
16	2.90×10^{-08}	1.16×10^{-08}	4.80×10^{-11}	50	3.30×10^{-11}	57
17	1.70×10^{-08}	6.80×10^{-09}	2.40×10^{-11}	40	1.10×10^{-11}	45
18	2.10×10^{-08}	8.40×10^{-09}	4.51×10^{-11}	44	3.01×10^{-11}	52
19	1.10×10^{-08}	4.40×10^{-09}	2.00×10^{-11}	38	1.00×10^{-11}	43
20	1.50×10^{-08}	6.00×10^{-09}	3.00×10^{-11}	41	2.00×10^{-11}	48

The slope values of RMS voltage regression lines and the data points of power spectral density for all 20 volunteers before and after the task redesign are given in Table 4.

Discussion

From the data presented in Tables 2 and 3, it may be inferred that the risk of back injury for farmers while lifting 20 kg of weight after the redesign will be much lesser than that of the lifting technique followed previously, as the mean value of LI has been reduced from 3.24 to 1.5.

Besides the fact that the reduction in back

compression force is quite evident after the redesign, it is worth noting that the average back-compression force value has been brought down from 4141.74 N to 2975.64 N which is much below the Back-Compression Design Limit (BCDL) of 3425.129 N implying that the stresses exerted on L4/L5 are now within safe limits.

A similar trend is observed while analysing the sEMG results of the participants. A clear reduction in the intensity of EMG signal was observed for the redesigned task (Figure 6 (b)) compared to the original task (Figure 6(a)). The reduction in the EMG voltage potential signifies a reduction in the muscle activity of the participant after the redesign of the task.[31]

The low EMG activity during flexion in the redesigned task can be attributed to the fact that the volunteer's range of bending was reduced due to the addition of a platform to increase the vertical distance at which load was placed ($V_2 > V_1$) and due to the reduction of horizontal distance between the volunteer's coronal plane and the weight to be lifted ($H_2 < H_1$). Similarly, the low EMG activity during extension (load lifting) is attributed to the reduced distance of travel (D) after the task redesign.

The RMS voltage regression lines with nearly the same voltage intercepts (shown in Figure 7(a)) depict that the muscles are at the same initial state before lifting the load (both in the case of the old lifting technique and the redesigned technique). Yet another interesting observation is the differences in the slope of the RMS regression line. From Figure 7(a), the slope of the RMS voltage of the old lifting technique was 1×10^{-8}, while it was 4×10^{-9} for the redesigned activity. A higher slope signifies higher firing rates of the individual motor units for the same period, which gives evidence of early muscle fatigue for the old lifting activity compared to the redesigned lifting activity.[27,28] The slope of the regression line has reduced by as much as 60% after redesigning the task, indicating a reduction in the onset of muscle fatigue.

Similarly, the power spectral density distribution shown in Figure 7(b) indicates a reduction in the peak spectral power by approximately 50.23% post-redesign of the task. Besides, there has been a shift in the peak power frequency towards the positive x-axis. As can be noted from Figure 7(b), the peak power, initially observed at 37 Hz, has shifted to 43 Hz after redesigning the lifting activity. The reduction in peak power is attributed to the lowered release of voltage potential from each motor unit, while the increase in the peak power frequency might be due to the recruitment of more motor units in lifting the given load thereby lowering the burden on individual motor units. As a result, the muscle group experiences delayed onset of fatigue.[27,29,30]

Similar results were observed for all the volunteers as evident from Table 4. The slope of the voltage regression line decreased for the lifting task after redesign for each volunteer. It can also be observed that the frequency values increased, and peak power values decreased for all the volunteers after the task redesign.

Overall, the findings of this study reveal that musculoskeletal problems in farmers can be reduced by the systematic redesign of lifting techniques. The outcomes of this study would serve as a framework to analyse the risk associated with any manual lifting activity and help to devise appropriate postural modifications to lower the risk of injuries.

Conclusions

In this study, the ergonomic risk assessment was performed for the lifting techniques used by the farmers. The initial findings revealed that the risk of low back discomfort in farmers was extremely high, indicating the presence of physical overload and poor lifting method which involves over-flexion and over-extension of the erector spinae muscle group. To mitigate the same, the recommendations proposed in the literature were taken into consideration and the lifting task was redesigned. The various parameters that helped analyse the risk associated with the lifting task were calculated using analytical, numerical, and experimental methods. RWL and LI were calculated using a revised NIOSH lifting equation,

low back compression force was predicted with the help of 3DSSPP software and muscle fatigue response was experimentally recorded using sEMG.

The following observations were made after the ergonomic redesign of the task:

(a) There was a 111.12% increase in the recommended weight limit and a 52.77% reduction in the lifting index calculated using the revised NIOSH lifting equation. The increased recommended weight limit and reduced lifting index signifies that the individual can lift a load higher than the one being lifted in the initial posture, without risk of MSDs.

(b) There was a 28.15% reduction in low back compression force calculated using the 3DSSPP software.

(c) The average back-compression force value has been brought down to 668.95 lb after the redesign, which was much lower than the Back-Compression Design Limit (BCDL) of 770 lb implying that the stresses exerted on L4/L5 were within safe limits.

(d) Analysis of muscle activity using sEMG indicated approximately 60% reduction in the slope of the voltage regression line, a 50.23% reduction in the value of peak spectral power, and a shift of peak spectral power to higher frequency. This was an indication of reduced muscular fatigue level after the redesign of the task.

From the above-mentioned findings, it can be inferred that these recommendations can be implemented in daily manual lifting tasks to avoid the high risk of muscle injuries and pain. Also, in further research, these tools, when used in combination, can be effectively applied to assess the potential risk of injuries for various lifting tasks under a wide range of work settings. For the first time, the present work reported that the change in the lifting posture according to NIOSH guidelines would delay the onset of fatigue in erector spinal muscles during manual lifting activities.

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Original Article

Exploring Risk of Posture and Musculoskeletal Disorders among Smartphone Addicted Youth: a Protocol Paper

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ABSTRACT

Introduction: Smartphones with rapid advancement in telecommunication technology causing high usage leads to addiction, especially among youth. Concerning health, smartphone addiction influences posture causing neck-shoulder pain. However, the mechanism of how smartphone addiction causes pain related to posture control is still doubtful. Anticipatory feed-forward motor control mechanism has proposed that smartphone usage is a static low-level activity influenced by muscle fatigue and discomfort. Therefore, this study aimed to explore neck-shoulder muscle fatigue, particularly at the upper trapezius about smartphone addiction behaviors and adopted posture while using smartphones among youth. This study aims to investigate the relationship between smartphone addiction, risk of posture and the relationship between trapezius muscle fatigue, and neck-shoulder pain among youth.

Methods: A cross-sectional study design will be conducted through convenient sampling among students at secondary schools in Malaysia. The Smartphone Addiction Scale, Rapid Assessment Upper Limb, Nordic Musculoskeletal Questionnaire and Electromyogram will be used as outcomes tools.

Discussion: This study investigates the risk of smartphones in terms of duration usage among adults. Fatigue over the upper trapezius muscle has not yet been investigated among youth which will provide fundamental findings on how faulty posture during smartphone usage might cause neck pain.

Keywords: Musculoskeletal discomfort, Risk of posture, Smartphone addiction, Youth

Introduction

Smartphones with rapid advancement in telecommunication technology and their application cause high demand and usage. Smartphones have rapidly become the preferred device for most Malaysians to remain connected. Smartphone users continue to rise from 68.7% in 2016 to 75.9% in 2017 as a result of affordable devices and data packages, aggressive promotions by service providers, increasing demand of use and reliance on smartphone-based applications.[1]

High usage of smartphones causes addiction, especially among youth.[2] Among the population according to age groups, adolescents were addicted to smartphones as a result of demand for the internet, social media, games, communication and entertainment. Therefore, smartphone addiction was shown to be prevalent among adolescents, which was reported recently in Korea, Singapore and New Zealand.[2,3,4]

However, excessive use of mobile phones causes

musculoskeletal health problems. Smartphone addiction found to be associated with neck pain and shoulder pain.[5] Concerning health, a smartphone is one of the devices that influence posture and body mechanics causing upper body pain such as neck pain and shoulder pain.[6] The static and awkward posture during smartphone usage also produces stress on the cervical spine, changing the cervical curvature and pain threshold at the neck which contributes towards neck-shoulder pain and this musculoskeletal pain found to be associated with smartphone addiction.[6,7] Prolonged use of smartphone can lead to forwarding head posture (FHP), which can be accompanied by Guyon Canal Syndrome (GCS).[8]

A study by Lee et al. (2017) has similar findings on the effects of smartphone usage on musculoskeletal health. They reported that neck flexion is affected by posture while using a smartphone. Neck flexion in the standing position is larger than sitting. Neck flexion also was affected by smartphone usage duration.[9,10] Therefore, as usage time increases, the neck flexion angle increases which subsequently increases the risk of neck pain among smartphone users. They justified that these effects were caused by pain in the cervical erector spinae and increased upper trapezius activity, quantified using EMG. The adopted posture with forward head posture in adults increases upper trapezius muscle activity and worsens with longer smartphone usage. Higher mechanical loading and neck muscle control experienced with forward head posture contribute to a higher risk of neck pain. However, the study only investigated the risk of smartphones in terms of duration usage among adults. Fatigue over the upper trapezius muscle was also not yet investigated among youth which will provide fundamental findings on how faulty posture during smartphone usage caused neck pain.

The mechanism of how smartphone addiction causes pain in the neck and shoulder which is related to posture control is still doubtful.[11] Anticipatory feed-forward motor control mechanism has proposed that movement control following a static low-level activity is influenced by muscle fatigue and discomfort.[11,12] Smartphone usage among school students should be integrated with awareness of health concerns through social responsibility and research opportunities. Enhancing awareness of the effect of excessive usage of smartphones and the internet to mediate the upcoming irreversible risk is crucial in promoting healthy lifestyles among youth. This study aims to evaluate smartphone addiction behaviors, the posture adopted, muscle activity and muscle fatigue in relation to posture adoption while using smartphones among youth.

The study objectives are:

i. To determine smartphone addiction behaviors among youth at secondary schools.
ii. To evaluate the risk posture while using smartphones among youth at secondary schools.
iii. To investigate the relationship between smartphone addiction, risk of posture and musculoskeletal disorder.
iv. To determine the relationship between trapezius muscle fatigue, neck-shoulder pain and smartphone addiction among youth.

Methods

A cross-sectional design study will be conducted through Convenient sampling among students at a secondary school in Negeri Sembilan, Malaysia. This study considered a specific type of non-probability sampling method that relied on data collection from students who were available to be the data sources. Respondents will be screened for their eligibility before participation.

The inclusion criteria are secondary school students aged between 13-17 years old and using smartphones for at least 3 months. Respondents who have experienced injury less than six months ago or were suffering from any inflammatory, degenerative, or neuromuscular condition related to the upper extremity and neck for three months, undergo surgical procedures and rehabilitation and be unable to comprehend English or Malay will be excluded in this study which to minimized confounding factors.

Outcome tools:

Assessment tools used are the Smartphone Addiction Scale, Rapid Assessment Upper Limb and Nordic Musculoskeletal Questionnaire.

i. Smartphone addiction scale (SAS) was a scale for smartphone addiction that consisted of 6 factors and 33 items with a six-point Likert scale (1: ''strongly disagree'' and 6: ''strongly agree'') based on self-reporting. The six factors were daily-life disturbance, positive anticipation, withdrawal, cyber space-oriented relationship, overuse, and tolerance.

ii. Rapid Upper Limb Assessment (RULA) was a reliable tool to be used in assessing biomechanical and postural loading, particularly in the neck, trunk and upper limb. Participants' posture while using mobile phones has been observed and assessed without any instruction not to distract their concentration.[13]

Assessment of RULA involves 3 steps: scoring of working posture for each body part, grouping the body part posture and development of grand score. A score from 1 indicates the most neutral position to a range of 4 maximum score which indicates the worst position for each body part. Score A was presented as the combined individual scores for shoulder, elbow and wrist, and score B was calculated from neck, trunk, and legs. Muscle use and force exerted attributed a score of 1 and 0 respectively which represented both groups performed static posture and no adding load. These scores are added to each score of A and B to obtain scores C and D. The combination of scores C and D determined the 'grand score' which reflects the postural and musculoskeletal load. The total grand scores indicate work posture and load are acceptable (score 1 or 2), require investigation further (score 3 or 4), to investigate further and change soon (score 5 and 6), or to investigate and change immediately (score 7). The assessment was carried out using a worksheet.

Ergonomic exposures that might be influenced by smartphone usage were also investigated such as awkward body posture, static body posture, awkward grip, awkward hand movement, repetitive tasks, sitting, standing and usage of vibration mode. They were asked to rate the frequency of exposures during smartphone usage on a 5-Likert scale ranging from 0 = never (does not occur at all), 1 = occasional (1-2 times per day), 2 = often (3-5 times per day) and 3 = always (more than 5 times per day or continuously). Descriptive analysis has explained physical exposures and ergonomic risk by using frequency distribution. A frequency table was used to present the analysis of findings.

iii. The Nordic Musculoskeletal Questionnaire will be used to determine musculoskeletal symptoms that might be experienced by respondents. The questionnaire consists of 12 items. The survey questionnaire was divided into five sections including socio-demographic, physical exposures and musculoskeletal symptoms experienced by respondents. Physical exposures comprise eleven (11) physical factors including awkward body posture, static body posture, awkward grip, awkward hand movement, lifting load, pushing load, pulling load, repetitive task, sitting, standing and usage of vibrating tools to assess the physical exposures experienced by subjects. Body part-specific musculoskeletal symptoms will be determined by using a body map of nine anatomical body regions which evaluate discomfort, pain, and severe pain for the last 6 months. The frequency of musculoskeletal symptoms: never (does not occur at all), occasional (1-2 times per day), often (3-5 times per day) and always (more than 5 times per day or continuously) and severity of musculoskeletal symptoms: no discomfort (feel comfortable and no bodily distress), discomfort (feel uncomfortable), pain (aches, stiffness, numbness, tingling or burning sensations) and severe pain (extreme sensation of aches, stiffness, numbness, tingling or burning sensations that causing great bodily distress) were determined.

iv. Electromyogram (EMG) will be used for an experiment on experiment on muscle activity to be conducted. EMG assessment can be used to investigate the myoelectric manifestation of cervical muscle fatigue, analysis of cervical muscle

activation patterns and analysis of cervical neuromotor control. Analog data of muscle activity with sample rate up to 100-10 000Hz interfaced with a 6-channel signal amplifier with gain amplification of (8-500Hz and 15-500Hz) will be collected. The measurement will be performed by placing electrodes on the skin's surface and the electrical activity of upper trapezius muscles underneath will be recorded. Skin inspection will be demonstrated before the electrode placement to reduce the skin impedance and avoid noises on the EMG readings. The EMG electrodes paste directly on the upper trapezius muscle belly of both sides after careful palpation and parallel to its muscle fibers. The electrodes are fixed in bipolar with both active electrodes for measuring and ground electrodes for reference point.

The procedure for electrode placement is below:

a) Location of electrodes – electrodes will be placed at 50% on the line from the acromion to the spine on the seventh vertebrae (C7).
b) Orientation – in the direction of the line between the acromion and the spine on the seventh vertebrae (C7).
c) Reference electrode placement – on the spinous process of the seventh cervical or around the wrist.
d) Clinical test - elevate the acromion end of clavicle and scapula; extend and rotate head and neck toward the elevated shoulder with face rotated in the opposite direction.

Respondents will perform 3 trials of resisted Maximum Voluntary Isometric Contractions (MVC) and 1 trial of 20% MVC. Then 15 minutes of muscle activity will be taken for each subject. The frequency and variation of the EMG signal for baseline are to be calculated initially.

Later, the MVC and trail of 20% MVC readings is used to normalize the raw data. The raw data will be collected using offline mode which is later transferred into the software. Analog data of muscle activity with a 6-channel signal amplifier will be collected. The myo-electrical signal of the surface will be converted to analog data which is later converted to digital data at the signal analysis personal computer interface. Analysis of EMG will be conducted by using the amplitude probability distribution function (APDF) to evaluate the static, median, and peak levels of upper trapezius activities during activity. Fatigue analysis for upper trapezius muscles for each group of respondents will be determined.

Procedures of Study

Data collection requires a minimum of 1-2 days of working period for each school to complete 2 phases of the survey. A total of 750 respondents is required to participate. Data collection involves 3 phases.

The procedures of the study were divided into 3 phases (Figure 1). The details as below:

Phase 1 of data collection:
Students are required to complete a self-administered questionnaire:

i. Smartphone Addiction Questionnaire to determine the behaviors of smartphone addictions
ii. Nordic Musculoskeletal Questionnaire to investigate musculoskeletal pain they might experience within 3 months.

Phase 2 of data collection:
Posture assessment using Rapid Upper Limb Assessment (RULA) will be conducted by researchers to identify the level of postural risk while using a smartphone. Researchers will observe and assess respondents' posture without any instruction so as not to distract their concentration with smartphone activity. Subjects performed their favorable posture and usual norm with smartphones without any specific instruction.

Phase 3 of data collection:
A total of 25 respondents will be allocated using stratified random sampling for muscle activity testing using EMG assessment. The experiment aims to determine muscle activity during smartphone activity. EMG measurement will be performed by placing electrodes on the skin's surface and the activity of upper trapezius muscles underneath will be recorded. The procedure is non-invasive and does not require physical samples/body samples from respondents.

The researcher will apply a safe and non-invasive technique with a pair of electrodes over the bilateral upper trapezius because the upper trapezius muscles are the most superficial and palpable of neck muscles and major stabilizing muscles of the neck. At the end of phase 2, the findings for objectives 1, 2 & 3 will be obtained through descriptive analysis.

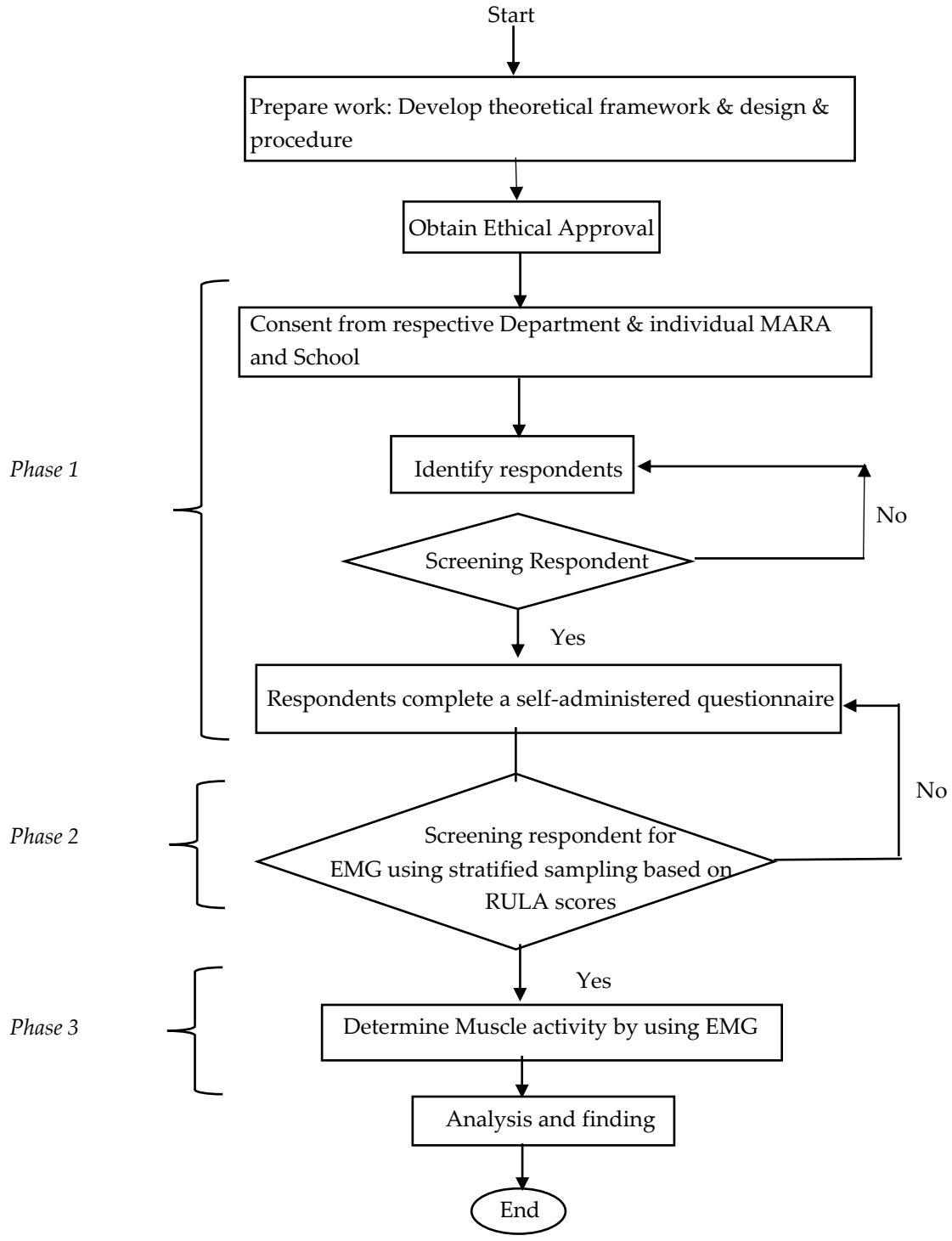

Figure 1: The research flow and phase of the data collection procedure

Data analysis

Descriptive analysis will be used to determine addictive behavior among secondary school students. To evaluate and investigate the relationship between addiction and risk of posture will be determined through the Chi-Square and Pearson Correlation analysis. The relationship between upper trapezius muscle fatigue and neck-shoulder pain will be determined through SPSS analysis by using Linear regression analysis. The

analysis will be conducted to assess the ability of upper trapezius muscle fatigue to predict neck-shoulder pain. At the end of this study, a regression model between upper trapezius fatigue and musculoskeletal neck-shoulder pain will be obtained.

Discussion

The findings from this study will contribute to new knowledge on why smartphone addiction impaired health, especially neck and shoulder pain. Evidence-based understanding of how musculoskeletal disorder is caused by smartphones would enhance awareness of smartphone usage, especially among youth. Ergonomic awareness of health is fundamental to overcoming the health problem specifically referring to the cause root of musculoskeletal disorders among youth. In Malaysia, a lack of ergonomic awareness is a great concern that contributes to musculoskeletal health complaints. The awareness of smartphone addiction is crucial among young as they are exposed to long duration of activity on social media and internet usage. Therefore, enhancing awareness of the effect of smartphone usage excessively which to mediate the upcoming irreversible risk is crucial in promoting a healthy lifestyle among youth. Musculoskeletal health impairment also contributes to increased medical expenditure. Awareness of the source of pain related to muscle fatigue among smartphone addicts for prevention measures would lower medical expenditure and enhance physical health. Research output will contribute towards Malaysian legislative efforts in health and education to minimize complaints of musculoskeletal problems among youth.

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Original Article

Health status of police personnel in a selected subdivision of Bengaluru District, Karnataka, India

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ABSTRACT

Introduction: Police personnel perform untiring duties to maintain law and order. The objectives of this study were to assess the physical and mental health status of police personnel in a selected rural subdivision of Bengaluru District.

Methods: A cross-sectional study was conducted among 142 police personnel in 7 police stations of the selected rural subdivision using a universal sampling technique. A structured interview schedule was used, which included socio-demographic details, occupational details, anthropometry, blood pressure and blood sugar measurements, Patient Health Questionnaire-9 (PHQ-9) to screen for depression and Perceived Stress Scale (PSS) to identify stress.

Results: The mean age of the police personnel was 40.28±10.97 years. Most of the workforce were males (83%). About 68.3% of the studied group were obese. High random blood sugar and high blood pressure values were observed in 5.6% and 48.6% of the personnel who had no previous history of diabetes mellitus and hypertension. The prevalence of mild to severe depression was found to be 36% and that of high stress was 83.1%.

Conclusion: The high prevalence of increased blood pressure, obesity, depression and perceived stress warrants the need for routine screening and application of various levels of prevention. Health promotion and improved working conditions can improve their health status.

Keywords: Depression, Obesity, Physical health status, Police personnel, Stress

Introduction

Police personnel are law-enforcing authorities who deal with a variety of stressors, such as unpredictable work schedules, shift-based work, encountering criminals and dangerous situations, and a highly hierarchical system of ranking.[1,2] The general well-being of the police personnel is also affected by the lack of organizational support, occupational stress and psychological distress due to the nature of the occupation.[3–6] Long working hours, night shifts, exposure to violence and harassment could impact both physical and mental health status in this population. Chronic non-communicable diseases are a matter of concern among police personnel in India.[7,8] Physical health affected due to chronic diseases affects the productivity of the police personnel thereby impacting the general public who are dependent on their services.[8] Substance abuse is on the rise in this occupational group due to inadequate coping skills, stressors, inadequate working conditions and poor work-life balance.[2] Only those police officers with severe mental illnesses such as suicidal tendencies access mental health services, others who experience stress have inadequate coping strategies and poor support from the workplace. The reasons stated include stigma, confidentiality, and inability to identify that they are encountering a mental illness.[9] The

law-enforcing activity includes suppression of negative emotions, which causes deleterious effects on the immune system thereby causing ill health.[10] Considering this, we aimed to assess the physical and mental health status of police officers of a selected rural subdivision in Bangalore District.

Methods

A cross-sectional study was conducted among police personnel working in seven stations in a rural subdivision of Bengaluru District, between January 2022 and June 2022. A universal sampling technique was employed. All temporary, contract and permanent police personnel working in the 7 police stations of our field practice area were included in the study.

Based on availability and inclusion criteria, 142 police personnel were interviewed. We excluded subjects who were unavailable, even after three visits to the particular police station for an interview, due to reasons like long leave, maternity leave, training, or deputation.

Ethical clearance for this study was obtained from the Institutional Ethics Committee of St. John's National Academy of Health Sciences (IEC No. 03/2022). Permission from the Superintendent of Police, Bengaluru District and the Deputy Superintendent of Police, Hebbagodi, Bengaluru District were obtained. Permission was also obtained from the Administrative Medical Officer of the Government Taluk Hospital in the study area. Written informed consent was obtained from all the participants. Since the study was conducted during the pandemic, COVID-19 appropriate behavior was followed while conducting interviews and the same was reinforced to the police personnel.

The study tool consisted of four parts which included questions on Socio-demographic details, Physical health status, Patient Health Questionnaire-9 (PHQ-9)[11] to assess depression and Perceived Stress Scale (PSS)[12] to assess stress. One of the important aspects of our study tool on physical health was about known history of non-communicable diseases which included diabetes mellitus, hypertension, thyroid disorders and cardiac disorders. The interview also included the substance use pattern of the police personnel. A calibrated weighing machine and stadiometer were used to measure the weight and height of the study subjects respectively. Random Blood Sugar was checked using a calibrated Gluco-spark glucometer and blood pressure was measured using an Omron digital sphygmomanometer.

A structured questionnaire was used for data collection, entered in Microsoft Excel and analyzed using SPSS version 21. In statistical analysis, categorical data was represented using frequencies and proportions, whereas range, mean, and standard deviation were computed for continuous data if the data followed a normal distribution. The chi-square test was applied for bivariate analysis.

Results

A total of 142 police personnel in our study area were included in our study based on availability and inclusion. The mean age of the study participants was found to be 40.28±10.97 years. Most of the police personnel 119 (83.8%) were males and 136 (95.8%) of the police personnel were Hindus. Seventy-one (50%) of the police personnel were graduates. The key sociodemographic findings are enumerated in Table - 1.

Table 1: Socio-demographic profile of the police personnel.

Variables		N(%)
Education Status	Post-Graduation	11(7.7)
	Graduation	71(50)
	PUC	38(26.8)
	SSLC	22(15.5)

Marital Status	Married	118(83.1)
	Unmarried	24(16.9)
Type of family	Nuclear family	94(66.2)
	Others	48(33.8)
Designation	Circle Inspector	1(0.7)
	Sub Inspector of Police	4(2.8)
	Assistant Sub Inspector of Police	19(13.4)
	Head Constable	59(41.5)
	Constable	56(39.4)
	Others	3(2.1)
Monthly Income	<10000 INR	2(1.4)
	10001-20000 INR	6(4.2)
	20001-30000 INR	54(38)
	30001-40000 INR	48(33.8)
	>40000 INR	32(22.5)
Duration of service in Karnataka State Police	≤10 years	56(39.4)
	11-20 Years	27(19.0)
	21-30 Years	55(38.7)
	≥31 Years	4(2.8)
Distance of residence from workplace	≤ 5 km	63(44.4)
	6 to 10 km	17(12)
	> 10 km	62(43.6)

Table-2: Comorbidities, Substance use profile and Body Mass Index of the police personnel.

Variables		**N(%)**
Previous History of Comorbidities	Diabetes	22(15.5)
	Hypertension	24(16.9)
	Diabetes and Hypertension	12(8.45)
	Others	4(2.8)
Substance use (Ever used)	Alcohol	40(28.2)
	Any form of tobacco	9(6.3)
	Both Alcohol and Tobacco (any form)	8(5.63)
Body Mass Index	<18.5 Underweight	3(2.1)
	18.5-22.9 Normal	20(14.3)
	23-24.9 Overweight	20(14.3)
	≥25 Obesity	97(68.3)

The mean weight of the police personnel was 76.37±11.90 kilograms and the mean height was 170.04±6.385 centimeters. The mean Body Mass Index (BMI) was 26.38kg/m². The results of these parameters are summarised in Table 2.

High blood pressure ≥140/90 mm Hg and sugar values >200 mg/dl among the study population are depicted in Figure 1. Among our study participants who did not have a previously known case of Hypertension, 78(55%) had high blood pressure values and among those who were known cases of Hypertension, 21(15%) had high blood pressure values (not under control). Similarly among those who were not a previously known case of Diabetes Mellitus, about 8(5.6%) had high blood sugar values and among known cases of Diabetes Mellitus 10(7%) had high blood sugar values (not under control).

The PHQ-9 is used as a screening tool for depression in this study. The PHQ-9 classifies probable depression into five categories based on the scores namely No/minimal depression, Mild depression, Moderate depression, Moderately severe depression and Severe depression. About 36% of the police personnel were found to have mild to severe depression. The PHQ-9 results are depicted in Figure 2.

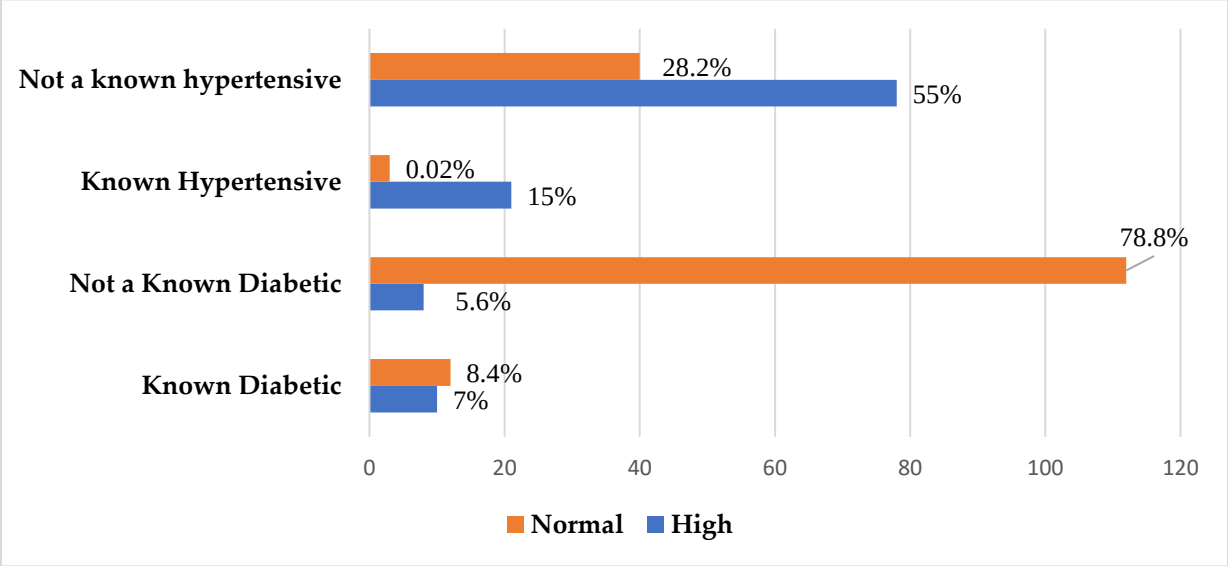

Figure 1: Categorisation of blood sugar and blood pressure values among study population. (N= 142)

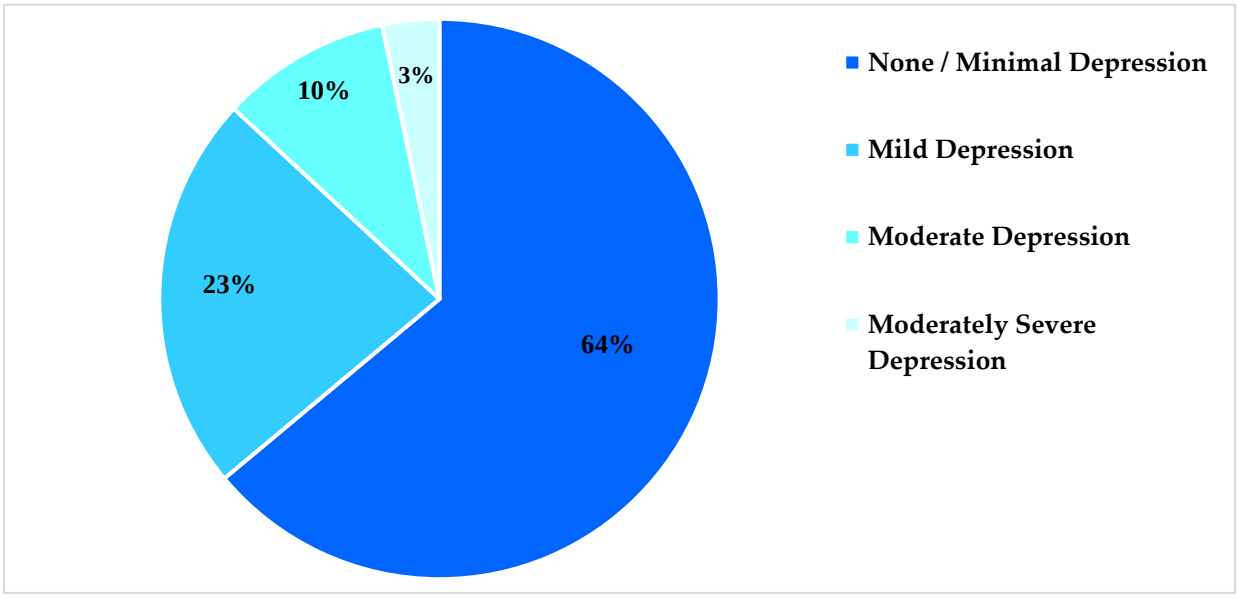

Figure 2: Level of depression according to PHQ-9 (N=142)

To assess the stress among the study subjects, the Perceived Stress Scale was used. The scale classifies perceived stress into low, moderate and high perceived stress. Among our study population, about 83% had high perceived stress. The complete results of PSS are depicted in Figure 3.

In multivariate analysis, the diabetic status had a significant association with educational status, alcohol usage and mental status (Depression) of the police personnel and the hypertensive status had a significant association with education status, alcohol usage and distance from residence of the police personnel.

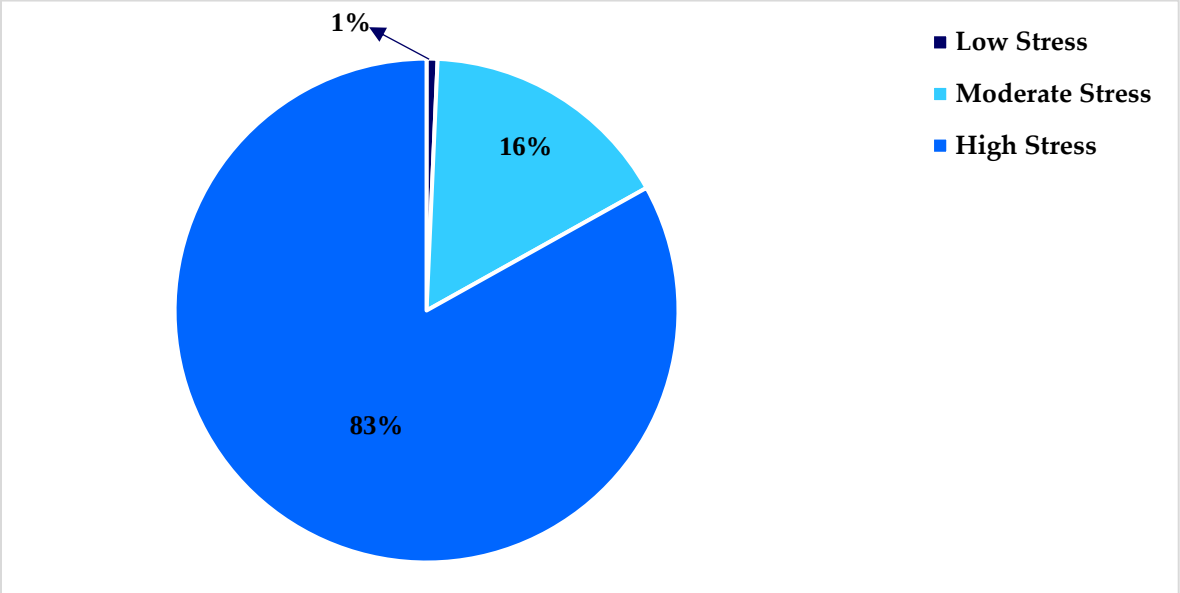

Figure 3: Level of stress according to PSS (N=142)

Discussion

This study aimed to assess the physical and mental health status of the police personnel working in a selected subdivision of Bengaluru District. About 83.8% of the police personnel were males substantiating the findings of Kishan Kumar et al. who found 95.10% males in their study.[8] About 33% of the police personnel were in the age group of 41 to 50 years as compared to Felix Johns et al. who found it to be 50.4%.[13] This study also found most police personnel were Hindus by religion, most of them living in nuclear families and found many graduates. The present study found that 68.3% of the police personnel were in the obese category and the mean BMI was 26.38 kg/m^2 as compared to Kishan Kumar et al. who found 36.7% of the police personnel were obese and the mean BMI was 24.[8] Our study also found that 69.7% and 14.08% of the police personnel were having high blood pressure and high blood sugar levels, whereas Felix Johns et al. found it to be 17.9% and 12.5% of the population had high blood sugar levels.[13] Parkash et al. observed the prevalence of hypertension in police personnel in Haryana to be 36.4%,[14] but in our study, we screened for high blood pressure where blood pressure was measured only once due to want of time, hence a follow-up and diagnosis may probably find many of the individuals with high blood pressure to be having pre-hypertension. In line with our study, Saudi Arabian police personnel also were observed to have high sugar levels, cholesterol levels and obesity.[15] Nearly 40% of our study population had substance use. This is in line with the study done by Boyanagari et al.[16] The high prevalence of substance use corroborates with occupational stress and maladaptive coping strategies. The study participants reported that this occupation has irregular working hours, lack of housing facilities closer to the workplace, frequent transfers, inadequate training and opportunity for advancement, leave issues due to repeated duties and not filling vacant posts. A study done by Boyanagiri et al. found that similar factors have contributed to stress and substance use among

police personnel.[16] Queiros et al. also observed that police personnel suffer from severe occupational stress and burn out and if this is not addressed by improving the working conditions, this could result in counterproductive work behaviours, increased mental illnesses, use of excessive force and violence at the workplace.[5]

According to our study about 36% of the police personnel had mild to severe depression according to PHQ-9 and 83% of them had moderate to severe stress according to PSS, whereas Katelyn K et al. found depression and stress among law enforcement personnel to be 44% and 61% respectively.[9] Lack of social support, post-traumatic stress, exposure to death, abuse and violence at work can contribute to depression in this population.[17] Simple screening using PHQ-2 can identify the high risk for depression/suicidality in this population and ensure adequate timely management is provided. Violenti et al. have identified exposure to abused or dead children, murders, use of violence in duty, physical attacks, administrative issues such as inadequate support from supervisors, lack of trust in the justice system, the law being lenient with the perpetrators of crime and insufficient manpower as stressors in police personnel.[18] As per the Occupational Safety, Health and Working Conditions Code 2020, all employees should be supported with information, instruction, training and supervision to ensure health and safety are not compromised.[19] However, this component is lacking in this occupational group. Due to COVID-19, the work burden of police officers increased, as they were involved in ensuring social distancing, lockdown measures and mask usage. These factors could have contributed to increased stress in this population.[20] Physical exertion, prolonged standing, unhealthy diet at irregular hours, exposure to mental and physical trauma, and low decisional latitude in this occupation cause stress and hypertension. This can make this population prone to coronary artery diseases. Wellness interventions such as the promotion of a healthy diet including 5 servings of fruits and vegetables intake per day, reduced salt intake, regular physical activity of at least 30 minutes per day, sleep hygiene, yoga and stress management training can be offered to this group of individuals. Annual Medical Examinations, non-invasive 10-year cardiovascular risk assessments, and a Tobacco cessation program can be provided at the workplace.[21] Hartley et al. have identified police personnel to be having higher depression levels and CVD risk factors such as high cholesterol levels, smoking and obesity as compared to the general population. The contributing factors observed are night shifts, improper sleep hygiene, and stress resulting in an inflammatory process.[22] Noise levels on the road and particularly at traffic intersections are high, and that could be another contributing factors.[23] We have not assessed the noise level and environmental noise related health problems in this study.

As a part of this study, those officers requiring medical advice for their mental and physical health conditions were given one-to-one counseling for lifestyle modifications and referred to the weekly Mental Health Clinic and Non-Communicable Disease Clinic of the nearby Government Taluk Hospital for further evaluation and management. Filling of vacant posts if any, to ensure adequate personnel management and arrangement for police residential quarters in the subdivision to avoid long travel could improve the quality of life of this population. Optimization of hours of work per day is essential.[17] Employee Assistance Programs with counseling services, access to cardiovascular workouts such as treadmills, the establishment of community gyms/open-air gyms, exercise bikes and strength training, and time allotment for games such as volleyball and softball could improve physical activity in this population.[24]

Conclusions

Stress, depression, and obesity were significantly high in this occupational group as compared to the general population. Regulated working hours, post-duty offs, annual medical examinations with a focus on physical and mental health, access to

mental health services, positive mental and physical health programs and residential quarters near the workplace can improve the physical and mental health status of the police personnel.

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Original Article

Impact of High-Heeled Footwear on the health of the young female students of selected colleges of Mangalore, India

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ABSTRACT

Introduction: High-heeled shoes are a leading cause of foot problems and chronic lower limbs, as well as discomfort, fatigue, and an increased risk of injury. The research aimed to analyze the influence of wearing high-heeled shoes on the foot health of young females. The study emphasizes the need to create awareness among females about the detrimental impacts of utilizing heeled footwear over the long term on discomfort, BMI, and functional capacity. A slight change in footwear choices could significantly reduce discomfort and disability experiences.

Methods: Purposive sampling was used to select 50 young female students studying in Mangalore's undergraduate college for the cross-sectional study. A pre-designed and pre-tested structured Google Form questionnaire was used to examine the socio-demographic characteristics and outcome measures, including the location of pain, the intensity of the pain, and functional ability. Data was collected in the second half of 2020. Descriptive and inferential statistics were used to analyze the data.

Results: According to the survey, 46% of young female students exhibited poor functional activities while wearing high heels. It was found that 12% of students had pain in their toes all of the time, 8% had pain in the arch of their foot, and 25% had discomfort in their lower back occasionally. About two-thirds (64%) felt averagely manageable discomfort.

Conclusion: The study found that wearing heeled shoes has a significant influence on women's musculoskeletal systems. Young females will be better able to resist pain from the deforming effects of footwear if they condition their feet properly and choose the appropriate footwear.

Keywords: Foot pain, High heeled footwear, Young female students

Introduction

The ultimate fashion signifier of being a woman is high-heeled shoes. The sexiest and most feminine shoe a lady may wear is the high-heeled shoe. High heels have the power to alter the wearer's posture and appearance dramatically. Heels lengthen the leg and slim the calves and ankles. Wearing heels creates a contradiction because the physical changes affect how a woman feels and are often regarded. A woman grows taller and strikes a defiant attitude that represents sexuality and strength. High heels, on the other hand, can make a lady helpless, teetering and wobbly, unable to walk, docile, and weak.[1]

Even though high heels are detrimental to health and comfort, ladies nonetheless wear them on occasion. Women frequently make sacrifices for the sake of foot fashion and pay a great price when pain and deformity arise.[2] According to the Spine Health Institute, 72% of women would wear high heels at some point throughout their lives.[3] According to a survey, 48.5% of women wore high

heels daily or on weekends for social engagements. When worn regularly, high heels put a strain on the back, toes, ankle, and knee joints.

High-heeled shoes can harm the spine, hips, knees, ankles, and feet, as well as significantly affect posture and stride. High heels also cause toe sprains, leg and back pain, and greater weight bearing on the toes.[2] Furthermore, wearing high heels causes poor posture and increases the chance of falling, especially among the elderly. Long-term use of high-heeled shoes causes changes in body weight distribution on the feet, with increased weight bearing on the frontal area of the foot. Wearing high heels might disrupt bodily balance and functional functioning. In women between the ages of 20 and 29, high heels cause lower back discomfort.[5]

By flexing or forward bending the hips and spine, the human body strives to compensate for the off-kilter balancing heels. High heels, particularly pointed ones, tighten the calf, hip, and back muscles as a result of the added pressure. Excessive muscle fatigue and strain are the result.[2] Muscle discomfort was mostly observed in the foot and lower limb owing to high heels, with 29.6% and 24.7 % respectively, while back pain accounts for 9.9%. High heels cause venous insufficiency in the calf muscle, producing foot and lower limb pain. The muscles of the lower back are also harmed as lumbar curvature increases.[6]

The data above reveals that wearing high heels causes a variety of health concerns. The influence of high-heeled footwear on the health of young females piqued the researcher's curiosity. As a result, women should be aware of how to avoid the negative effects of high-heeled footwear as well as the potential risks. The goal of this study was to discover a link between pain levels and functional activities to improve future health. The findings of this study could help young females determine and execute healthy footwear choices to avoid further complications.

Methods

High heels have been worn by women at some point in their lives, and many do so daily. In clinical and institutional settings, the prevalence ranges from 39% to 78%, comprising a significant share of the female population.[7] The goal of the study was to look into female students' footwear preferences in terms of comfort. Following a review of the literature, a survey was created with the assumption that long-term usage of high-heeled footwear had a negative influence on the health of young women.

Through an internet platform, a cross-sectional survey was conducted targeting the female universe doing their graduations in Mangalore. The sample size was estimated using the one-sample mean formula.[8] Considering the standard deviation (σ) of the sample age as 5.12 with a precision (d) of 1.6 and a 95% confidence interval ($Z_{1-\alpha/2}$ - two-tailed probability), the sample size was calculated using this formula: $N = Z^2_{1-\alpha/2} \times \sigma 2 / d^2$. Thus, the sample size required for the study was 39.34. Considering a possible 10% loss of sample, the final sample size was 50. To pick the sample and extract as much information as possible that could be acquired, purposive sampling was performed. This enables us to describe, how the population will be significantly affected by the findings. The pain was assessed using the numerical pain rating scale.[9] The questionnaire was adapted from FHSQ[10] and was formatted as follows: The first portion was for the sample's sociodemographic characteristics, followed by questions to determine the sample's footwear-wearing habits. The final component aimed to determine the sample's foot health using three subcategories: site of pain, level of pain, and functional abilities. A questionnaire test was used to ensure that the questions were understood and delivered in an electronic format. Young women, 18–20 years old, studying in selected degree colleges and available during the data collection were included. Those who had any neurological condition affecting lower limbs were non-ambulatory and relied on walking aids, as well as those who refused to sign the consent form, were excluded

Young female students were asked about their sociodemographic and clinical characteristics during interviews. The baseline data was collected on the type of footwear worn, heel height, back pain history, frequency and duration of wearing, and reasons for wearing high heels. All participants underwent a clinical examination that included measuring their height and weight while barefoot and wearing light clothing on a calibrated weighing scale. The BMI (body mass index) was determined. The participants completed a self-administered foot health questionnaire that included both foot-specific and general health questions. The toes, arch of the foot, heel, calf muscles, knees, and lower back were all evaluated for pain. The discomfort felt when wearing high-heeled footwear was rated on a numerical pain rating scale. Functional ability was elicited using a 5-point Likert scale.

The institution's ethics committee provided ethical permission, and ethical practice was

followed throughout the investigation. The questionnaire was created and adapted from prior studies to capture the frequency and duration of wearing high heels over time. The schedule was created and validated by subject matter specialists. A reliability of 0.72 (Cronbach's alpha) was obtained.[11] Eligible samples (50) were selected through purposive sampling and were directed to a Google form to complete a pre-designed questionnaire. Instead of providing a written signature, respondents confirmed their approval electronically. The ethics committee authorized the protocol. The location of pain, level of pain, and functional ability were all measured using a foot health questionnaire.

Statistical analysis was undertaken using descriptive statistics and Spearman's correlation coefficient. Non-parametric tests like Chi-square tests were used. The significance level was set at $p < 0.05$.

Results

The online survey received replies from 50 female students, the majority of whom were young ladies in their final year of study (62%). The socio-demographic information on the questionnaire included height and weight measurements. The participants were instructed to choose comfortable footwear. Questions on frequency, duration of use, heel height, and how certain shoes made them feel were used to probe wearers' habits.

More than half (58%) of young ladies had a healthy BMI. Flat shoes were chosen by 75% of respondents, compared to 21% who chose high-heeled shoes. Nearly 64% of students wore heels between 2.5 and 3.5 cm. One-third of the respondents (34%) associated footwear with a fashionable appearance and utilized it as a dress guideline (56%).

Four out of five (80%) of the respondents chose high-heeled shoes for the event. We found that most students do not wear high heels beyond 2.5 cm for everyday tasks. For 3-6 hours, about 40% of females wore high heels. A significant number of respondents reported that it made them feel more feminine. When wearing high heels, 22% of respondents claimed that it improved posture and provided a feeling of being taller.

The sites of pain were most common in the toes (12%) and heels (14%), respectively, for female students. Wearing high-heeled shoes occasionally caused pain in the lower back (48%) in nearly half of the respondents.

Detailed data on the pain level of the respondent might be observed in Table 1. While the data on functional ability are displayed in Table 2.

Table 1: Pain assessment using the visual analog scale (N=50)

Level of pain	Number of sample = 50	
	Frequency (f)	Percentage (%)
Mild	16	32.0
Moderate	33	66.0
Severe	1	2.05

Table 2: Functional ability assessment (N=50)

Functional ability	Number of sample =50	
	Frequency (f)	Percentage (%)
Good	9	18
Average	18	36
Poor	23	46

Table 3: Correlation between pain level and functional activities and BMI (N=50)

Correlation coefficient	Pain – functional ability	Pain - BMI
r	-0.0076	-0.1584

*Significant at $p < 0.05$

Discussion

Women's attractiveness is enhanced by high heels, but their lumbar curvature is altered. In this era, high heels are becoming increasingly popular. The bulk of the young women in the sample (46%) were under the age of 20, while 36% were over 20 years old. Consistent findings are observed in several studies conducted on heel height among females who wear high heels. High-heel wearers were more prevalent among the younger generation (ages under 24 years).[12, 13,14,15,16]

Carrying extra body weight puts a lot of strain on the bottom of the foot. Extra weight can cause harm to the foot and ankle joints.[17] Foot and ankle disorders are significantly more common in people with a higher BMI. The majority of the young females (58%) in the present research had a normal BMI. According to a study on the prevalence of foot deformity among urban working women, more than half of the women (65%) had a normal BMI.[18] Because of the affluent lifestyle of individuals, particularly students, the prevalence of overweight and obesity is on the rise in our era.[19] The findings of other studies are inconsistent, showing that the majority of the informants were overweight (BMI of 25.45 +/- 4.51 kg/m).[7,13]

According to our statistics, more than half (52%) of the women wore flat shoes, 32% casual shoes, and 16% high heels. Supporting studies revealed that the majority of women (38%) wore wedge heels, and the majority of them (40%) wore HHS with a leather sole.[16, 20] Similarly, the findings of the study conducted on the comfort of young adults were consistent. They started to wear sneakers (48.52%) and ballerina flat versions (14.2%) more frequently, and also chose to wear flat heels up to 2 cm (33.88%) and boots daily (14.88%).[12]

The present study findings revealed that the majority of young females (80%) wore high heels at least once on special occasions such as parties and social gatherings, whereas only 8% of the sample wore high heels all the time. The findings are consistent with a study on the association of pain and functional limitations among working women. The results showed that flat shoes were worn every day, as were comfort shoes, while heeled shoes were worn 2-3 times per week.[21] The study findings are supported by a study conducted on heel height and low back pain wherein women (45%) wore heels daily during their working hours.[14]

According to the findings of the current study, 64% of females wore heels less than 2.5 cm, and 6% wore heels more than 5 cm. Furthermore, the findings of the study on musculoskeletal discomfort and high heels revealed that 63% of females wore HHS for four days each week and 37% wore HHS for at least seven hours every day.[16] Studies on awareness of risk related to footwear problems report that heels should not be higher than 2 inches in height. The pressure on the forefoot increases as the heel height increases.[20] When women wore heels, the results were comparable, according to a study on back pain and functional limitations.[14]

In contrast to our findings, an article on sales promotion girls found that 89.4% of young girls wore middle heels (5-7 cm) and 10% of young girls wore high heels (8-10 cm).[13] Results from the study on high heels and comfort shoes discovered that the majority of people do not wear high heels (above 5 cm), but when asked what style of shoe they would like to wear more often, a substantial number of people said models with high heels. With varied models, younger people chose heel heights of more than 7 cm (12.84%).[12]

According to the current study data, 56% used heels as a dress code, 34% to seem fashionable, and 22% to improve posture and appear taller. Another study on the prevalence of musculoskeletal pain with different heel heights showed that high heels were worn by 14% of women, 77% for comfort, 7% for work, and 2% for other reasons.[22] In other studies, when respondents were asked what high heels meant to them, the majority associated them with beauty and femininity, followed by sacrifice and discomfort.[12]

According to the findings of the current study, 12% of the participants always experienced toe discomfort, and 14% had heel pain. Consistent findings were observed in studies on heels and musculoskeletal discomfort. High heels caused discomfort in the foot and lower limb (29.5% and 24.7%), but flat sandals caused pain in the foot and lower limb (39.5% and 19.8%, respectively).[14, 16, 23] The findings are also in line with those of a survey of 200 ambulatory responders, which found that 21% of them felt ankle pain.[20]

The current study found that 64% of the participants had tolerable pain and 2% experienced severe discomfort. The findings are in line with a study on the impact of high heels on the young generation. Results found that 18.8% of the sample had foot edema.[15] Long heels can cause both heel and back pain. The findings of the present study confirmed that 90% of the participants had no back pain. Approximately

68% of females from another study report low back discomfort, with 11% of individuals reporting probable impairment as a result of LBP symptoms.[13, 15] The findings are in line with the findings of a study that found that 45% of women's backs hurt as a result of wearing heels.[14]

Limitations

Researchers confined the usage of foot health questions in the tool to a few subsections. Only one location was used to collect research samples. The sample size was limited to a small group of female students, which, if increased, could improve the study's results. Personal interviews, rather than online interviews, could have provided more in-depth information about the risk variables for the study. Because the research was conducted on a small scale, the results cannot be generalized, and thus it still needs improvement and future research. Furthermore, because of the small number of respondents, the respondents' traits were less diverse.

Conclusion

The study results indicate that wearing high-heeled shoes occasionally causes pain in the lower back, and functional limitation ranges from minimal to moderate. Young women should choose comfortable shoes to maintain good foot health and avoid foot pathology.

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Original Article

Knowledge, Perception and Practices regarding COVID-19 among frontline Nurses at Selected Hospitals in Sri Lanka during COVID-19 Pandemic

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ABSTRACT

Introduction: The World Health Organization confirmed the COVID-19 epidemic situation as a public health emergency and is an emerging public health problem that has threatened millions of lives worldwide. Since COVID-19 has significantly affected the healthcare system globally, it is essential to update healthcare workers especially frontline nurses on the best practices for the proper management of the disease. The study aimed to assess Knowledge, Perceptions, and Practices regarding COVID-19 among frontline nurses at the National Institute of Infectious Diseases, National Hospital of Sri Lanka, and Base Hospital Mawanella in Sri Lanka.

Methods: This cross-sectional study was conducted among 257 frontline nurses from main three hospitals in Sri Lanka from June 2020 to December 2021. A validated, pre-tested self-administered questionnaire was used for data collection. Kruskal Wallis test and Chi-square test were applied to find significant factors associated with good knowledge, using SPSS version 25.

Results: The average age of the 257 participants was (31.8 ± 6.6) years and most (95%) of them were female. Of them, 79.4% had good knowledge, and the knowledge level of the nurses was significantly associated with their marital status ($p=0.04$) and their participation in the COVID-19 management workshop or lecture ($p \leq 0.001$). There was a statistically significant median score difference between participants' knowledge, and three hospitals ($p<0.05$).

Conclusion: The findings demonstrated that the nurses had overall good knowledge, positive perception, and good practice on COVID-19. This study highlighted the factors influencing knowledge about COVID-19 that must be addressed in future education, awareness, and preparing the programs.

Keywords: COVID-19, Knowledge, Nurses, Perception, Practice, Sri Lanka

Introduction

COVID-19 has significantly affected the healthcare system globally and continuous evidence shows that the update of healthcare workers on the best practices for the proper management of the disease is essential. Caring in times of pandemics is extremely stressful for healthcare workers (HCWs), especially for nurses.[1,2] Nurses are the first contact in most instances and are required to provide immediate care under life-threatening conditions even in any pandemic. In addition, as the patient's family cannot be present at the patient's bedside due to many restrictions, nurses stand in for family members and facilitate access and communication between patients and their loved ones.[3]

Low levels of knowledge, negative perceptions, and poor practices towards COVID-19 among healthcare workers directly lead to late diagnosis,

poor adherence to infection control, and a faster spread of the disease.[4] Further, stigmatization by society due to the contagious nature of the illness, nurses may refuse to care for patients which leads to a most complex dilemma concerning a mindset of patient avoidance and a preference for caring for infectious patients.[5]

COVID-19 infection among HCWs can be common at the initial stage of the disease outbreak. Further, knowledge is crucial for establishing positive perceptions and preventive strategies that can reduce the infection rate among nurses. Zhang et al. (2020) reported that the lack of knowledge among frontline HCWs is the causative factor for the transmission of infection.[6] Similarly, a study from Greece found that a high level of knowledge among HCWs was significantly associated with a positive attitude and practice toward preventive health measures.[7]

Inadequate knowledge, improper practices, and negative perceptions can directly affect the patient's care and would increase the risk of infection among both the nurses and patients as well as nurses' willingness to work during any pandemic.[8] According to the available data, knowledge, perception, and practices regarding COVID-19 among HCWs especially among frontline nurses in Sri Lanka have not been studied up to date in Sri Lanka. Thus, this study aimed to assess the knowledge, perception, and practices regarding COVID-19 among frontline nurses at selected main three hospitals in Sri Lanka during the COVID-19 pandemic.

Methods

A descriptive cross-sectional study was conducted among frontline nurses in three hospitals in Sri Lanka as National Institute of Infectious Diseases (NIID), Angoda, National Hospital of Sri Lanka (NHSL), and Base Hospital, Mawanella (BHM). The study was carried out from June 2020 to December 2021. A total of 320 male and female frontline nurses who had been directly involved in the management of COVID-19 in all three selected hospitals were included and those who were on long-term leave (maternity leave, wedding leave) and were not willing to participate in the study were excluded. A pre-tested, validated, self-administered questionnaire (SAQ) was used to collect data on sociodemographic details, and knowledge, perceptions, and practices regarding COVID-19. SAQ was designed by the researcher after an intensive literature review and expert advice from the supervisors. This SAQ was validated judgementally by experts in the fields of Medicine, Microbiology, and Nursing. The experts were invited to check the relevance and suitability of the SAQ for the Nurses in the Sri Lankan setting. All experts made some overall changes, especially in the wording and the understanding of the local language. These changes were corrected by the researcher. The SAQ was prepared in English language and a back-to-back translation process was used to translate it into Sinhala and Tamil language to assess the accuracy of the information. A score of "one" was given for every correct answer and a score of "zero" was given for every incorrect answer or no answer in the knowledge section of the SAQ.[9] The total score was converted into percentages and interpreted as follows; Good Knowledge - 76% - 100%, Adequate Knowledge - 50% - 75%, and Poor /Inadequate Knowledge - 0% - 49%.[10]

The SAQ was pre-tested for acceptability and comprehension and to assess the clarity and suitability of the wordings used in the questions, at Homagama Base Hospital, and modifications were made to the questionnaire by improving the clarification of questions, dropping some questions, and changing some words. The administration of the SAQ for the collection of data was carried out by the researcher. Following the formal introduction, the importance of the study and the nature of the study were explained onsite by using an information sheet at the selected hospitals among frontline nurses, and an email address was obtained from nurses who were willing to participate in the study. Initially, an informed consent form was emailed to each participant who fit for inclusion criteria. Once the consent was obtained from them, the SAQ was distributed via a Google form. Each participant was instructed to fill in the Google form during their free time to enhance compliance without disturbing their routine activities. SAQ was administrated among 320 nurses. However, only 257 participants responded and returned the

questionnaire. Data analysis was done by using the statistical software SPSS version 25. Descriptive statistics were applied to obtain percentages and means with standard deviation and relevant inferential statistics was performed to interpret the findings. Kruskal-Wallis test was used to assess the median knowledge score between three unrelated groups (three hospitals) based on the non-normal distributions. A p-value of < 0.05 was considered statistically significant in all tests.

Ethical approval was obtained from the Ethics Committee of the Faculty of Nursing, KAATSU International University, and the National Hospital of Sri Lanka. Permission to conduct the study was obtained from the Director, the National Institute of Infectious Diseases, the National Hospital of Sri Lanka, and Base Hospital Mawanella. Privacy, confidentiality, and anonymity of the subjects were ensured during data collection.

Results

The mean age of the participants was 31.87 (±6.67) years. Most of them were female [245, (95%)], and 94(66%) of them had less than 5 years of experience in their current working hospital. Nearly two-thirds [164(64%)] of participants were married and 224 (87%) had a nursing diploma as the highest education level (Table 1).

Table 1. Socio-demographic and work-related characteristics of the study participants

Characteristics	Frequency (%)
Age in years	
<30	147 (57.2)
30-40	86 (33.5)
≥40	24 (9.3)
Gender	
Male	12 (4.7)
Female	245 (95.3)
Marital status	
Married	164 (63.8)
Unmarried	93 36.2)
Highest educational Level	
Diploma	224 (87.2)
Graduate	32 (12.5)
Postgraduate	1 (0.3)
Working hospital	
NIID	120 (46.7)
NHSL	86 (33.5)
B.H.Mawanella	51 (19.8)
Working experience in hospital	
<1 year	75 (29.2)
1-5 year	94 (36.6)
6-10 year	57 (22.2)
≥10 year	31 (12.0)
Attended any workshop on COVID-19	
Yes	169 (65.9)
No	88 (34.1)
Working experiences in COVID-19 Management units	
<6 months	79 (30.7)
6-9 months	35 (13.6)
≥ 9 months	143 (55.7)
Maximum hours of work in COVID-19 unit/shift	
<1	17 (6.6)
1-3	37 (14.4)
≥ 3	203 (79.0)

In addition, 118(46%) of the participants were aware of the incubation period of COVID-19 and 244 (95%) mentioned that COVID-19 can be transmitted through air/droplets. Further, 251 (98%) of them stated that pneumonia is the main complication of COVID-19 and supportive care is the main treatment strategy available in Sri Lanka for the management of COVID-19 (Table 2).

Table 1: Knowledge of disease COVID-19

Knowledge related question	n (%)
Incubation period (correctly mentioned)	118 (45.9)
Symptoms of COVID-19 infection	
Headache	243 (94.6)
Fever	251 (97.7)
Cough	245 (95.3)
Sore throat	203 (79.0)
Skin rash	65 (25.3)
Mode of transmission	
Air/Droplets	244 (94.9)
Skin contact	185 (72.0)
Feco-oral route	222 (86.4)
Complications of COVID-19	
Pneumonia	251 (97.7)
Respiratory failure	245 (95.3)
Death	222 (86.4)
Available treatment of COVID-19 in Sri Lanka	
Antiviral therapy	144 (55.3)
Supportive care	234 (91.4)
Vaccination	6 (2.3)

Table 2: Knowledge about COVID-19, its management, and preventive measures

Statements	Yes n (%)	No n (%)	Don't know n (%)
COVID-19 is a viral disease	248 (96.5)	9 (3.5)	0 (0)
COVID-19 is transmitted by direct contact with infected persons	238 (92.6)	12 (4.7)	7 (2.7)
COVID-19 is transmitted by dealing with domestic animals	113 (44.0)	42 (16.3)	102 (39.7)
Vaccines are available for COVID-19	227 (88.4)	23 (8.9)	7 (2.7)
Antibiotics are the drug of choice in treating COVID-19	193 (75.1)	47 (18.3)	17 (6.6)
The virus may be more dangerous for the elderly	245 (95.3)	9 (3.5)	3 (1.2)
The virus may be more dangerous for patients with chronic diseases	249 (96.9)	6 (2.3)	2 (0.8)
Healthcare workers are more prone to COVID-19	223 (86.8)	26 (10.1)	8 (3.1)
COVID-19 always causes death	224 (84.7)	31 (12.4)	2 (0.8)
COVID-19 is transmitted through eating contaminated food of COVID -19 patient	87 (33.9)	120 (46.7)	50 (19.5)
COVID-19 is transmitted by arthropods	161 (61.6)	15 (5.8)	81 (31.5)
COVID-19 leads to pneumonia, respiratory failure, and death	237 (92.2)	19 (7.4)	1 (0.4)
Persons with COVID-19 cannot infect the virus others if they have no symptoms	205 (79.8)	40 (15.6)	12 (4.7)
Using a hand sanitizer with 70% alcohol is better than washing hands with soap and water	188 (73.2)	52 (20.2)	17 (6.6)
Preventive Measures			
Wash hands with soap and water or sanitizer	257(100)	0 (0)	0 (0)
Avoid touching eyes, nose, and mouth always	257(100)	0 (0)	0 (0)
Wearing facemask	257(100)	0 (0)	0 (0)
Covering the nose and mouth while coughing	254 (98.4)	3 (1.2)	0 (0)
Avoiding crowded public places	256 (99.6)	1 (0.4)	0 (0)
Frequency cleaning and disinfecting surfaces	254 (98.8)	2 (0.8)	0 (0)
Keep at least one-meter distance between people	245 (95.3)	11 (4.3)	1 (0.4)
Washing nose with a salty solution	187 (72.8)	22 (8.6)	48 (18.7)
Avoid direct conduct with colleagues	198 (77.0)	42 (16.3)	17 (6.7)

Furthermore, 248(97%) participants mentioned that the COVID- 19 is a viral disease, and 237(92%)

of them stated that COVID-19 leads to pneumonia, respiratory failure, and death. Only, 227 (88%) of them stated that vaccines are available for COVID-19. Further, 193 (75%) of them stated that antibiotics are the drugs of choice in treating COVID-19 and 224 (85%) of them mentioned that COVID-19 is the cause of death. Nearly, 223 (86%) of participants mentioned that HCWs are more prone to develop COVID-19. In addition, all participants stated that washing hands with soap and water, avoiding touching eyes, nose, and mouth, and wearing a facemask are correct preventive measures against COVID-19 spread. Further, 245 (95%) of participants mentioned that keeping at least a one-meter distance between people is a preventive measure for COVID-19 infection (Table 3).

Overall, 204 (79.4%) had a good level of knowledge and 6 (2.3%) had a poor level of knowledge, and the mean knowledge score was 78.11(±8.62). Further, the knowledge level of the participants was significantly associated with their marital status (p=0.04) and their participation in the COVID-19 management workshop or lecture (p=0.00) (Table 4). There was a statistically significant median difference of knowledge score across all three hospitals (p = 0.00) with a median of 78.0 (75.6-85.4) for NIID, 78.0 (73.2-80.5) for NHSL and 82.9 (78.0-85.4) for BH Marawilla (Kruskal-Wallis test).

Table 3: Factors associated with knowledge level among all participants

Socio-Demographic Characteristics	Poor Knowledge n (%) n=6	Adequate knowledge n (%) n=47	Good Knowledge n (%) n=204	p-value*
Gender				0.79
Male	0 (0)	2 (4.3)	10 (4.9)	
Female	6 (100)	45 (95.7)	194 (95.1)	
Marital Status				0.04
Married	4(66.7)	20(42.6)	140(68.6)	
Unmarried	2(33.3)	27(57.4)	64(31.4)	
Educational level				0.36
Diploma	6 (100)	44(93.6)	174(85.3)	
Graduate	0 (0)	3(6.4)	29(14.2)	
Postgraduate	0 (0)	0 (0)	1(0.5)	
Experience in COVID-19 management (months)				0.40
<6	1(16.7)	22(46.8)	56(27.4)	
6-9	1(16.7)	6(12.8)	28(13.7)	
>9	4(66.6)	19(40.4)	120(58.9)	
Maximum hours working with COVID-19 patients				0.78
<1	0 (0)	4(8.5)	13(6.4)	
1-3	0 (0)	8(17.0)	29 (14.2)	
>3	6 (100)	35 (74.5)	162 (79.4)	
Attended lectures on COVID-19				0.00
Yes	0 (0)	35(74.5)	134 (65.7)	
No	6 (100)	12 (25.5)	70 (34.3)	

*- Chi-square test

Only 229(89%) of participants stated that they would get COVID-19 and only 10 (3.9%) of participants were not worried about being a nurse in the health sector in the present situation. Approximately 135 (52%) of the participants stated that transmission of COVID-19 can be prevented by frequent hand washing. Nearly, 184(82%) of participants agreed to vaccinate against COVID-19 and 185 (72%) were agreeable to taking more responsibility for infection control in their unit/ward in the present situation. However, 15(6%) of the participants mentioned that COVID-19 is not a preventable disease and nearly 219 (85%) of participants stated that standard precautions can protect them against COVID-19 (Table 5).

Nearly two-thirds, 218 (85%) of participants mentioned that they know how to wear PPE

correctly. Further, 135 (64%) of participants gave an incorrect percentage of TCL that is used for cleaning linen and nearly 216 (84%) of participants stated that they are willing to attend to a COVID-19 patient (Table 6).

Table 4: Perception regarding COVID-19 among all participants

Questions	Definitely No n (%)	May be n (%)	Most probably n (%)	Definitely Yes n (%)
Do you think you will get COVID-19	11(4.4)	17(6.6)	188(73.0)	41(16.0)
You are worried to be a nurse in the health sector in the present situation	10(3.9)	26(10.1)	41(16.0)	180(70.0)
Transmission of COVID-19 can be prevented by washing hands frequently	15(5.8)	25(9.8)	82(31.9)	135(51.5)
If you get COVID-19, you will agree to be isolated in a health facility	7(2.7)	43(16.7)	31(12.1)	176(68.5)
Will you be afraid of catching COVID-19 when you are giving care to a COVID-19 patient?	22(8.6)	23(8.9)	69(26.8)	143(55.6)
If the COVID-19 vaccine is available, will you have it	13(5.1)	33(12.8)	27(10.5)	184(71.6)
If anyone gets the coronavirus, do you think the possibility of survival is high	19(7.4)	115(44.7)	79(30.7)	44(17.2)
Do you take more responsibility for infection control in your unit/ward in the present situation?	21(8.2)	31(12.0)	20(7.8)	185(72.0)
COVID-19 is a severe disease	16(6.2)	76(29.6)	44(17.1)	121(47.1)
COVID-19 can be prevented	15(5.8)	31(12.5)	79(30.7)	131(51.0)
Standard precautions can protect us against COVID-19	18(7.0)	20(7.8)	35(13.6)	184(71.6)
I am confident that Sri Lanka can overcome COVID-19	16(6.2)	113(44.0)	73(28.4)	55(21.4)
Regulations taken by the government are enough to combat disease	27(10.5)	80(31.1)	93(36.2)	57(22.2)
COVID-19 is currently diagnosed in Sri Lanka	20(7.8)	27(10.5)	40(15.6)	170(66.1)
I am confident that the hospital is treating COVID-19 patients effectively	13(5.1)	57(22.1)	66(25.7)	121(47.1)

Table 5: Practices regarding COVID-19

Statement	Yes/Correct n (%)	No/Wrong n (%)	Not responded n (%)
Do you know how to wear PPE correctly?	218(84.8)	39(15.2)	0 (0)
Do you know how to remove PPE correctly?	214(83.3)	43(16.7)	0 (0)
What percentage of TCL do you use for linen cleaning?	90(35.0)	162(63.0)	5(2.0)
What percentage of TCL do you use for cleaning instruments?	165(64.2)	91(35.4)	1(0.4)
Do you wear a mask in your working area?	241(93.8)	16(6.2)	0 (0)
Frequently you wash your hands at your workplace	110(42.8)	147(57.2)	0 (0)
Will you willingly attend to a COVID-19 patient?	216(84.0)	38(14.8)	3(1.2)

Discussion

The study evaluated the knowledge, perception, and practice regarding COVID-19 among nurses working at main three hospitals in Sri Lanka. Nurses are one of the most important key players in the battle against COVID-19 as HCWs during the pandemic. The knowledge, perception, and practice of nurses towards the COVID-19 pandemic play a very important role in the way they accept patient care, the measures put in place to control its spread, and their willingness to seek and adhere to care.[11] The present study revealed

that most of the nurses (79%) had a good level of knowledge about COVID-19 control and prevention. Nurses may have more opportunities for being counseled or educated on the disease and its management through different means of communication. Similarly, a high level of knowledge was reported from studies done among HCWs in Vietnam, China, and Pakistan.[12] In addition, these findings are consistent with the findings of studies conducted in other countries such as Nepal and Greece.[4,7] Nurses with a good level of knowledge might lead to early diagnosis, proper adherence to infection control, and a slower spread of the disease.

Further, the study showed that most of the nurses were aware of the main symptoms of COVID-19 such as fever (97.7%), headache (94.6%), cough (95.3%), and sore throat (79%). This would enable them to identify patients early and to identify if they get the illness. The majority of the nurses knew that COVID-19 transmission occurs through air/droplets (94.9%), and direct contact (72%). This is quite a contrast to the findings of a study conducted in Ho Chi Minh City Hospital, Vietnam where only less than two-thirds of answers related to the transmission by close contact with an infected person.[13] In addition, the majority of participants (>95%) were aware that patients with underlying chronic diseases are at a high risk of getting an infection and this finding is consistent with some previous studies conducted on COVID-19 in Vietnam and China.[14,15]

Further, the study revealed that the knowledge level of the nurses was significantly associated with their marital status (p=0.04) and their participation in the COVID-19 management workshop or lectures (p=0.00). The plausible justification for the association between workshop attendance and knowledge level is that those who have participated in the workshop may have greater exposure to the experts and educational material on COVID-19 and its management which influences the level of knowledge. However, in contrast to these findings, a study conducted among Egyptians found that knowledge about COVID-19 was significantly associated with age, education level, and income.[16] Similarly, another study done in Bangladesh found that age and residence were the associated factors of knowledge level.[17]

In addition, the findings revealed that most of the participants had positive perceptions towards COVID-19 control and prevention where more than 80% of nurses mentioned that COVID-19 can be prevented. A similar finding was observed in a study conducted by Wake, 2020.[11] In addition, nearly 70% of participants are worried about being a nurse in the health sector in the present situation, and 55.6% are afraid of catching COVID-19 when they provide care to a COVID-19 patient. However, 71.6% perceived that standard precautions can protect them against COVID-19. These fears were more apparent in studies done in some other countries. A study in Henan, China, found that around 85% of the surveyed HCWs were afraid of becoming infected at work.[6] Similarly, in a study done in Turkey fear of coronavirus among intern dentists was moderate.[18]

Several studies have been conducted to assess practices among nurses and other HCWs regarding COVID-19. The present study revealed that the majority of the participants had positive practices regarding COVID-19 management. The reasons could be because of the success rate in COVID-19 prevention and control in Sri Lanka and this may be due to the acquisition of adequate knowledge and proper practices among nurses. It was stated that individuals with a high knowledge score would practice more preventive measures.[7] In addition, it is noteworthy to report that in the present study, the majority of participants (84%) reported their willingness to attend to care for COVID-19 patients. Similarly, research conducted in Saudi Arabia, Pakistan, and China found that more than 80% of participants had good practices regarding COVID-19 management.[6,19,20] However, in contrast to these findings, a study done in Ethiopia indicated that the general prevalence of good practice was only 25.9%.[21]

However, some gaps in the practice were identified among nurses in the present study. The

practices on cleaning linen and instruments were not satisfactory. Further, only 42.8% of the nurses were washing their hands frequently at their workplace. This finding does not comply with the five times of hand hygiene recommended by the WHO in their daily practice. In contrast to this finding, a study done in Uganda showed a higher percentage (76%) of HCWs comply with frequent hand washing.[22] Frequent awareness needs to be arranged for nurses to address these practice gaps through the support of the administration.

Limitations

Since this study was conducted only among nurses in three hospitals, the generalizability of these findings may be questioned. As the pandemic is evolving rapidly, the findings may have now changed too. Further, the study participants were only nurses and other HCWs were not included in the study. Thus, findings may not be generalized to all HCWs in Sri Lanka.

Conclusions

The study identified that frontline nurses in three hospitals in Sri Lanka had good knowledge, perception, and practice towards COVID-19 and its management. However, there were a few gaps in the knowledge, perception, and practice. Early attention to such gaps would enable nurses to further improve the care of COVID-19 patients while protecting nurses from getting the infection.

It is important to build the confidence of nurses regarding their practice of COVID-19. Further, more frequent workshops and lectures should be conducted to improve their knowledge, perceptions, and their confidence in practice. In addition, recorded video clips on identified aspects can be distributed among nurses to improve their knowledge and practice on COVID-19.

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Original Article

Musculoskeletal Pain and its Ergonomics risk factors among school teachers from Tamil Nadu, India: A cross-sectional study

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ABSTRACT

Introduction: Teachers are often exposed to occupational hazards like musculoskeletal pain which may force them to early retirement from their jobs, affecting their quality of life. This study aimed to estimate the prevalence of musculoskeletal pain among government school teachers and to assess its ergonomic risk factors.

Methods: A cross-sectional study was conducted among government school teachers in Kundrathur Block, Kancheepuram District, Tamil Nadu, India. The Nordic Musculoskeletal Questionnaire was used to estimate the prevalence of musculoskeletal pain. The study was conducted from June to November 2019 for 6 months. In total, 400 participants were included in the study. Descriptive statistics like frequency and percentage were used for different variables and the various risk factors as well as inferential statistics like prevalence, confidence interval, odds ratio, and chi-square test were used for finding the association between the dependent and independent variables.

Results: The prevalence of musculoskeletal pain among school teachers was 69.8%. Binary logistic regression analysis showed that the factors such as sex (adjusted odds ratio [aOR] = 2.47; 95% confidence interval [CI]: 1.47-4.15) with p-value = <0.01* and number of students in each class (aOR= 1.86; 95% CI: 1.12-3.08) with p-value = <0.01* were identified to be significant risk factors associated with musculoskeletal pain.

Conclusion: The prevalence of musculoskeletal pain among school teachers was found to be high. This clearly shows the significant burden of this occupational hazard on the teacher's community, which should be addressed to focus on its prevention.

Keywords: Ergonomic risk factors, Musculoskeletal pain, Prevalence, School teachers

Introduction

Occupational health problem is common among the working population due to ergonomics risk factors. Musculoskeletal pain is one of the most common health issues that arise in this population. According to the World Health Organization (WHO), musculoskeletal disorders are the highest contributor to the global need for rehabilitation and it is the condition that often co-exist with non-communicable diseases and mental health issues.[1] National Institute for Occupational Safety and Health (NIOSH) states that musculoskeletal disorders are soft-tissue injuries caused by sudden or sustained exposure to repetitive motion, force, vibration, and awkward positions. These disorders can affect the muscles, nerves, tendons, joints, and cartilage in your

upper and lower limbs, neck, and lower back.[2] Musculoskeletal pain causes disability by lessening the ability to do work, thereby affecting the overall quality of life. World Health Organization (WHO) and the International Labour Organization (ILO) report that the risk factors for Musculoskeletal pain are activities and environments involved with rapid or repetitive motion, forceful exertion, the concentration of excessive mechanical force, awkward or non-neutral posture, and vibrations.[3] Some working populations are experiencing more work-related musculoskeletal pain. The teaching profession stands out among them. Musculoskeletal Pain is one of the most common physical health complaints of teachers during their careers. Teachers always play an important role in the transformation of society. The teaching profession is not only limited to teaching. Teachers are doing extra activities other than the teaching and these activities normally exceed their traditional allocation. These extra activities include paper correction work, supervision duties, election duties, and conducting the school's annual program competition. These may affect their organizational aspect resulting in various health problems compromising the quality of their life. Musculoskeletal pain among teachers may force them to early retirement from their jobs. Compared to private school teachers, government school teachers face increasing occupational demands like a greater number of classes per day, excess student strength, continuous teaching with no adequate breaks in between, handling more than one subject, and lack of teaching aids. Other factors to be considered are age, gender, and duration of the teaching experience.

The teaching job forces the working individual to maintain a certain awkward or non-neutral posture for a long time. These awkward postures include writing on a blackboard with arms extended, bending or stooping, and standing for a sustained period. These may act as an influencing factor for developing musculoskeletal pain. Because of the constant pain, sick leave is increasing which impairs the curriculum and affects productivity in the teaching profession. Among school teachers, the most commonly reported sites for musculoskeletal pain were the neck, shoulder, lower back, and upper limbs.[4,5,6,7] In recent years, the research on the teaching profession is steadily increasing but most studies focus only on the prevalence of common health problems, not on their risk factors. By concentrating on this area, we can improve the personalized prevention programs for teachers. This study aims to estimate the prevalence of musculoskeletal pain and to assess the ergonomic risk factors associated with it.

Methods

This cross-sectional study was carried out among government school teachers in Kundrathur block, Kancheepuram District, Tamil Nadu, India. The study period was 6 months from June to November 2019. Based on the intense review of the literature, the prevalence of musculoskeletal pain was found to be 74.47%.[8] Taking it as prevalence, with a limit of accuracy of 5% and with a Z value of 1.96, the sample size calculated was 296. About 10% of the sample size of 30 was added to take care of any refusal to participate in the study and the total minimum sample size arrived for the study was 326. Using a multi-stage random sampling technique, Kanchipuram district was chosen for the study. Under the Kanchipuram district, Kundrathur block was selected using the lottery method. All Government schools under the Kundrathur block were enlisted and selected for the study. A list of all teachers employed by selected government schools was compiled, and only those teaching at high and higher secondary levels were included in this study. Even though the desired sample size is 326, we have recruited all 488 teachers who have met the inclusion criteria for the study. Out of 488 participants, 88 did not give informed consent due to time constrain and other concerns about the study. Hence 400 were included in the study which was more than the sample size required.

Ethical clearance was obtained from the Institutional Ethics Committee of Sri Ramachandra Medical College and Research Institute (SRIHER) [CSP-MED/19/JUN/53/63]. Permission to do the study was also obtained from the Chief Education Officer, Kancheepuram District, and Tamil Nadu for conducting Interviews in Government Schools. Participants

were government school teachers (both male and female) handling high and higher secondary level, and also including music, art, and physical teachers in the age group of above 20 years and who gave informed consent. Primary and middle school teachers were excluded from the study due to the lack of permission from the concerned authority. The pilot study was conducted among School teachers using the validated Instrument before the actual study to know the difficulty of participants in understanding the terms and time required to fill out each questionnaire. Pre-testing of the questionnaire was done to obtain information on socio-demographic details and teaching-related characteristics. Government high school, Mathur, Sriperumbudur Block (outside the study area) was chosen and participants who gave informed consent were included in the pilot testing. A total of 25 participants were studied. The data from the pilot study was not included in the final analysis of the results. Based on the pre-testing, there was no need to make changes to the final format of the questionnaire.

Before data collection, the headmasters of the selected school were contacted by phone about the visit and briefed about the importance and usefulness of the study. On the day of data collection, each teacher was contacted in person and a written consent form was given. After informing the details of the study, the teachers were requested to sign the consent form, only if they were willing voluntarily to participate in the study. A standardized Nordic Questionnaire is a self-administered tool, created by Kourinka et al for screening musculoskeletal pain in an ergonomic context.[9] The Nordic Musculoskeletal Questionnaire consists of a human body diagram showing nine anatomical areas (neck, shoulders, elbows, wrist/hands, upper back, lower back, hips, knees, and ankles). All the subjects were asked to answer yes or no if they had problems such as pain, discomfort, ache, or numbness in the specified areas mentioned in the diagram in the last 12 months and 7 days and whether it affected their normal activity. This questionnaire is proven to be a valid and reliable screening tool for assessing musculoskeletal symptoms for various working groups including teachers. Permission for using the study tool was duly obtained.

Data compilation and analysis were done using the Statistical Package for Social Sciences (SPSS) version 21 software. Descriptive statistics were calculated for background variables and the various risk factors. Prevalence and 95% confidence intervals were calculated. The odds ratio was calculated to find the association. The chi-square test was done for the test of statistical significance.

Results

A total number of 400 teachers from high and higher secondary schools in the Kundrathur block participated in this cross-sectional study. Out of 400 school teachers, the mean age of the teachers was 45.7 years (SD ± 7.5 years). The minimum age of teachers was 24 years and the maximum age was 58 years. The majority 184(46%) of the teachers belong to the age group of 41 to 50 years. The percentage of male teachers was 85(21.3%) and females were 315(79.7%).

Among the study participants, 11(2.8%) teachers were currently smoking and the number of teachers consuming alcohol was 19(4.8%). Most of the teachers, 297(74.2%) chose the private mode of transport followed by the public mode of transport which was 103(25.8%). The mean duration of traveling was 40.35 minutes (SD ± 31.84 minutes) and most of them 228(57%) travelled less than 30 minutes to reach the school. Out of 400 teachers, 200(50%) travel less than 10 kilometers (km) to reach the school, 137(34.2%) travel 11 to 20 km, 36(9%) travel 20 to 30km, and 27(6.8%) travel more than 30km to reach the school. The majority 162(40.5%) of teachers had 10 to 19 years of teaching experience with an overall mean of 17.88 years (SD ± 8.08 years). The majority of them, 266(66.5%) reported the average number of students per class was more than 40, and a few teachers 96(24%) are handling more than 1 subject. Most of the teachers 361(90.2%) reported 21 to 30 hours of teaching per week. Of the school teachers 204(51%) reported being involved in continuous teaching for less than 45 minutes. The Background, personal details, and teaching-related characteristics of the participants are given in (Table 1).

Table 1: Background characteristics, personal details and teaching related characteristics of the participants (n = 400)

Characteristics	n (%)
Age in years	
21-30	18(4.5%)
31-40	86(21.5%)
41-50	184(46%)
51-60	112(28%)
Sex	
Male	85(21.25%)
Female	315(78.75%)
Current smoker	
Yes	11(2.8%)
No	389(97.2%)
Alcohol consumption	
Yes	19(4.8%)
No	381(95.2%)
Duration of travel	
≤30 min	228(57.0%)
31 – 59 min	62(15.5%)
60 – 89 min	68(17.0%)
≥90 min	42(10.5%)
Mode of transport	
Public transport	103(25.8%)
Private transport	297(74.2%)
Distance	
≤10 km	200(50.0%)
11 – 20 km	137(34.2%)
21 – 30 km	36(9.0%)
>30 km	27(6.8%)
Teaching experience(years)	
1-9 years	66(16.5%)
10 – 19 years	162(40.5%)
20 – 29 years	129(32.2%)
≥30 years	43(10.8%)
Average students per class	
≤40 students	134(33.5%)
>40 students	266(66.5%)
No. of subjects teaching	
1 subject	304(76.0%)
>1 subject	96(24.0%)
Hours of teaching per week	
≤20 hours	36(9.0%)
21-30 hours	361(90.2%)
>30 hours	3(0.8%)
Hours of continuous teaching	
≤45min	204(51.0%)
More than 45min	196(49.0%)

The overall prevalence of musculoskeletal pain was found to be 69.8% with a 95% confidence interval from 64.9% to 74.2%. The prevalence of musculoskeletal pain was greater in females (84.2%) than compared in males (15.8%) and this difference was statistically significant (p-value<0.01*). The prevalence of musculoskeletal pain was greater among teachers between 41 to 50 years of age (45.9%) when compared to other age groups and the difference in prevalence is insignificant with p-value = 0.85. (Table 2).

Out of 400 participants, the prevalence of musculoskeletal pain in any part of the body was 279(69.8%), 267(66.8%), and 266(66.5%) for the last 12 months, 7 days, and 12 months of work-limiting pain respectively. The most affected part of the body was the neck, with 102(25.5%) having pain for the last 12 months and 91(22.8%) having pain for the last 7 days. Next to the neck, the most affected part was the hips/thigh where 97(24.3%) had 12 months of pain, and 87(21.8%) had 7 days of pain. The other most affected parts for the last 12 months were the knee 93(23.3%), shoulder 71(17.8%), ankle/feet 56(14%), and wrist/hands 44(11%). The least affected part in the last 12 months was the lower back 39(9.8%), elbows 24(6%), and the upper back 19(4.8%). (Table 3)

Table 2: Prevalence of Musculoskeletal pain as per sex and age group (n = 279)

Prevalence of Musculoskeletal pain based on age and sex	n (%)	95% CI	p-value
Sex			
Male	44(15.8%)	15.7-18.2	**<0.01***
Female	235(84.2%)	69.4-92.4	
Age group			
21 – 30 years	11(3.9%)	1.6 – 6.2	0.85
31 – 40 years	60(21.5%)	16.7 – 26.3	
41 – 50 years	128(45.9%)	40.1 – 51.7	
51 - 60 years	80(28.7%)	23.4 – 34.1	

*p value <0.05 is significant

Table 3: Prevalence of musculoskeletal pain according to Standardized Nordic Questionnaire - 12 months/ 7 days/ 12 months work limiting pain (n = 400)

Body parts	12-months prevalence n (%)	7-days prevalence n(%)	12 months of work-limiting pain n(%)
Neck	102(25.5%)	91(22.8%)	90(22.5%)
Shoulder	71(17.8%)	66(16.5%)	63(15.8%)
Elbows	24(6.0%)	19(4.8%)	19(4.8%)
Wrist/hands	44(11%)	38(9.5%)	38(9.5%)
Upper back	19(4.8%)	15(3.8%)	14(3.5%)
Lower back	39(9.8%)	32(8.0%)	32(8.0%)
Hips/thigh	97(24.3%)	87(21.8%)	90(22.5%)
Knee	93(23.3%)	83(20.8%)	83(20.8%)
Ankle/feet	56(14%)	48(12%)	51(12.8%)
Any musculoskeletal pain	279(69.8%)	267(66.8%)	266(66.5%)

Among the participants, female was found to have increased odds of developing musculoskeletal pain compared to male by 2.7 times (Odds Ratio [OR]=2.73; 95% confidence interval [CI]: 1.7-4.5) with p-value <0.05*. Those teachers who travel utilizing public transport had 1.8 times (OR=1.84; 95% CI: 1.08-3.12) with p-value <0.05* increased risk of developing musculoskeletal pain compared to those who travel using private transport. Teachers whose traveling distance of

more than 30 minutes had a high risk of developing musculoskeletal pain by 1.5 times (OR= 1.56; 95% CI: 1.02-2.42) with p-value <0.05*. Those, who had teaching hours more than 21 hours per week had 1.7 times (OR= 1.77; 95% CI: 1.14 – 2.75) with p-value <0.05* increased risk of developing musculoskeletal pain compared to those with teaching hours less than 21. Those teachers with an average number of students per class of less than 40 are at high risk of developing musculoskeletal pain by 1.8 times (OR=1.80; 95% CI: 1.16-2.78) with p-value <0.05*. Teachers, who are continuously teaching for more than 45 minutes had an increased risk of musculoskeletal pain by 1.8 times (OR= 1.80; at 95% CI: 1.16 – 2.78) with p-value<0.05*..

Table 4: Association between certain risk factors and musculoskeletal pain (n = 400)

Particulars	Musculoskeletal pain			Crude Odds ratio (95%CI)	p-value	aOR (95%CI)	p-value
	Present	Absent	Total				
Age							
>50 years	80	32	112	1.11(0.69-1.80)	0.64		
≤50 years	199	89	288	1			
Sex							
Female	235	80	315	2.73(1.66-4.49)	**<0.01***	2.47(1.47-4.15)	**<0.01***
Male	44	41	85	1			
Currently smoking							
Yes	7	4	11	0.75(0.21-2.62)	0.65		
No	272	117	389	1			
Consuming alcohol							
Yes	12	7	19	0.73(0.28-1.90)	0.52		
No	267	1142	381	1			
Mode of transport							
Public	81	22	103	1.84(1.08-3.12)	**0.02***	1.28(0.70-2.34)	0.41
Private	198	99	297	1			
Travelling time							
> 30min	129	43	172	1.56(1.02-2.42)	**0.04***	1.49(0.90-2.47)	0.12
≤30min	150	78	228	1			
Number of years of teaching							
>10years	2 18	91	309	1.18(0.71-1.94)	0.52		
≤10years	61	30	91	1			
Teaching hours per week							
>21hours	190	66	256	1.77(1.14-2.75)	**<0.01***	1.31(0.74-2.31)	0.34
≤21hours	89	55	144	1			
Number of students in each class							
≤40 students	105	29	266	1	**<0.01***	1.86(1.12-3.08)	**<0.01***
>40 students	174	92	134	1.91(1.18-3.10)			
Continuous teaching							
>45min	149	47	196	1.80(1.16-2.78)	**<0.01***	1.31(0.74-2.30)	0.34
≤45min	130	74	204	1			

^Chi-square test, #Multivariate logistic regression analysis, *p value <0.05 is significant

In the logistic regression model, the significant risk factors identified by univariate analysis such as sex, mode of transport, traveling time, teaching hours per week, the number of students in each class, and continued teaching were added as predictors. This established that sex (aOR=2.47; 95% CI: 1.47-4.15) with p-value = <0.01* and number of students in each class (aOR=1.86; 95%CI: 1.12-3.08) with p-value = <0.01* were found to be significant risk factors associated with musculoskeletal pain. (Table 4).

Discussion

This cross-sectional study was done to find out the prevalence of musculoskeletal pain among school teachers and to find out their association with certain related risk factors. This study was carried out among high and higher secondary school teachers working in Kundrathur block of Kancheepuram district, Tamil Nadu, India. In this study, it was found that the overall prevalence of musculoskeletal pain among teachers was 69.8% (95% CI: 64.9% to 74.2 %). In a study done by Vaghela et al among Gujarat school teachers, the prevalence of musculoskeletal pain was found to be 74.47%, which was close to our study.[8] In another study done by Thaseen et al among Chennai city school teachers to determine the impact of musculoskeletal pain, the prevalence was found to be 75.1% which was also similar to our study.[10]

In this study, we found, that 69.8% of teachers had musculoskeletal pain in any part of the body for the past 12 months, 66.8% of them had pain in the last 7 days and 66.5% of teachers had work-limiting pain. Solis–Soto et al conducted a study among Bolivian school teachers, and it was found that 86% of teachers had musculoskeletal pain in some parts of the body in the last 12 months, 63% had them in the last 7 days and 15% of teachers had work limiting pain. The high prevalence of work-limiting pain among school teachers in our study was due to the difference in the educational system, health-seeking practices, and availability of sick leave.[11] The present study also showed the most affected part of the body was the neck, with 25.5% having pain in the last 12 months and 22.8% having pain in the last 7 days. The next most affected part was the hip/thigh where 24.3% of teachers had pain in the last 12 months and 21.8% had pain in the last 7 days. The study conducted by A.N. Alias among school teachers in the Terengganu region, Malaysia also reported that 22.6% of teachers had neck pain in the last 12 months and 22.2% of them had pain in the last 7 days, which was similar to our findings.[12] The prevalence of neck pain was found to be high in our study probably because most of the teachers maintained their heads in a forward bending posture for marking attendance and reading from the book and also in a backward bending posture for writing on the blackboard.

On assessing the association between musculoskeletal pain and sex, it was found females had a higher risk of developing musculoskeletal pain by 1.1 times more than male teachers and it was statistically significant (p-value <0.05). Chiu et al in their study also reported female teachers are at high risk of developing both neck pain and upper limb pain by 2.39 times and 1.89 times respectively.[13] This may be due to female teachers having less physical strength, after working hours they are eventually involved in domestic household work, increasing their susceptibility to musculoskeletal pain. On assessing the mode of transport and risk of musculoskeletal pain, teachers who were using a public mode of transport were at high risk of developing musculoskeletal pain by 1.8 times and it was statistically significant (p-value<0.05). Bogaert et al investigated the effects of various physical activities on teachers' health and the study did not show any significant association between the mode of transport and teachers' mental and physical health.[14] Teachers using public transport such as buses and trains are coming from a long distance and for a longer duration, which may prone them to adopt certain awkward postures while traveling which increases the risk for musculoskeletal pain. In our study, it was found, that teachers teaching more than 21 hours per week were at high risk of developing musculoskeletal pain by 1.7 times and it was statistically significant (p-value<0.05). Temesgan et al conducted the study among Ethiopian school teachers, and it was found teachers with teaching hours more than 30 hours per week were at high risk of developing shoulder

and neck pain by 1.57 times and the association was statistically significant.[15] Teachers with excessive teaching hours per week were exposed to cumulative effects of heavy workloads making them more prone to musculoskeletal pain. On assessing the association between musculoskeletal pain and duration of continuous teaching, it was found teachers who are being indulged in continuous teaching for more than 45 minutes were at high risk of developing musculoskeletal pain by 1.8 times and it was statistically significant (p-value<0.05). Teachers indulged in continuous teaching were involved in maintaining awkward postures like forwarding bending or backward bending and constant stretching of arms making them more prone to musculoskeletal pain. Studies shows that increased job stress also increases the odds of getting musculoskeletal pain.[16]

Our present study also showed teachers with an average class strength of fewer than 40 students were at high risk of developing musculoskeletal pain with the odds being 1.86 and which was statistically significant (p-value<0.05) which was contradicted to the study by Amit et al conducted among Philippines school teachers, which showed no significant association between musculoskeletal pain and the average number of students per class.[17] Our present study did not find any significant association between musculoskeletal pain and participant age, educational status, smoking habit, alcohol consumption, and teaching experience.

Conclusion

The present study concludes that the overall prevalence of musculoskeletal pain was high (69.8%) and the majority of them had neck pain which was followed by other body parts such as hips/thigh, knee, and shoulder pain. Demographic variables like sex and teaching-related characteristics such as hours of teaching, the average number of students per class, and continuous teaching were found to play an important role in inducing musculoskeletal pain among school teachers. This can be easily avoided by adopting proper working postures during their teaching hours.

The present study recommends that the school authorities and policymakers understand this occupational hazard faced by teachers in their working environment and also urge them to take the appropriate measures to prevent it. The teachers need to have proper health education or health promotion programs on ergonomic risk factors that they are going to encounter in day-to-day life as a part of their job and comprehensive prevention strategies for managing this hazard. Limitations of the present study are that results are based on a questionnaire, and clinical examination was not done hence there may be a chance of responder's bias in the study.

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Original Article

Prevalence of work-related musculoskeletal disorders and ergonomic risk assessment among production workers of pig slaughterhouse in the town municipality of Ang Thong, Thailand

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ABSTRACT

Introduction: Work-related musculoskeletal disorders (WMSDs) are a significant health concern among workers, especially in the meat processing industry. Their impacts have been well documented and reported on numerous occasions. The study aimed to determine the prevalence of WMSDs and the ergonomic assessment of exposure to their risk factors.

Methods: This cross-sectional study was conducted in a pig slaughterhouse in the town municipality of Ang Thong, Thailand. Data were collected from April to July 2021 from 108 participants who answered a questionnaire. The descriptive questionnaire for WMSDs was adapted from the Standardized Nordic Questionnaire in Thai and the Bureau of Occupational and Environmental Diseases, Department of Disease Control of Thailand. Ten individuals received an ergonomic assessment of their exposure to risk factors using the Rapid Entire Body Assessment (REBA) method.

Results: According to the study, 94.4% of participants working in pig slaughterhouse production reported experiencing the prevalence of WMSDs in the last seven days. Additionally, 93.5% of workers reported experiencing the prevalence of these disorders within the past 12 months. It has been observed that 29.6% of participants experience higher pain levels in their hands, while 25.9% experience it in their wrists, respectively. Based on the results of an ergonomic risk assessment using the REBA method, the half-cutting operator position presents a moderate level of risk.

Conclusion: The study revealed that most of the workers at the pig slaughterhouse had to use their hands and arms to apply repeated pressure consistently. The occurrence rates of WMSDs within the last seven days and 12 months were highest in the hands or wrists, followed by the upper arms and shoulders. Therefore, it is crucial to implement ergonomic measures to minimize the risk factors for WMSDs among production workers in pig slaughterhouses.

Keywords: Prevalence, Rapid Entire Body Assessment, Slaughterhouse, Work-related Musculoskeletal Disorders

Introduction

Work-related musculoskeletal disorders (WMSDs) are a significant health problem in many countries. Workers may be subjected to hazardous working environments and potential risks resulting in physical pain, discomfort, and restricted mobility in bones, joints, ligaments, tendons, blood vessels, or muscles.[1,2,3] The risk factors include physical and biological factors, social psychology, workers, equipment, work environment, and working conditions. The significant risk factors are usually related to increased compensation and health costs, reduced productivity, and lower quality of life for workers.[4]

In 2020, WMSDs were reported as the major cause of sickness in the USA at a prevalence rate of 31% in 0.35 million people (29.8 per 10,000 labor force). The most common parts of the body affected by injury or illness were the trunk (47.03%); back, including the spine and spinal cord (32.64%); and upper extremities (31.42%).[5] According to the Social Security Office of Thailand's 2013–2020 annual report, the prevalence of WMSDs from poor working conditions was continuously top-ranked, with a significant increase of 1,104 cases in 2020. The report also showed that the most common reasons were sprains and muscle stiffness caused by poor working posture and lifting (16.4%).[6]

The effects of WMSDs frequently reported in the meat processing industry were 64.9%, including fatigue, swelling, and pain, which impact the quality of life and ability to perform daily activities.[7] Workers in pig slaughterhouses are exposed to various risk factors that can cause WMSDs due to repetitive motions and poor posture. It has been reported that these workers commonly experience wrist or hand pain, with a prevalence of 54.8%.[8] In addition, according to a report by the New Zealand Industry Training Organization, the meat processing industry has the highest incidence of WMSDs, compared with other sectors in the country.[9] Previous studies have found that WMSDs affect the wrists, shoulders, neck, and back due to the performance of highly repetitive tasks, lifting heavy weights, and working in suboptimal positions. Health promotion to avoid risk factors can help workers prevent and control occupational diseases, reduce the rate of illness, and achieve a better quality of life. However, only a few studies have been carried out on the topic. Therefore, we aimed to investigate the prevalence of WMSDS and risk factors among production workers of pig slaughterhouses in the past seven days and the past 12 months. We also aimed to evaluate body postures using the Rapid Entire Body Assessment (REBA) method to determine the risk level of WMSDs in pig slaughterhouses.

Methods

A total of 108 production workers from a slaughterhouse in the town municipality of Ang Thong, Thailand, participated in the study. Due to the small number of participants, all were included in the study. The inclusion criteria for the sample were the ability to communicate in Thai and consent to participate in this research. All participants filled out the questionnaire to determine the prevalence of WMSDs. We collected data by distributing self-administered questionnaires and conducting face-to-face interviews with participants. And to select a purposive sample of 10 individuals working in different sections of the slaughterhouse to conduct an ergonomic assessment of their exposure to risk factors using the REBA method.

Data were collected to evaluate the prevalence of WMSDs through a three-part questionnaire of 108 participants.

i. The first part included general information, including sex, age, marital status, education, body mass index (BMI), medical history, serious accidents affecting body parts, smoking, and alcohol use;

ii. The second part included work information, including task and position, working duration (years), accidents at the workplace, and perceived health risks on the job; and

iii. The third part included a modified standard Nordic questionnaire in the Thai language to

analyze musculoskeletal symptoms.[10]

All the participants were required to fill out a self- or interviewer-administered questionnaire and a sample of 10 individuals were selected for an ergonomic assessment of their exposure to risk factors using the REBA method. Data were collected from April to July 2021. Five experts reviewed the items and tested them for content validity. The questionnaire was analyzed using the item objective congruence (IOC) index, which produced scores between 0.67 and 1.00.[11] In addition, the items were thoroughly reviewed and precisely modified based on feedback from an expert. The questionnaire was tried out on 30 workers in a slaughterhouse who were not included in the study.

The research conducted in Thailand (COA No.: 052/2021; IRB No.: P1-0190/63) was approved by the Institutional Review Board of Naresuan University on February 18, 2021. Informed consent was also obtained from all participants before starting data collection.

Data analysis was performed by using the Statistical Package for Social Sciences (SPSS) version 17.0 for Windows (SPSS Inc., Chicago, IL, USA). Descriptive statistics were applied to summarize the study variables (mean and standard deviation for continuous variables, frequency and percent for categorical variables). The prevalence of WMSDs in the past seven days and past 12 months are presented as frequency and percentage. The REBA method provides a scoring system to assess the required body postures. The method tables are then used to compile the risk factor variables, generating a score representing the risk level of WMSDs.

Results

The study showed that 58.3% of participants were male, while 41.7% were female, participants' ages ranged from 26 to 33 years (Mean = 33.25, SD = 8.48), 50% were married and 44.4% were single, 35.2% had secondary education, and 42.6% had 1-2 years of experience. Similarly, 15.7% carried out carcass cutting and trimming operations, 98.1% had no additional occupation, and 79.6% perceived health risks on the job. The health status assessment of the participants showed that 37% had a normal BMI and 37% had lower BMI values, 88.9% had no underlying diseases, 81.5% had no serious accident affecting body parts, 50.9% were nonsmokers, 49.1% did not consume alcohol, and 63% had no accidents at workplace (Table 1).

Table 1: Characteristics of the production workers of a pig slaughterhouse in the town municipality of Ang Thong, Thailand (N = 108)

Characteristics	Mean ± SD or N (%)
Sex	
Male	63 (58.3)
Female	45 (41.7)
Age (Years): Mean = 33.25, SD = 8.483, Max = 52, Min = 19	
18 - 25	26 (24.1)
26 - 33	30 (27.8)
34 - 38	25 (23.1)
≥ 39	27 (25.0)
Marital status	
Single	48 (44.4)
Married	54 (50.0)
Widowed	3 (2.8)
Divorced/Separated	3 (2.8)
Education	
Primary school	27 (25.0)
Junior high school	38 (35.2)
High school/ Vocational	30 (27.8)

Characteristics	Mean ± SD or N (%)
Diploma/High Vocational Certificate	6 (5.6)
Bachelor's degree	7 (6.4)
Additional occupation	
Yes	2 (1.9)
No	106 (98.1)
BMI (Kg/m^2): Mean = 21.20, SD = 5.50, Max = 43.1, Min = 12.9	
< 18.5	40 (37.0)
18.5 - 22.9	40 (37.0)
23.0 - 24.9	8 (7.4)
25.0 - 29.9	12 (11.2)
≥ 30	8 (7.4)
Medical history	
No underlying disease	89 (82.4)
Diabetes	1 (0.9)
Obesity	1 (0.9)
Kidney disease	1 (0.9)
Gout	1 (0.9)
Hypertension	9 (8.4)
Osteoarthritis	2 (1.9)
Other	4 (3.7)
Serious accident of body	
Yes	20 (18.5)
No	88 (81.5)
Smoking	
Never smoked	55 (50.9)
Former smoker	11 (10.2)
Current smoker	42 (38.9)
Alcohol consumes	
Never	47 (43.5)
Daily or almost daily	3 (2.8)
Quitted drinking	1 (0.9)
Less than monthly	53 (49.1)
Weekly	4 (3.7)
Perception of health risks on the job	
Yes	86 (79.6)
No	22 (20.4)
Position/Job Description	
Pig inspector	8 (7.4)
Stunning/Head cutting operator	8 (7.4)
Half cutting operator	17 (15.8)
Red pork offal portioning operator	5 (4.6)
White pork offal portioning operator	15 (13.9)
Carcass cutting/Trimming operator	17 (15.8)
Sanitary operator	4 (3.7)
Basket cleaning operator	4 (3.7)
Warehouse operator	10 (9.3)
Engineering/Maintenance	3 (2.8)
Safety officer	1 (0.9)
Office operator	7 (6.4)
Weighing/Quick chill operator	8 (7.4)
Manager	1 (0.9)
Working duration (Years): Mean = 2.58, SD = 1.54, Max = 8.0, Min = 0.1	
< 1	9 (8.4)

Characteristics	Mean ± SD or N (%)
1 - 2	46 (42.6)
3 - 4	40 (37.0)
≥ 5	13 (12.0)
Accidents at workplace	
Yes	40 (37.0)
No	68 (63.0)

Note. BMI: Body Mass Index

The prevalence rates of WMSDs in the past seven days and past 12 months were 94.4% and 93.5%, respectively. One person in the past 12 months had no pain or discomfort in any parts of the body. Pain or discomfort occurred mostly in the hand or wrist (29.6%), upper arm (23.1%), and shoulder (18.5%) in the past seven days. The most affected regions in the past 12 months were the hand or wrist, upper arm, and shoulder, with annual prevalence rates of 25.9%, 23.1%, and 22.2%, respectively. Within the past seven days and past 12 months, the most common symptom experienced was sprain at 64.8% and 75.9%, lasting for an indefinite period at 58.3% and 68.5%, respectively (Table 2).

The risk level distribution of the most frequent body posture was determined using the REBA method. The risk assessment data showed that a moderate risk level was observed in the following tasks or positions: half-cutting operator, stunning operator, head-cutting operator, and carcass-cutting operator. Additionally, a low-risk level was observed in the following positions: pig inspector, trimming operator, weighing operator, quick chill operator, pork offal portioning operator, and basket cleaning operator (Table 3).

Table 2: The prevalence of WMSDs among the participants in the past 7 days and past 12 months
(N = 108)

Characteristics	*N* (%)	
	7 days-WMSDs	12 months-WMSDs
Pain or discomfort in parts of the body		
Yes	102 (94.4)	101 (93.5)
No	6 (5.6)	7 (6.5)
The parts of the body in pain		
Neck	2 (1.9)	2 (1.9)
Shoulder	20 (18.5)	24 (22.2)
Upper back	8 (7.4)	7 (6.4)
Lower back	11 (10.2)	17 (15.8)
Upper arm	25 (23.1)	25 (23.2)
Lower arm	3 (2.8)	1 (0.9)
Hand/ Wrist	32 (29.6)	28 (25.9)
Knee	3 (2.8)	0 (0.0)
Calf	3 (2.8)	4 (3.7)
Foot	1 (0.9)	0 (0.0)
The symptoms		
Pain	35 (32.4)	25 (23.1)
Whiplash injury	1 (0.9)	0 (0.0)
Cramp	2 (1.9)	1 (0.9)
Sprain	70 (64.8)	82 (76.0)
Duration of pain condition		
During work time	8 (7.4)	3 (2.8)
After work	36 (33.3)	30 (27.8)

Characteristics	N (%)	
	7 days-WMSDs	12 months-WMSDs
All-day	1 (0.9)	1 (0.9)
Indefinite period	63 (58.3)	74 (68.5)

Note. WMSDs: Work-related Musculoskeletal Disorders

Table 3: The results of an ergonomic risk assessment using the REBA method (n =10)

Task/Job	REBA score			Risk level
	Group A	Group B	Result	
Pig inspector	3	1	3	Low
Stunning	4	2	5	Moderate
Head cutting operator	3	5	5	Moderate
Trimming operator	3	1	3	Low
Carcass cutting operator	2	4	4	Moderate
Half cutting operator	5	5	7	Moderate
Weighing operator	2	1	2	Low
Quick chill operator	2	1	2	Low
Pork offal portioning operator	2	1	2	Low
Basket cleaning operator	2	1	2	Low

Note. REBA: Rapid Entire Body Assessment

Discussion

The study showed that most of the workers in the pig slaughterhouse had to work with their hands or arms to exert repetitive force all the time, such as holding knives for carcass cutting and trimming, holding carcass splitting saws, and cleaning baskets. The prevalence rates of WMSDs in the past seven days and the past 12 months were higher in the hands or wrists, followed by the upper arms and shoulders, because workers hold tools throughout the workday. This is consistent with research carried out in New Zealand, which reported a prevalence of 64.9% among meat processing workers, and most of the symptoms were observed in the hands or wrists (54.8%).[8] Most of them had sprains and an unstable period of pain, and they experienced the symptoms after work each day. Pain relief can be obtained by using medications and applying a massage or compress. In Brazil, most of the symptoms occurred in the feet (68.8%) and hands (28.1%), with most workers feeling discomfort in at least one part of their body (83.3%). Their symptoms were pain (56.7%) and fatigue (45.0%), and 50% were treated with medications.[12] In Venezuela, the report showed that the prevalence of musculoskeletal discomfort was 77%, and most of the symptoms occurred in the shoulders (49.4%), back (47.1%), and hands or wrists (31.6%). The sample consisted of 174 workers in the processing and production of meat products.[13]

The REBA method showed that the highest risk score was 7 (moderate risk level), and it was observed in the half-cutting operator position. The moderate risk scores were due to the awkward postures adopted by the entire body when performing tasks such as stunning, head cutting, carcass cutting, and half cutting. With this risk score, it is recommended to develop a new standing tool design to reduce worker discomfort. Appropriate working postures

should be applied for positions with low-risk scores, such as pig inspector, trimming operator, weighing and quick chill operator, pork offal portioning operator, and basket cleaning operator. The report in Brazil also showed that physical activities mostly caused discomfort in worker body parts.[14] A Columbian study reported that the exposure level to risk factors for WMSDs among meat processing workers decreased from very high (risk score = 38) to medium (risk score = 24). The evaluation was conducted using the individual risk assessment (ERIN) method. These studies will reference how ergonomic interventions can be carried out in the meat processing industry.[15] Similarly, it is important that animal slaughterhouse workers have good level of knowledge, positive attitudes, and practices toward the safe handling of meat, and compliance with the local legislations, and it can be improved through workshops and training.[16]

Recommendations

Several limitations should be considered when applying the results of the present study. Firstly, the study's cross-sectional design makes it difficult to establish causation. Secondly, the study was conducted in a small population, meaning that the findings may not be generalizable to larger groups. Therefore, it is recommended that the researcher expand their study to different areas to gain a more comprehensive understanding of the factors involved. Additional qualitative studies should also be conducted, with a focus on factors such as psychological stress, inappropriate temperature, ergonomic parameters, and study area expansion.

This study highlights the need for preventive actions against the chronic symptoms of WMSDs among workers in pig slaughterhouses. Therefore, ergonomic strategies should be implemented to decrease the risk factors associated with these disorders. Future studies should examine all groups of workers in pig slaughterhouses in different regions and explore the relationship between WMSDs and factors such as social psychology, stress, physical activity, and task rotation. Additionally, programs aimed at preventing WMSDs should be considered.

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Original Article

Resumption of dental practice after COVID-19 lockdown: perspectives of dental professionals in Karachi, Pakistan

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ABSTRACT

Introduction: In the COVID-19 pandemic, the implementation of the lockdown led to the closure of dental practices. Restricting treatment to emergency patients, having to use Personal Protective Equipment and the fear of contracting the virus led to modifications in the techniques and methods used to provide efficient dental care to the patients. However, it caused a significant psychological and financial impact on the dental community. The purpose of this research was to evaluate dentists' perceptions regarding the psychological, financial, and general impact of the COVID-19 pandemic on the reopening of their dental practices.

Methods: This cross-sectional analytical study was conducted using a validated questionnaire, which was distributed among 257 dental practitioners working in Karachi through the social media app (WhatsApp®) from May 2021 to May 2022. The questionnaire included four sections and 26 items, recording data for demographics, psychological effects on resumption of dental practices, workplace disinfection, and precautionary measures along financial impacts. Data were analyzed using SPSS, version 21.0. p-value ≤ 0.05 was taken as statistically significant.

Results: A total of 200 filled questionnaires were received, making the response rate 77%. The majority of respondents were females (67%). More than half of the respondents (55.5%) were working in dental OPDs. Most participants affirmed that they did not have a COVID-19 screening area nor patient triage was being done in dental OPDs. Closure of dental practices caused financial problems for all dental practitioners, more specifically for those that were associated with both public and private types of practices (84.9%). The majority of the dentists in private practice (94.4%) declared that their workplaces were being disinfected, while 47.7% of dental practitioners working in the dental OPD affirmed that they had enough financial stability to keep using Personal Protective Equipment. Approximately 64.9% of professionals practicing in dental OPDs and 33.3% in private practice believed that the reopening of dental practices was responsible for the re-spread of the coronavirus

Conclusion: Significant anxiety and stress related to COVID-19 were seen among dental practitioners. Some CDC-recommended guidelines such as the use of Personal Protective Equipment were being implemented whereas COVID-19 screening and patient triage were found deficient.

Keywords: COVID-19, Dental Practitioners, Impact, Psychological Stress

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Introduction

In 2019, the world was hit by a fatal pandemic known as COVID-19 caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-Cov-2). The first case originated in Wuhan province of China on December 31st 2019,[1] but soon took over the world and was announced as

a global health issue on 31st January 2021.[2] According to WHO consensus globally, as of 12th May 2022, there had been 516,922,683 confirmed cases of COVID-19 including 6,259,945 deaths, whereas in Pakistan alone there had been 1,528,833 confirmed cases with 30,375 deaths.[3] To control the spread of the virus and protect individuals, a worldwide lockdown was imposed, which was enforced in Pakistan on 23rd March 2020. The lockdown affected all aspects of life, and dentistry was no exception.

One of the most important considerations in dentistry is the prevention of infection by controlling cross-contamination. According to several reports, Coronavirus spreads through respiratory droplets e.g. during sneezing, while talking or even coughing, having physical contact with the person affected by a coronavirus, or by touching a contaminated surface. It stays on inanimate surfaces like metal, glass, or plastic for approximately 9 days if the surface is not disinfected.[4, 5] Dentists work close to patients and are therefore exposed to aerosols and droplets.[6] In April 2020, the American Dental Association (ADA) and the Center for Disease Control and Prevention (CDC) advocated dentists limit dental procedures to emergency and urgent care only.[7] As a result, numerous public and private dental practices had to be closed down since they became financially unviable. However, with the gradual decrease in cases, it was decided to ease the lockdown restrictions, and finally, the government terminated the lockdown in September 2020.

On 24th November 2021, a new variant of COVID-19, B.1.1.529 was reported to the World Health Organization (WHO) which was named Omicron on 26th November 2021 and classified as a Variant of Concern (VOC).[8] On 9th May 2022, the National Institute of Health (NIH) in Pakistan reported its first case of Omicron subvariant BA.2.12.1. Omicron is much more contagious and spreads faster than any other variant and according to the Center for Disease Control and Prevention (CDC), anyone infected with this variant can spread the virus to another regardless of the vaccination status.[9]American Dental Association (ADA) put forth specific measures to limit the spread of COVID-19. These included inquiring about patients' recent travel history; identifying symptoms of respiratory tract infection (RTI), recording patients' body temperature, and regularly decontaminating and disinfecting contact surfaces such as door handles, furniture and washrooms. In addition, rinsing patients' oral cavities with 1% hydrogen peroxide before proceeding with dental treatment, usage of a rubber dam and high-volume suction in procedures were also the recommended course of action.[10] Unfortunately, many dental practitioners in Pakistan were not aware of such guidelines to prevent cross-infection and hence were insecure and hesitant while treating their patients in the prevailing circumstances with the fear of getting infected themselves.[11] In addition, since the outbreak of this pandemic, an increase in demand for protective measures by dental healthcare workers was noticed but due to the lack of availability of appropriate Personal Protective Equipment (PPE), there was a rapid increase in their anxiety level. The fear of getting infected by this particular virus and its further transmission to loved ones and the community had spread panic among all healthcare providers, including dentists. Because of the disruption in the provision of routine dental procedures due to the lockdown, a devastating impact on the dental industry was observed, and due to the uncertainty of the emergence of new variants, it was hard to estimate the degree and longevity of this disruption. This has also translated to economic and social struggles for the global dental community.

This study aimed to evaluate the dentists' perceptions regarding the psychological, financial and general impact of the COVID-19 pandemic on the reopening of their dental practices. Based on the results of this study, recommendations can be made towards safer practices and coping mechanisms so dentists can continue their professional commitments and clinical procedures and develop a working environment that will not put a burden on the

practitioner's psychological and financial well-being while prioritizing patient care.

Methods

This cross-sectional analytical study was conducted at Sindh Institute of Oral Health Sciences, Jinnah Sindh Medical University, Karachi from May 2021 to May 2022. Data was collected using a questionnaire with items assessing the issues faced by dentists on reopening or resumption of their clinical practices after the cessation of pandemic-related lockdown in the city of Karachi, Pakistan. All practicing dentists working in either the public or private sector who consented to be a part of this study were included. The total population of dental practitioners in Karachi is estimated to be 5000. As there was no specific outcome target, the sample size was calculated based on the assumption that the expected maximum frequency of the outcome factor is 50%. Using version 3.01 of Open Epi software for epidemiologic statistics, the required sample size for a 90% confidence level was 257 dental practitioners.

The fundamental draft of the questionnaire was formulated for the present study based on feedback from three dental specialists regarding the issues they were facing in the reopening of their dental practices. In addition, a pertinent literature search was made to identify items that could be modified and used in the local context. This process ensured that relevant items were developed for the questionnaire. The initial draft was piloted on eight dental health care providers, to determine the ease of understanding the questionnaire items, and any ambiguity in this regard was addressed, to finalize the survey form.

The final questionnaire included four sections and 26 items. The first section recorded the primary demographic data of the participants. The second section consisted of items inquiring about the psychological effects faced by dental practitioners on reopening or resumption, workplace disinfection, precautionary measures along financial impacts.

After approval was obtained from the Institute's Ethical Review Board (Ref. No: JSMU/IRB/2021/423), the data was collected electronically by distributing the questionnaire via WhatsApp®. The link to the questionnaire along with the consent form was distributed among dental specialists through the social media platform (WhatsApp®) for the sake of convenience and to ensure that physical contact with the study participants was minimized. The instructions to fill out the form were mentioned along with the link. The potential respondents were reminded at one week's intervals to submit the form to maximize the number of responses collected. Confidentiality of the data was ensured and only the primary investigators had access to any identifiers.

Statistical Package for Social Sciences (SPSS) (SPSS Inc., Chicago, IL, USA) version 21.0 was used to analyze data. Mean and standard deviations of continuous variables were recorded. For categorical variables, frequencies and percentages were calculated. Stratification of data was done based on gender and practice. The chi-square test was used to assess the differences between the types of practices concerning the impact of reopening dental practices and a p-value ≤ 0.05 was taken as a statistically significant.

Results

A total of 200 dentists out of 257 participated in the study, making the response rate 77%. The demographic details of the study participants are given in Table 1. Table 2 compares the responses of dentists working in different setups (public vs private) to the questions related to the modification of their practices.

Table 3 shows the responses of the participants on a 3-point Likert scale, related to various aspects of their clinical practices after re-opening. Data was summarized in mean and standard deviation.

Table 1: Demographic details of the study participants.

Variable		n (%)
Gender	Male	66 (33%)
	Female	134 (67%)
Type of Practice	Dental OPD	111(55.5%)
	Private setup	36(18%)
	Both Practices	53 (26.5%)

Table 2: Comparison of responses based on type of practice of study participants

1) Dental practice has a COVID-19 screening area for patients				
	Both Practices	Dental OPD	Private Practice	**p-value**
Yes	21(10.5%)	34(17%)	24(12%)	0.001
No	32(16%)	77(38.5%)	12(6%)	
2) Patient triage being done indental practice currently				
	Both Practices	Dental OPD	Private Practice	**p-value**
Yes	28(14%)	46(23%)	23(11.5%)	0.049
No	25(12.5%)	65(32.5%)	13(6.5%)	
3) Performing elective dental procedures				
	Both Practices	Dental OPD	Private Practice	**p-value**
Yes	40(20%)	81(40.5%)	23(11.5%)	0.462
No	13(6.5%)	30(15%)	13(6.5%)	
4) Aware of the CDC guidelines recommended to prevent the spread of corona virus				
	Both practices	Dental OPD	Private Practice	**p-value**
Yes	45(22.5%)	90(45%)	21(10.5%)	0.714
No	8(4%)	31(15.5%)	5(2.5%)	
5) Undertaken any training for the proper precautionary measures to prevent the spread of corona virus				
	Both practices	Dental ODP	Private Practice	**p-value**
Yes	22(11%)	39(19.55)	20(10%)	0.094
No	31(15.5%)	72(36%)	16(8%)	
6) Closing of dental practices during lockdown caused any financial problems				
	Both practices	Dental OPD	Private practice	**p-value**
Yes	45(22.5%)	71(35.5%)	30(15%)	0.006
No	8(4%)	40(20%)	6(3%)	

Table 3: Comparison of responses on 3-point Likert scale based on type of dental practice

1) Feel anxious about contracting COVID-19 from practice				
	Both practices	Dental OPD	Private practice	**p-value**
Yes	41(20.5%)	101(50.5%)	31(15.5%)	0.158
Unsure	3(1.5%)	1(0.5%)	1(0.5%)	
No	9(4.5%)	9(4.5%)	4(2%)	
2) Feel anxious that you might transmit COVID19 to your family members because of practice				
	Both practices	Dental OPD	Private practice	**p-value**
Yes	49(24.5%)	103(51.5%)	35(17.5%)	0.468
Unsure	0(0%)	3(1.5%)	0(0%)	
No	4(2%)	5(2.5%)	1(0.5%)	
3) Comfortable with the use of tele dentistry for dealing with patients				
	Both practices	Dental OPD	Private practice	**p-value**
Yes	30(15%)	62(31%)	22(11%)	0.635
Unsure	10(5%)	30(15%)	7(3.5%)	
No	14(7%)	20(10%)	5(2.5%)	
4) Arranging the seats in waiting area 6 feet apart will help prevent the spread of virus				
	Both practices	Dental OPD	Private practice	**p-value**
Yes	38(19%)	87(43.5%)	29(14.5%)	0.074
Unsure	8(4%)	5(2.5%)	5(2.5%)	
No	7(3.5%)	19(9.5%)	2(1%)	
5) Work place being disinfected				
	Both practices	Dental OPD	Private practice	**p-value**
Yes	37(18.5%)	7 (37.5%)	34(17%)	0.016
Unsure	4(2%)	14(7%)	2(1%)	
No	12(6%)	22(11%)	0(0%)	
6) Dental practice been affected by the current pandemic				
	Both practices	Dental OPD	Private practice	**p-value**
Yes	4 (20.5%)	93(46.5%)	33 (16.5%)	0.260
Unsure	2(1%)	7(3.5%)	1(0.5%)	
No	10(5%)	11(5.5%)	2(1%)	

When asked about the presence of the COVID-19 screening area, the majority of the practitioners (69.4%) working in the dental OPD affirmed that they did not have any such provision. Similarly, more than half of respondents (58.6%) practicing in the dental OPD and 47.2% of the respondents working in both OPDs and private practices declared that patient triage was not being done in their dental practices. In contrast, about two-thirds of respondents (63.9%) indicated that triage of the patients was being conducted. Closure of dental practices had caused financial problems for all dental practitioners, particularly for those who were associated with both types of practices (84.9%). The majority of the dentists (94.4%) in private practice declared that their workplaces were being disinfected, while 47.7% of dental practitioners working in the dental OPD affirmed that they had enough financial stability to keep using PPE. Approximately 64.9% of dental professionals practicing in dental OPD and 33.3% in private practice believed that the reopening of dental practices was responsible for the spread of the coronavirus.

The majority of the participants, irrespective of the type of their practice, felt that the fear of contracting the virus from patients followed by a lower number of patients visiting their dental setups were the main factors affecting their practices (Figure 1).

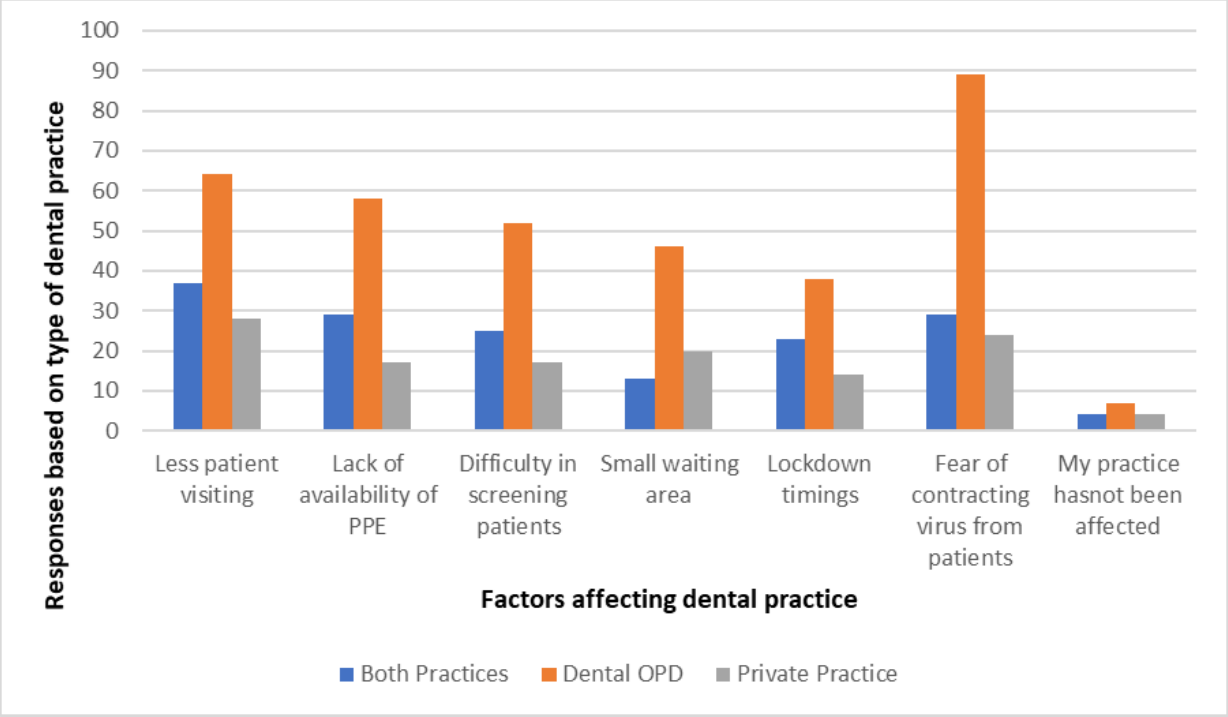

Figure 1: Factors perceived as affecting the practice of respondents due to the pandemic

Figure 2, shows the responses related to precautionary measures being taken by the respondents. The majority of the participants working in all setups reported utilizing disposable surgical facemasks and face shields the most as a precautionary measure against COVID-19 infection.

In Figure 3, the type of precautionary measures respondents were asking patients to take are shown. Participants in all types of practices reported asking patients to wear a facemask in the waiting areas and to sanitize their hands as the most significant precautionary measure.

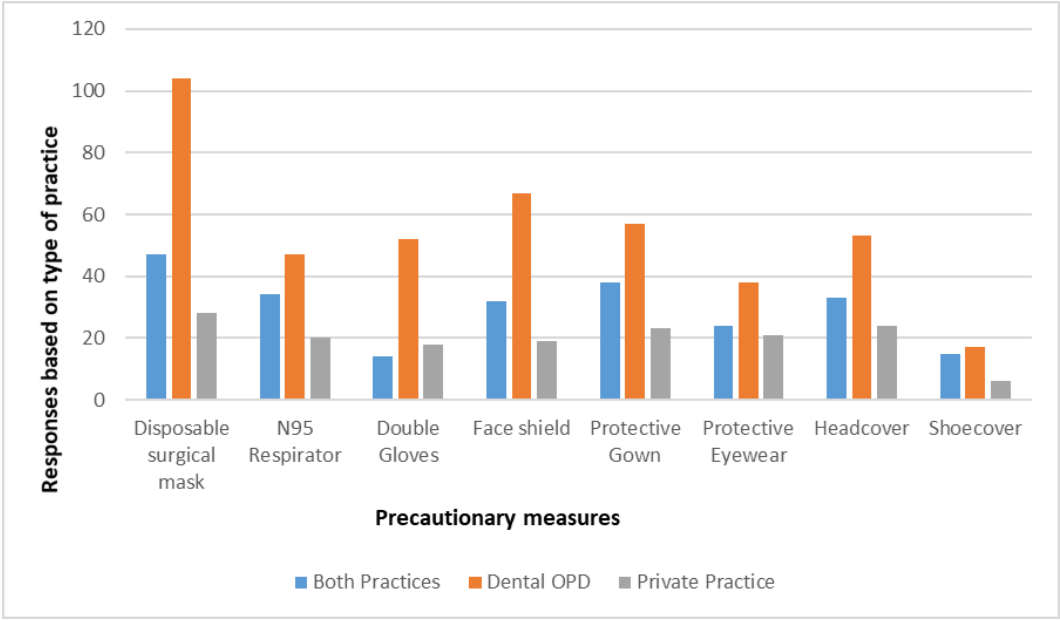

Figure 2: Responses related to precautionary measures being taken in different types of dental practices by respondents

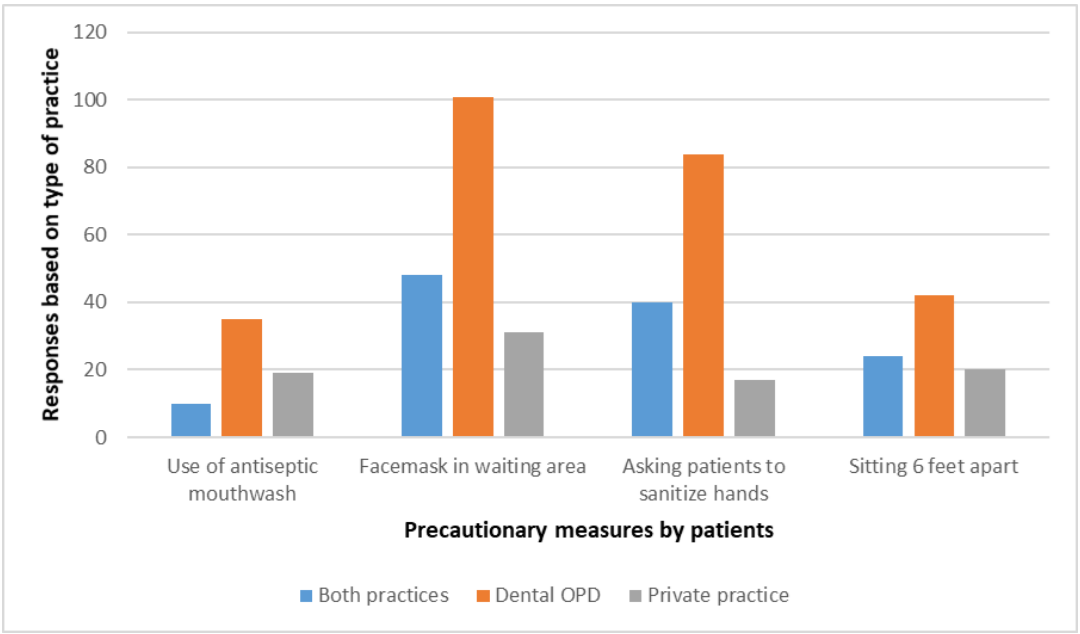

Figure 3: Responses related to the type of precautionary measures respondents were asking patients to take

Discussion

This study was conducted to determine the psychological and financial apprehensions that dental healthcare workers faced when clinical practices had to be shut down in the face of COVID-19-related lockdown and the modifications they had to make to resume their dental practices once lockdown restrictions were eased. The results of this study add to the evidence that the daily increase in the cases of COVID-19 has significantly impacted the working practices of the dental community.

The majority of the participants of this study were female, and the reason for this could be the increasing global trend of females opting for professional careers, including dental surgery, compared to males[12], as well as the greater number of registered dentists in Pakistan being females.[13] Irrespective of whether their dental practice involved the public or private sector, most of the participants felt anxious about the

possibility of contracting the virus from their practices and transmitting it to their families. This was similar to a study conducted by Kamran et al. who concluded that the majority of dentists (75%) were afraid of getting infected in the workplace and even a greater number (92%) were afraid they might transmit the infection to their families and acquaintances.[14] Most participants advocated that they will be more comfortable using other means such as teledentistry to deal with patients not in need of emergency services thus avoiding unnecessary in-person visits. Another research by Mahendran et al. about the psychological impacts of COVID-19 on staff in a dental teaching hospital showed that about 16.7% of participants had severe generalized anxiety while 53.3% had some anxiety symptoms about the COVID-19 pandemic. The majority of the participants in that study were concerned with the impact of COVID-19 on their loved ones, their health as well and the inherently infective nature of the disease. About 33% of participants did not have access to appropriate Personal protective equipment (PPE).[15] In addition to the fear of illness, a lesser number of patients visiting dental facilities during the lockdown also severely affected the practice of dental health professionals financially. Since dental treatment in developing countries is already considered non-essential, in the wake of the pandemic and lockdown where the government instructed restricted and 'only-essential' movement of the population, dental treatment has taken a further hit. Those patients who would otherwise consider visiting dental practices for their treatment needs showed further reluctance. A study conducted in Poland found that about 71.2% of the participating dentists entirely suspended their dental practice. The main reasons for this were the lack of adequate training of dental practitioners to implement the pandemic protocols, the availability of personal protective equipment, subjective perception of the risk of COVID-19 infection, and generalized anxiety about the ongoing pandemic.[16] However participants in the current study were aware of the CDC guidelines to prevent the spread of the virus but had not received any training for implementation of the precautionary measures.

The participants reported not having access to appropriate and sufficient PPE as a protective measure against possible infection, making them hesitant to provide dental treatment to patients whose exact status of disease would be unknown and despite this, they were still performing elective dental procedures. Since the additional use of specific PPE equipment like gowns, N95 masks and face shields which were not previously used in every patient is now considered essential, the added cost incurred resulted in a financial burden for the dental health professionals participating in the study making it difficult for them to sustain their practices. The lockdown and cessation of dental practices have affected the dental practices of most of the respondents of our study, causing financial problems for them irrespective of the sector in which they practice. However, the majority of dental health professionals affirmed that they would continue their dental practices despite the additional costs involved. This shows a commitment by the participants to take the necessary precautionary measures to decrease the spread of infection through their practices. The initial closure of routine dental care in the UK resulted in profound stress and anxiety about financial stability among dentists. The cost of personal protective equipment as well as fewer patients visiting the clinics were quite concerning. The British Dental Association surveyed its members and found that only 8% of practices were confident in maintaining their financial sustainability.[17]

Most of the participants reported neither having a COVID-19 screening area nor patient triage being followed in their practices. This was particularly seen with dental health care professionals working in private setups. In the face of the pandemic, the provision of a dedicated area in clinical practices where incoming patients can be screened for possible symptoms of COVID-19 is recommended to

curtail the spread of infection. This may present difficulty in dental setups that are already operating in limited spaces but may be easier to apply in dental OPDs. However, all participants reported that their workplaces were being disinfected. In addition, the most frequent measure dentists were instructing their patients to undertake was to don facemasks in the waiting area. This is an effective step in reducing cross-infection in a closed area where multiple individuals may be seated. Moreover, the frequent use of hand sanitizer was also recommended by dental practitioners in all clinical setups. Only a few practitioners asked patients to use antiseptic mouthwash before the dental procedure, even though this has been shown to reduce cross-contamination.[11] Social distancing has been recommended as a necessary measure in the prevention of COVID-19 infection. The majority of the practitioners, particularly those working in Dental OPDs, suggested that arranging seats in the waiting area six feet apart could help prevent the spread of the virus.

Most participants also felt reopening dental practices could result in the rapid spread of the coronavirus, even though continued closure would result in significant financial problems for dental professionals. Therefore, constant monitoring needs to be ensured so that even with the gradual reopening of dental practices, the spread of infection is curtailed by continuously following the recommended protocols issued by regulatory authorities.

Even though the lockdown caused significant difficulty for the dental community, it was undeniably an important measure to prevent the ongoing rise in coronavirus cases. Study author Bhatt, from the faculty of medicine at Imperial College London, said, "Lockdown has had a really dramatic effect on reducing the rate of transmission, and without it, there would have been many more deaths from COVID-19".[18]

Although people have adapted to the new normal, with the occurrence of new variants, cases continue to rise at an alarming rate. Therefore, following the COVID-19 Ordinance, all dental practices and facilities should have a protection concept that is appropriate to the situation and operation.[19] It is imperative to come up with strategies that would not only help contain the virus but also decrease the psychological burden on dental practitioners. Development and adherence to the set of guidelines and protocols proposed by national and international health organizations comprise mandatory vaccinations,[20,21] carrying out dental procedures in an airborne infection isolation room, high level of infection control measures such as transmission-based precautions as well as the implementation of teledentistry to minimize the direct contact with patients.[22-26] Adherence to a work plan for proper channeling of patients, easy access to specialized services dealing with handling psychological stress and ensuring mental wellness, monetary support, beneficial funds, child care and housing support are a few of the measures that can help ease the financial and psychological burden of health care workers including dental practitioners.[27]

It is recommended that at an individual level, maintaining a healthy lifestyle, meditation, listening to podcasts, reading books, keeping a journal, physical exercise, staying connected to friends and family, getting adequate sleep, a healthy diet, staying hydrated and seeking help when needed can be beneficial.[28, 29]

One of the limitations of this research is that only dental professionals practicing in Karachi were included in this study, therefore the results of the study cannot be generalized to the dental practitioners of the rest of the country. Also, the data collected was based on quantitative responses, and possible reasons behind the responses of the participants were not sought. Therefore, further research probing the influencing factors through qualitative study designs could be planned.

Conclusions

This study shows that the COVID-19 pandemic and the ensuing lockdown resulted in significant anxiety and stress among dental health professionals, both because of the fear of

contracting COVID-19 as well the financial implications arising from the closure and limited patients in their practices. Even though the majority of the dentists reported using the appropriate PPE including gloves, masks and additionally coveralls and face shields in clinical practice following COVID-19, some recommended measures including the provision of triage and pre-treatment screening were not being practiced. COVID-19 is a reality with which dental health practitioners need to co-exist and realize the financial cost caused by the decrease in the number of patients requiring only essential treatment as well as the added cost of supplemental PPE. However, they seem determined to take all essential measures to continue to provide dental health services to their patients and their community even in the face of the pandemic.

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Original Article

Statistical Data Analysis in Emergency Management Elements of Indian State of Tamil Nadu Manufacturing Industries Utilizing LPG

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ABSTRACT

Introduction: Process safety is becoming more difficult as requirements increase. When balancing quality, volume, and safety on a budget, major accidents are unavoidable. The inability of organizations to absorb unwelcome and unanticipated disruptions is a major contributor to complacency and a decline in safety attitudes. The inability of industries to interpret standards impedes self-regulation.

Methods: A total of 50 emergency management element (EME) questionnaires were developed to evaluate the state of an industry. These questionnaires were categorized as first aid, personal protective equipment (PPE), communication systems used in plants, safety education and training, occupational hygiene and health, management systems on accident reporting, safety and health, analysis and investigation, and procedures and protocols. From 32 LPG industries in Tamil Nadu districts, information for all 50 questions was gathered and the statistical tool "Analysis ToolPak" in Excel 2010 was used to analyze the data.

Results: This study conducted a comprehensive statistical analysis of various aspects of industrial on-site emergency planning. The questionnaire's reliability was determined using Cronbach's alpha test. Utilizing descriptive statistics, t-tests for means, one-way ANOVA, and histograms, statistical evaluation was conducted. Encouragingly, all the results were favorable, providing compelling evidence that the LPG-utilizing industries in various regions of Tamil Nadu, India, are exceeding safety requirements.

Conclusion: In conclusion, the findings suggest that improved legal frameworks, laws, and implementation of EME in communication systems can greatly enhance the development of safety in plants, fire protection, and emergency health services. These measures can significantly reduce the occurrence of accidents and improve the response time to emergencies, ultimately saving lives and reducing property damage.

Keywords: EME, Fire Protection, Safety

Introduction

Safety is defined as the state of being free or protected from danger, accident, hazard, injury, damage, or risk.[1] It relates to the minimizing of human-hazard contact in an industrial setting and is primarily concerned with preventing physical harm to people or property. An emergency is defined as an accident or incident with the potential to cause serious damage or death. It might cause major property damage, interrupt manufacturing and factory activities, and have a harmful influence on the environment.[2-4] Major accidents with fire,[5] explosion,[6] and toxic releases

can happen in factories, and those that store and handle chemicals that pose fire, explosion, and toxic hazards above a threshold level are known as "Major Accident Hazard (MAH) Factories.[7]

The main technical and functional requirements of a new Complex Emergency Management System (known as SiGES) that was constructed in July 2003 at the Porto Marghera petrochemical complex, close to Venice, were outlined.[8] On the property, nine chemical manufacturing facilities produce a wide range of potentially dangerous substances, including ethylene, propylene, butadiene, chlorine, vinyl chloride, hydrogen cyanide, toluene di-isocyanate, hydrogen fluoride, etc. Local policies for industrial risk prevention in Italy were discussed in some detail.[9] They updated the document, and then a genuine accident happened to highlight the planning's shortcomings. As part of their report, they also mentioned that the lessons learned from this experience suggested some multi-organizational directions and methodological approaches for future studies on risk management and communication.

HSEM, a sophisticated multilayered emergency management system, was defined.[10] According to their information, the HSEM is a thorough model that considers risk assessment, disaster prevention, mitigation, and preparedness. Additionally, they stated that this model was thought to be dynamic and capable of maintaining multiple interdependencies between events, actions, actors, context, and the other elements of the process. The accident emergency management system at the chemical industrial park was analyzed.[11] It detailed the parallels between the immune system and the accident emergency management system in terms of their current environments, action objects, functions, and adjustment mechanisms. As a result, they were able to improve the accident emergency management system in chemical industrial parks and analyze how well it performed overall.

The study focused on disaster simulation and its relationship to emergency management and contemporary simulation, enhancing its assistance to first responders, the dynamic response to crisis evolution, as well as the improvement in training and management of safe routing and handling of injured people.[12] To federate multidisciplinary models for industrial plant emergency management, a new line of research into the use of interoperable simulation was created with the introduction of these components. A Petri-net based simulation approach is suggested examination of the fire emergency response preparedness, which is structured to combat one of the flames but can handle multiple fires.[13] They discovered that while the distribution strategy based on fire severity is generally preferable to the average distribution, there are some circumstances where it is more effective. Additionally, it was stated that the various backup staffing strategies had been contrasted and that the fire conditions also affected how well the backup staffing was working.

The research on how the NEMS handled problems with group decision-making during times of crisis was finished in 2016.[14] To identify elements that hinder or support collaborative sense-making, it looks at several recent crises in China. They discovered a lack of professionalization, misaligned plans with crises, a lack of accountability, and fragmented leadership. It is further stated that the newly constructed NEMS finds it challenging to develop a shared understanding of a crisis because of these crucial factors. The information in a few gathered emergency scenarios was evaluated utilizing the CA approach.[15] That was the overarching pattern they found in the scenario descriptions. Additionally, most scenarios were designed to enhance response-related capabilities. The prevention and recovery capabilities, among other crucially important needed capabilities, were disregarded.

A novel methodological approach to simulating human errors in emergencies was proposed.[16] After researching the various aspects of human behavior that can affect operator reliability. They created a brand-new model based on the combination of fuzzy cognitive mapping methods

and the Analytic Hierarchy Process (AHP), a multicriteria method for planning and deriving meaning from complex decisions. A detailed examination and evaluation of the occurrences of injuries, illnesses, and accidents at industrial sites, with a classification of the results based on the danger and salubrity of the manufacturing process.[17] They enabled users to assess the level of industrial and workplace safety continuously and impartially. They ultimately concluded that the implementation would significantly contribute to a thorough approach to the objective of raising safety levels at industrial sites.

Developed numerous strategies for utilizing big data in emergency management by merging the general design of the big data system with safety science ideas (EM).[18] Additionally, they showed that such techniques are repeatable and generalizable, allowing for the broad use of big data technology in the creation of operational applications across numerous EM industries. They stated that the safety risk monitoring and early warning system of hazardous chemicals established by the Ministry of Emergency Management, PRC further validated the viability of those technologies. A risk assessment approach for evacuating during hazardous cloud emissions was proposed.[19] They introduced the vulnerability model and accident probability to assess hazards. There was also a case study of the risk analysis of finding shelter in neighborhood residential dwellings in China.

The research on domino effects brought on by unintentional incidents, natural disasters, and intentional attacks over the previous 30 years was examined.[20] For the purpose of presenting the applicability of the current modeling methodologies and management tactics, a comparison study is done. They stated that to prevent and lessen domino effects, future studies should focus on strengthening the safety and security of chemical industrial regions and identifying key difficulties in the industry.

Following the establishment of the MEM, a bus accident in Chongqing's Wanzhou District was investigated.[21] Examining the issues that arose during the MEM's rescue procedure. To improve China's emergency management system, respond to incidents effectively, and safeguard public safety, they subsequently suggested making successful tactical improvements. In the process industry, emergency planning based on AI has been summarized.[22] They claimed that data-driven AI facilitates effective management of emergency planning. Traditional techniques were also unable to accurately extract features for emergencies.

To comprehend the variations in factors affecting health and safety that Korean workers may experience depending on their line of work, in particular to pinpoint the variations by employment type in terms of health status, the likelihood that workers will wear protective equipment, access to manuals on emotional expression, and information on risk factors affecting health and safety According to them, to improve the safety environment as primary health care providers by understanding factors related to the health and safety of part-time workers, the health and safety manager will require education and consultation, manual development, and early intervention.[23]

The threat zones have been calculated and potential scenarios of benzene dispersion from a poorly situated gas station in the city of Douala have been modeled.[24] The predicted threat zones are more dangerous for the gas station's employees, who are also significantly exposed to nearby homes and social infrastructure. If more research is done to examine the combined effects of gasoline emissions, it may be possible to determine whether the effects of benzene and other chemicals combined have cumulative or synergistic effects.

Examining the process safety management readiness system in major accident-prone factories that handle and store hazardous chemicals is the goal of this study. The creation of a questionnaire, data collecting, and statistical analysis of the LPG sectors are used to complete this study. In Excel 2019's "Analysis ToolPak," statistical techniques were employed to analyze the data. The article

identifies gaps in the current on-site emergency planning at MAH Factories that handle and store hazardous chemicals and offers suggestions for strengthening emergency management components.

Methods

The complexity of process safety is increasing as higher standards are established. The industry's incapacity to comprehend these regulations hinders self-governance. For this study, the emergency management element questionnaire was developed considering MAH factories' requirement for on-site emergency planning. The Emergency Management Elements were categorized into ten categories (Figure 1).

The approved questionnaires were classified as YES/NO/Comments, and their status was gathered from the 32 registered factories. The study examines MAH facilities in the Indian state of Tamil Nadu that handle dangerous chemicals. The data for all 50 questions were gathered from these factories through coordination and on-site visits. The collected data were analyzed using the statistical tool "Analysis TookPak" in Excel 2010. The questionnaire was evaluated statistically for descriptive statistics, t-test for means, one-way ANOVA, and histogram.

Figure 1: Emergency Management Elements

Results

The questionnaires used in this study were classified into several categories, including first aid, personal protective equipment (PPE), communication systems in industrial plants, safety education and training, occupational hygiene and health, accident reporting management systems, safety and health analysis and investigation, as well as procedures and protocols. Data for all 50 questions were collected and examined from 32 LPG industries located in the districts of Tamil Nadu.

For the data analysis, the statistical tool "Analysis ToolPak" in Excel 2010 was employed. This study conducted a comprehensive statistical analysis of various aspects of on-site emergency preparedness in industries. The reliability of the questionnaire was assessed using Cronbach's alpha test. Subsequently, descriptive statistics, t-tests for means, one-way ANOVA, and histograms were utilized to evaluate the questionnaire statistically.

The topics of Emergency Sirens and Alarms, as well as Escape Routes, exhibited a normal distribution with mean, median, and mode values converging to zero. Conversely, other topics displayed unequal means, medians, and modes, indicating skewed distributions. The topics of Fire Protection, Emergency Preparedness, On-site Emergency Plans, Assembly points, and Security yielded p-values greater than 0.05 and F<Fcrit, signifying statistical insignificance. These topics do not require improvement.

However, Fire Prevention, Emergency Health Services, and Mock drills demonstrated p-values less than 0.05 and F>Fcrit, indicating statistical significance. Thus, industries need to enhance

their performance in these areas. Furthermore, the topics of Fire Prevention, Assembly points, and Emergency Health Services exhibited relatively lower skewness and kurtosis, suggesting the need for improvement in Fire Prevention and Emergency Health Services.

SHV Energy Pvt Ltd, followed by Patwari Bakers, Hindustan Petroleum Corporation, Daewon India Autoparts Pvt Ltd, and SHV Energy Pvt Ltd Tuticorin, are required to prioritize the fulfillment of the complete set of questionnaires pertaining to Emergency Management Elements (Figure 2).

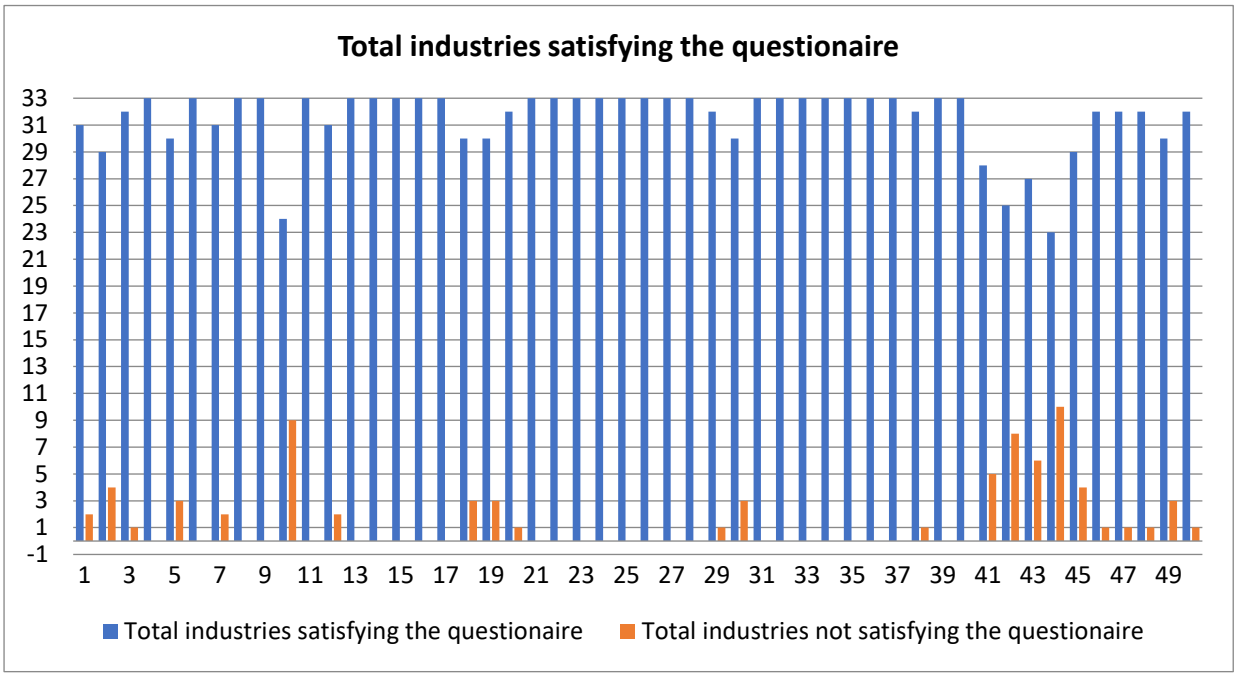

Figure 2: Total number of factories satisfying EME questionnaire

Table 1: Descriptive statistics

Parameters	Total control	Total industries satisfying the questionnaire
Mean	33	31.5
Standard Error	0	0.34
Median	33	33
Mode	33	33
Standard Deviation	0	2.43
Sample Variance	0	5.93
Kurtosis	∞	4.007
Skewness	∞	-2.063
Range	0	10
Minimum	33	23
Maximum	33	33
Sum	1650	1575
Count	50	50
Largest(1)	33	33
Smallest(1)	33	23
Confidence Level(95.0%)	0	0.69

Mean ≠ Median; SD and variance present

The data follows left skewed distribution with outliers (Kurtosis>3). This shows that all industries do not follow the same trend in the follow-up of a questionnaire. To look for the forecasted values, a confidence level with a 95% probability for the mean is calculated and reported. The data has a CI of 0.69 and hence the mean has 30.81 as the lower limit and 32.19 as the upper limit (Table 1).

In one-way ANOVA analysis, the p-value is less than 0.05 and the F value is greater than the F critic (Table 2). Hence, the null hypothesis is rejected when compared between columns and the data is statistically significant. Hence, overall data for emergency management elements need to be improved.

Table 2: One way ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	56.25	1	56.25	18.981	3.26135E-05	3.94
Within Groups	290.5	98	2.964285714			
Total	346.75	99				

Industry-wise comparison of emergency management elements

The industry-wise comparison of the different emergency management elements is given below (Table 3). The industries that satisfied all the questionnaires are as follows:

1. Control Industries
2. Covai LPG
3. Hindustan Petroleum Corporation
4. Indian Oil Corporation Ltd Sivagangai
5. Shv Energy Pvt Ltd
6. Meena LPG Industries Madukkarai
7. Shv Energy Pvt Ltd
8. Bharat Petroleum Corporation Limited
9. Meena LPG Industries
10. Patwari Bakers
11. Daewon India Autoparts Pvt Ltd
12. Dongwoo Surfacetech India Pvt Ltd
13. Hanon Automotive Systems India Pvt Ltd
14. India Yamaha Motor
15. Lotte India Corporation Limited
16. SSTP, BHEL
17. Sundaram Fastners Limited
18. Shv Energy Private Limited, Tuticorin

Table 3: Industry-wise comparison of emergency management elements

Industry Parameters	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Mean	1	0.92	0.88	0.92	0.78	0.88	0.878	0.9	0.88	0.82	0.94	0.96	0.98	0.939	0.96	0.98	0.98	0.94
Standard Error	0	0.039	0.046	0.039	0.059	0.046	0.047	0.043	0.046	0.055	0.034	0.028	0.02	0.0346	0.028	0.02	0.02	0.034
Median	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mode	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Standard Deviation	0	0.274	0.328	0.274	0.418	0.328	0.331	0.303	0.328	0.388	0.240	0.198	0.141	0.242	0.198	0.141	0.141	0.240
Sample Variance	0	0.075	0.108	0.075	0.175	0.108	0.109	0.092	0.108	0.151	0.058	0.0392	0.02	0.059	0.0392	0.02	0.02	0.058
Kurtosis	∞	8.534	3.974	8.534	-0.061	3.974	3.803	5.792	3.974	0.989	13.12	22.331	50	12.787	22.331	50	50	13.124
Skewness	∞	-3.193	-2.412	-3.193	-1.394	-2.411	-2.377	-2.750	-2.412	-1.718	-3.821	-4.841	-7.071	-3.778	-4.841	-7.071	-7.071	-3.821
Range	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Minimum	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maximum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sum	50	46	44	46	39	44	43	45	44	41	47	48	49	46	48	49	49	47
Count	50	50	50	50	50	50	49	50	50	50	50	50	50	49	50	50	50	50
Largest(1)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Smallest(1)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Confidence Level (95.0%)	0	0.078	0.093	0.078	0.119	0.093	0.095	0.086	0.0933	0.110	0.068	0.056	0.0402	0.0698	0.056	0.0402	0.040	0.068
F		4.261	6.682	4.261	13.821	6.682	6.836	5.444	6.682	10.756	3.128	2.042	1	3.195	2.041666667	1	1	3.128
p-value		0.042	0.011	0.042	0.0003	0.011	0.0104	0.0217	0.011	0.0014	0.0800	0.156	0.320	0.0770	0.156	0.320	0.320	0.080
F-crit		3.938	3.938	3.938	3.938	3.938	3.939	3.938	3.938	3.938	3.938	3.938	3.938	3.939	3.938	3.938	3.938	3.938

Discussion

When comparing the mean, median, and mode, it is observed that the median is equal to the mode. However, the mean deviates for industries that do not adhere to the entire questionnaire. The standard deviation (SD) is higher for SHV Energy Pvt Ltd, indicating a larger sample variance. Furthermore, Hanon Automotive Systems India Pvt Ltd, SSTP, BHEL, and Sundaram Fastners Limited exhibit higher kurtosis, indicating the presence of outliers and skewed distribution.

Daewon India Autoparts Pvt Ltd, Dongwoo SurfaceTech India Pvt Ltd, Hanon Automotive Systems India Pvt Ltd, India Yamaha Motor, Lotte India Corporation Ltd, SSTP, BHEL, Sundaram Fastners Limited, SHV Energy Pvt Ltd Tuticorin have p-values greater than 0.05 and F<Fcrit. Consequently, the null hypothesis is not rejected, indicating statistical insignificance when these industries are compared. Hence, there is no significant need for improvement in these industries.

On the other hand, Covai LPG, Hindustan Petroleum Corporation, Indian Oil Corporation Ltd Sivagangai, SHV Energy Pvt Ltd, Meena LPG Industries Madukkarai, SHV Energy Pvt Ltd Tuticorin, Bharat Petroleum Corporation Ltd, Meena LPG Industries, Patwari Bakers exhibit p-values less than 0.05 and F>Fcrit, leading to the rejection of the null hypothesis. Therefore, the data is found to be statistically significant when compared with control industries. These industries need to improve their adherence to the questionnaire.

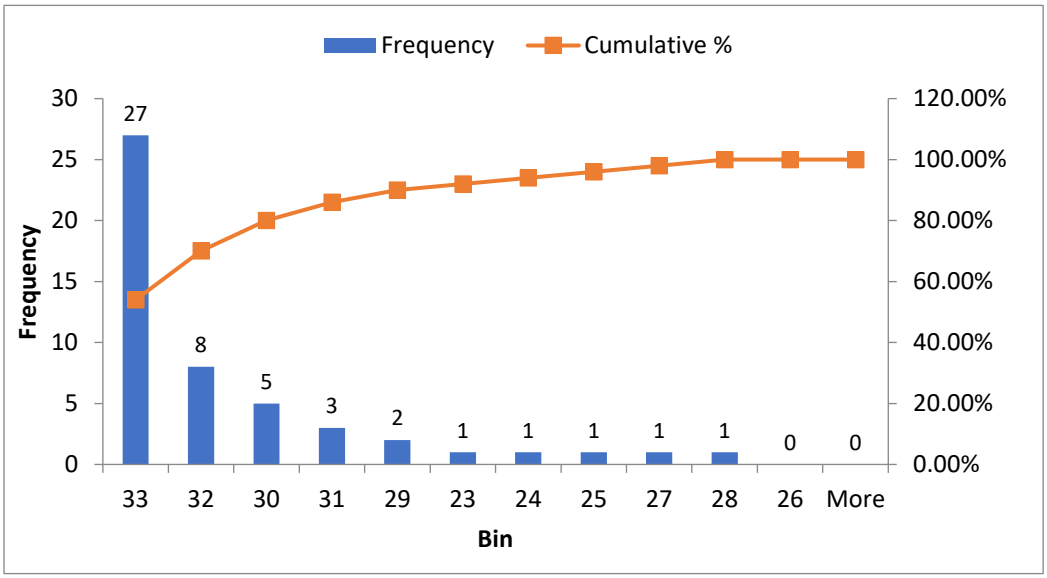

Figure - 3. Histogram for emergency management elements

The first two bars in the histogram above indicate that 35 questionnaires were followed by at least 32 industries or more (Figure 3). The remaining 15 questionnaires must be improved overall. They are as follows:

1. Have all the fires/incidents been investigated and corrective actions taken?
2. Whether the fire load study conducted in the plant?
3. Whether the flammable substances are periodically removed from the plant?
4. Do you have fixed or automatic firefighting installation(s) in your plant?
5. Are all self-closing fire doors in good condition and free from obstructions?
6. Whether the on-site emergency plan has been approved by CIF/DISH
7. Whether the updated emergency plan approved by CIF/DISH periodically?
8. Whether the fire NOC obtained from the fire department?
9. Whether an alternate assembly point is identified and specified?
10. Whether the plant has an Occupational health center? Is it under the control of a medical officer?

11. Whether the Occupational Health Centre has adequate paramedical staff?
12. Whether the Occupational Health Centre equipped with all facilities and antidotes?
13. Whether the plant maintain a dedicated Ambulance van for use in case of any emergency?
14. Whether nearby hospital facilities are available for emergency medical care?
15. Whether all the Truck and vehicle drivers and cleaners are involved in the onsite emergency mock drills

Analyzing overall data, most of the questionnaires were satisfied. However, a little more improvement is required.

Conclusions

Upon analyzing the entire data statistically, it is observed that the mean value is not equal to the median value and therefore the data is asymmetrically distributed. The mean value of YES status is lesser than its median value for some items and greater for some items. Hence, the items of YES status distributed are not symmetric about the mean but skewed left or right. The data points deviate from the sample mean and hence there exists standard error and variance values described. Confidence Interval values are calculated to explain the reliability of the estimate and likely to contain a value of an unknown population parameter and to check whether the predictions fall within this confidence interval.

Overall, the industries Covai LPG Pvt Ltd, Hindustan Petroleum Corporation, Meena LPG Industries Madukkarai, SHV Energy Pvt Ltd, Meena LPG Industries and Patwari Bakers have p-value less than alpha value (0.05) and F is greater than Fcrit and reject the null hypothesis. Hence, the data is statistically significant compared with control. Hence, the above-mentioned six industries need to be improved in satisfying the questionnaire set on Emergency Management Elements.

Overall, four topics Communication Systems adopted in the plant, Fire Protection, Emergency Health Services in Emergency Management Elements need to be improved.

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Original Article

Study on causal effects of occupational stress on healthcare workers at a selected healthcare facility in Oman

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ABSTRACT

Introduction: Occupational stress (OS) can be described as any physical or psychological change in an individual due to immediate or long-term reactions to workplace conditions that pose perceived threats or challenges to that employee. Typically, since work environments differ worldwide, scientists posit that the nature, sources, and causes of OS and the solutions proffered to address its impacts among healthcare workers (HCWs), differ markedly. The study aims to identify and examine the causal effects of OS on HCWs at the selected health facility in Oman.

Methods: The study adopted a quantitative design that utilized questionnaires to examine the causes and effects of OS on selected health workers. Data was collected from December 2021 to January 2022 from 150 health facility employees to obtain their opinions on the causes and effects of OS on their health, work life, and productivity.

Results: Findings revealed that 47% of the respondents were male and 53% were female. Further, the results also revealed that HCWs at the selected health facility have experienced a high prevalence of OS due to various factors ranging from staff shortages, as revealed by 56.2% of the participants, to work duration and loads, as revealed by 69.0% of the participants, and staff working conditions.

Conclusion: As a panacea, recommend management of healthcare facilities engage more highly qualified staff and create highly conducive work environments and training. Likewise, the management can provide modern-day facilities and amenities. It is envisaged that such measures will also reduce workloads, which will help the HCWs to rest, resuscitate, re-energize, and nurture effective stress. Furthermore, the measures will help create a stress-free, healthy, and conducive environment for the HCWs and greatly improve quality healthcare delivery services.

Keywords: Healthcare workers, Occupational Health, Occupational stress, Workplace safety

Introduction

Good health and well-being (Goal 3) is regarded as an integral component of the United Nations (UN) Sustainable Development Goals (SDGs) adopted in 2015.[1] Goal 3 is a universal call for action to promote healthy lives and the well-being of people worldwide.[2] Furthermore, it seeks to ensure that people of all ages, races, religions, and regions of the world have access to accessible, abundant, and affordable healthcare services. These include newborn, infant, maternal, adolescent, and reproductive health as well as the prevention of infectious and non-infectious diseases.[3] In addition, goal 3 aims to ensure universal health access to effective, safe, quality,

and inexpensive medicines and vaccines.[4] Based on the aforementioned, the timely delivery of healthcare services is considered one of the most important social amenities provided to individuals in any society. It is critical to the socio-cultural growth and economic development of any society.

Healthcare service delivery is typically provided by highly trained professionals or personnel otherwise termed healthcare workers (HCWs). The composition of HCWs in any typical healthcare facility includes physicians, nurses, nursing assistants, physiotherapists, and radiology as well as technicians in the pharmacy, health information sections, and maintenance and engineering departments. The ultimate goal of these HCWs is to safeguard the health and well-being of people and patients in the larger society. By so doing, they help to mitigate or eliminate the spread of diseases, epidemics, and pandemics worldwide. However, the job of HCWs is prone to numerous health and safety risks ranging from communicable diseases to occupational stress (OS). Other challenges include high patient loads, poor enumeration, and harsh working conditions among others that prevent their ability to timely and effectively deliver healthcare services in the wider society. Given the outlined challenges, HCWs are largely prone to OS and professional pressures, which impact their physiological, psychological, and ability to function effectively in their places of work.[5]

OS is defined as the change in an individual's physical or mental state as an immediate or long-term reaction to workplace conditions that pose perceived threats or challenges to that employee. OS is ascribed to various factors such as the work environment, organizational atmosphere, and conflict arising from the employee's job expectations.[6] Six Other factors include toxic work environments, unfavorable workloads, isolation, long working hours, role conflicts/ambiguities, lack of independence, and problematic peer relationships.[7-9] In addition, managerial bullying, harassment, and organizational climate are stressors that could result in OS.[7-10] Given the nature of their jobs, HCWs are exposed to these harsh conditions which result in OS. Typically, HCWs experience OS and professional pressures owing to job-related demands such as on-demand shifts, unsuitable work environments, and excessive administrative duties.[11]

Numerous studies have revealed that working in healthcare is challenging due to several reasons. For example, HCWs characteristically experience high workloads, long working hours, unpleasant working circumstances, dealing with difficult patients, uncertainty over patient treatment, and other occupational health and safety issues, which could result in OS. Trifunovic et. al reported that HCWs experience wide-ranging OS, which poses significant risks to their health and well-being.[11] For example, it can lead to physical, and mental, health, as well as behavioral disorders and social problems, including depression, anxiety, and suicidal ideation.[12-13] Other studies have also revealed that long-term stress causes high blood pressure, heart failure, or immune system compromise.[14]

Numerous studies have demonstrated that OS is widespread among HCWs. The reason is that HCWs have high expectations combined with a lack of time, skills, and social support, which could cause extreme anxiety, burnout, or physical sickness, as well as reduced quality of life and service delivery.[15-17] Stress and burnout are known to cause absenteeism and attrition. Similarly, anxiety and depression disorders caused by both work-related and non-work-related stress can severely affect HCWs.[18-19] Overall, OS can bring about changes in the physical or mental state of an individual due to working in a challenging environment such as the healthcare sector, whereas HCWs are most prone. In general, the review of the literature points to the fact that OS is harmful to both individuals and organizations.

Due to the differences in demographics, cultures, socio-economic, and work environments of people world, the sources, causes, and impacts of

OS in one country may differ markedly. Likewise, the solutions meted out to address such challenges in one country will not differ but may be ineffective in addressing OS-related problems among HCWs. Hence, further studies are required to address the problems of OS across the world. Therefore, the objective of the study is to examine the causal effects of OS on healthcare workers at a selected health facility in the Sultanate of Oman. The study also seeks to investigate the sources, causes, and impacts of OS among HCWs in Oman as well as proffer solutions and suggestions that reduce OS and professional pressures among the nation's HCWs based on the findings deduced from the selected health facility in the country.

Methods

This study adopted a descriptive and quantitative research technique by utilizing questionnaires to examine the causes and effects of OS on selected health workers at the health facility. Furthermore, the website of the health facility was used to determine the number of healthcare workers, their schedules, and the various departments to ensure equitable distribution of the questionnaires. The designed questionnaire comprised five (5) questions including gender, work description, work duration, as well as respondents' opinions on the causal effects, and potential solutions for reducing occupational pressure. The questionnaire was subjected to face validity and content validity by administering it to experts in the field.

To achieve a sample size the study utilized the Kriecjie and Morgan formula for determining sample size. Based on a population of 250 workers who work the health care units the sample size is calculated below:

$$n = \frac{X^2 NP(1-P)}{e^2(N-1)+X^2P(1-P)} \quad \text{.....Equation (1)}$$

Where: N = *Population Size = 245*

X^2 = *Chi Square Value = 3.841*

P = *Population Proportion = 0.5*

E = *Margin of Error = 0.05*

$$n = \frac{3.841^2\ X\ 245\ X\ 0.5\ (1-0.5)}{0.05^2(245-1) + 3.841^2\ X245\ (1-0.5)}$$

$$n = 150$$

Based on the sample size calculation 150 Health care workers are the respondents for the study. On completion, the questionnaire was distributed to 150 employees of the health facility who were selected randomly to obtain their opinions on the causes and effects of OS on their health, work life, and productivity. Data collection lasted from 28th Dec 2021 to 7th Jan 2022. It is important to state that before the commencement of the data collection process, the express permission of the chief medical director, healthcare personnel department, and management of the facility was processed and procured. Ethical approval was obtained from the research and ethics committee of ICEM. After data collection, the data from the questionnaires were coded and imported into Microsoft Excel for data analysis.

Results

This study aims to identify and examine the causal effects of OS on HCWs at the selected health facility in Oman in line with this the results of the study are presented below. The first section presents the demographic results of the study. The data includes the ages, gender, cadre, years of experience, and type of work performed by each health facility staff.

As can be seen (Table 1), the male gender accounts for 46.6% of the total population, whereas females account for 53.3% of the respondents in the study. The marital status analysis showed that 20% are unmarried, whereas 80% are married. The analysis of the workforce showed that there are 50 physicians, 46 nurses, 14 pharmacists, 12 laboratory scientists, and 20 administrative employees working in the various departments (such as indicated various things such as security, social workers, and cleaners) at the facility.

Table 1: Demographic data of the study respondents

Characteristics		Frequency
Gender	Male	70 (46.60%)
	Female	80 (53.30%)
Age	Age group (20-45) years	100 (66.60%)
	Age group (45-60) years	50 (33.30%)
Marital status	Single	30 (20%)
	Married	120 (80%)
Cadres	Doctors	50 (33.30%)
	Nurses	46 (30.60%)
	Pharmacist	14 (9.30%)
	Laboratory Scientists	12 (8%)
	Administrative Staff	20 (13.30%)
	Others (security, cleaners, social workers etc.)	8 (5.30%)
Years of experience	0-6 years	70 (46.60%)
	7-above	80 (53.30%)
Employment type	Temporary	73 (48.60%)
	Permanent	77 (51.30%)

Sources of OS

One of the objectives of the study was to identify and examine the perceived sources and causes of OS among staff at the health facility.

Table 2 shows the various sources or causes of OS among workers at the facility. As can be observed the causes of OS among the staff are numerous and varied, as outlined. However, these factors can be broadly grouped into personnel-related problems, work duration/loads, and staff conditions, independently or jointly contributing to OS among healthcare workers at the selected health facility.

Table 2: Sources/causes of OS among health workers

Occupational Stress	D	N	P	LS	AS	O
Inadequate staffing levels	32(21%)	20(13.3%)	8(5.3%)	5(3.3%)	8(5.3%)	2(1.3%)
Working hours are excessively lengthy	40(26.6%)	30(20%)	10(6.6%)	8(5.3%)	8(5.3%)	7(4.6%)
Taking care of a huge number of patients	35(23.3%)	42(28%)	10(6.6%)	7(4.6%)	7(4.6%)	8(5.3%)
Working with inadequate support personnel	5(3.3%)	7(4.6%)	2(1.3%)	1(0.6%)	1(0.6%)	0%
Call rooms and workstations in an unfavorable working environment	35(23.3%)	42(28%)	10(6.6%)	7(4.6%)	7(4.6%)	8(5.3%)
Time pressure	45(30%)	35(23.3%)	10(6.6%)	8(5.3%)	8(5.3%)	7(4.6%)

D- Doctors; N-Nurses; P–Pharmacists; LS–Laboratory Scientists; AS-Administrative Staff; O– Others

According to the results of this study, insufficient staffing levels were adjudged by 49.5 % of respondents as one of the major causes of OS among healthcare workers. Likewise, excessively

long working hours were also considered to be an essential cause of OS based on the opinions of 68.6% of the respondents. Long working hours are also regarded as one of the primary stressors experienced by physicians, nurses, laboratory scientists, cleaners, and others. Results from Table 2 further show that 72.4% of the respondents reported that taking care of a huge number of patients was the leading cause of stress. Even though the findings revealed that working with inadequate support was not a main contributor to stress as shown in Table 2 which revealed that only 10% agreed, the results further showed that 72.4% of the respondents agree that unfavorable working conditions were precursors for occupational stress. Further results from the analysis indicated that 75.1% of respondents agreed that time pressure was a leading cause of OS.

Table 3 outlines some selected OS coping mechanisms used by HCWs at the selected healthcare facility examined in this study. As can be observed, the HCWs have devised and used several methods such as prioritizing tasks, taking breaks, work-life balance, and relaxation to lower work stress.

Table 3: OS coping mechanisms of HCWs (weighted mean)

Occupational stress	D	N	P	LS	AS	O
Prioritizing and concentrating on only the most critical work-related tasks	45(30%)	40(26.6%)	10(6.6%)	8(5.3%)	18(12%)	8(5.3%)
Taking breaks from work to think, pray and listen to music	47(31.3%)	40(26.6%)	12(8%)	10(6.6%)	20(13.3%)	8(5.3%)
Making social arrangements that aren't work-related	20(13.3%)	12(8%)	2(1.3%)	2(1.3%)	5(3.3%)	1(0.6%)
Have some time for fun and joke about it at work to relieve tension.	20(13.3%)	12(8%)	2(1.3%)	2(1.3%)	5(3.3%)	1(0.6%)

D – Doctors; N – Nurses; P – Pharmacists; LS – Laboratory Scientists: Administrative Staff – AS; O – Others

Based on findings from Table 3 above, it can be seen that 128 (85.3%) HCWs agree that prioritizing tasks was a very crucial mechanism used in coping with OS. The table also shows that another coping mechanism used by HCWs was taking breaks from work which was agreed by 137 (91.3%) HCWs across all departments studied. Further findings from Table 3 also show that both making social arrangements and having time for fun were agreed by only 42 (28%) respondents across all departments respectively.

Discussion

This study is aimed at investigating the effects of stress on healthcare workers at a selected facility in Oman. Findings from Table 2 revealed that a major source of stress was inadequate levels of staffing. This result is shown by 49.5% of the respondents in this study who agree that low staffing is a crucial cause of stress. Labor shortages are known to put additional pressure on the few healthcare professionals available, as reported by various industries in the literature. These findings are in tandem with Ang[20] who reported that the high shortages of labor in the agricultural sector in New Zealand have resulted in high levels of stress among farmers in the country. One of the notable factors identified as the reason for the problem is labor shortages. The study observed that the inability of family-owned farms to employ workers to assist with farm work has an adverse effect on the stress levels of owners. In their study on the occupational wellness of women in Northern Eastern India,

Bhattacharyya and Chakrabarti[21] observed a link between the OS and labor shortages during the peak agricultural season. Similarly, the group of Agarwal and Shilpkar[22] observed that labor shortages are a critical determining factor of OS, as this results in increased workloads for existing workers. Kulkarni et al[23] reported a link between OS and labor shortages in the health sector in South Africa. The authors also reported that OS could result in the poor mental health of workers, particularly HCWs such as nurses, which was ascribed to increased workloads like during the peak of the COVID-19 pandemic. In Nigeria, the shortage of medical personnel remains a major challenge as noted by the nation's Medical Association. Hence, the country's doctor-to-patient ratio is 1:6000, which is well short of the World Health Organization's recommendation. This high physician-to-patient ratio was also detected in a Chinese study, which discovered that the greater physician-to-general-population ratio in China exacerbates Chinese physicians' professional stress. Further findings from table 2 revealed that long working hours are considered to be an essential cause of OS based on the opinions of 68.6 % of the respondents. Similar findings have been reported by Boran et. al.[24] Whose study on work-related stress among Jordanian HCWs observed that long workers (along with gender and job title) significantly accounted for OS among staff. In another study by Chou et al [25] LWHs were responsible for only OS but also burnout among HCWs, particularly nurses (66%) in Taiwan. More recently, Jung and Baek[26] reported that LWH is a major cause of depression among HCWs. Virtanen et al.[27] reported that the LWHs and OS experienced by HCWs could greatly endanger patients as well as staff. The findings of the study showed that the risks of hospital-associated infections increased when HCWs were subjected to LWHs. Another critical cause of OS among HCWs is the need to cater to large numbers of patients in the selected health facility. This study observed that the healthcare needs of numerous patients cause great pressure and workloads for HCWs with this causative factor. The results show that it is the second most noticeable source of tension in the selected health facility with 72% agreeing with this viewpoint as opposed to 27.6% of the respondents. The study by Zare et al[23] reported that 77.5% (or as high as 87% among nurses) of the HCWs in selected hospitals in Iran reported moderate to high levels of workplace stress due to workload among other factors. In another study, Wright[28] reported that high patient load is an important contextual factor of workplace stress as well as conflicts, burnout, and job satisfaction. Kaburi et al[29] reported that workload pressures arising from high patient loads could negatively affect even highly skilled HCWs like doctors and nurses. The study demonstrated that psychological working conditions are important indicators of workplace or work-related stress among HCWs. Nurses working with inadequate support staff were also identified as having a response rate of 4.6% as a factor of OS.

Furthermore, physicians, nurses, and care professionals generally reported that the inadequate/unavailability of workrooms is one of the key impediments to successful healthcare service delivery as well as stress. The results of the study are confirmed by the outcome of 109 out of 150 employees who responded positively. Lastly, time pressure was also adjudged to constitute one of the highest percentages of sources of tension among HCWs at the selected health care with 75.1% of the respondents confirming this view. Similar to the findings of this study, there have been reports of a high prevalence of OS among HCWs in similar healthcare facilities as well as in other nations such as India, Ghana, Iran, Taiwan, and Ethiopia among others. The study findings also suggest that OS is not country-specific or workplace, as evident in the varied reports from various geographical locations and workplaces. In addition, the safety culture of organizations plays a crucial role in the prevalence of occupational stress and professional pressures encountered by workers in general.[30-31]

One of the most critical approaches for alleviating work-related stress was identified as

setting priorities. These OS coping mechanisms help HCWs to identify and prioritize the most important workplace-related tasks and focus only on these to prevent burnout and stress. The study findings showed that 85.3% of the HCWs agree with the view that drafting a scale of preference for workplace tasks will go a long way in addressing workplace stress along with the extant challenges that hamper effective healthcare delivery. Another critical mechanism is taking breaks from workplace tasks and duties. By doing so, HCWs can relax, think, pray, and listen to music, which helps to recover and re-energize for their tasks. The results showed that 91.3% agree with the view that respondents require breaks in between work for effective management of work-related stress. Lastly, the third method of reducing stress is to create and spend time for social interactions, which can help relieve tension.

Under extreme stress, the human body may be unable to critically fight disease, which leaves room for various illnesses. Therefore, health practitioners and others must reduce/eliminate the detrimental impacts of stress through the application and use of various coping methods. The measures provide an avenue for HCWs to effectively deliver their tasks during work hours for the effective delivery of healthcare services to their patients.

Conclusions

Healthcare institutions in many developed and developing countries have identified the various factors that affect effective healthcare delivery. One of the most notable challenges is OS experienced by healthcare employees who typically comprise doctors, nurses, anesthetists, radiographers, and cleaners among others. In this study, various factors such as staffing levels, excessively long working hours, caring for numerous patients, support staff shortages, and time pressure account for the stress experienced by HCWs in the selected healthcare facility examined in this study. The findings also showed that the majority of sources of stress identified in the study can be broadly termed job-related variables, which shows that aspects related to job content and settings are the most common drivers of work-related stress. Again the findings of this study showed that OS is a major problem among the HCWs at the selected health facility. The high prevalence of OS reported by the study indicates more efforts are required to address the problem to prevent any disruptions to effective healthcare service delivery. Hence, the management of the health facility and others, in general, will need to hire more staff to reduce the workload of current HCWs, while also maintaining proper labor division. Furthermore, the authors opine that employing highly qualified HCWs, creating highly conducive work environments, and training could foster effective stress management and greatly improve quality healthcare delivery services. In addition, these measures could potentially ensure workers can rest, resuscitate, and re-energize, which ultimately creates a stress-free, healthy, and conducive environment for the HCWs. The management can provide modern facilities and amenities for the general improvement of the working environment for staff and patients, which could greatly improve the mental health and general well-being of HCWs and the healthcare service delivery by extension.

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Original Article

The impact of safety culture dimensions on workplace accidents: an application in the Moroccan automotive industry

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ABSTRACT

Introduction: There is a general accord that safety culture is multidimensional, but there is limited research and publications about those dimensions. Almost one-third of the publications presenting safety culture definitions do not discuss the safety culture dimension nor the relationship between the safety culture dimensions and workplace accidents. To further understand the factors influencing this correlation, the following study was established to investigate the relationship between the safety culture dimensions and occupational accidents. This study aims to identify the safety culture dimensions in the automotive industry in Morocco and its relations with occupational accidents.

Methods: A study was done with 35 of the largest automotive companies in Morocco. The effects of safety culture on workplace accidents in the automotive industry were examined based on a literature review, and a measurement questionnaire was created with a sample of numerous automotive workers during 2 months in the winter semester of November and December 2022.

Results: The results show that safety culture dimensions have a strong influence on avoiding accidents, especially the common safety culture dimensions, which represent 40%. Based on the results gained from the Questionnaire the common safety culture dimensions are employees' attitudes/unsafe behaviors, lack of staff participation, and inadequate supervision. In addition, the COVID-19 period had a big impact on the number of occupational accidents in the automotive sector: 40.54% of these occupational accidents occurred between 2020 and 2022.

Keywords: Automotive, Dimensions analysis, Morocco, Occupational accidents, Safety Culture

Introduction

Safety culture is currently considered a proactive safety performance measurement and strategy for safety improvement; especially during uncertain situations such as COVID-19 and partial or full lockdowns. Keeping satisfactory levels of employee safety is a critical area of concern for many organizations and industries. In addition, the literature in both safety culture and safety climate research fields is growing at an exponential rate regardless of the historically delayed research activity.[1]

Stressful life situations such as pandemics, and wars, can have numerous negative implications for the mental health and psychological

functioning of an individual.[2] This can also impact employee performance in the workplace. Likewise, a recent study examines the influence of safety culture as a boundary condition for the relationship between work, COVID-19, and employee performance.[3] In addition, safety culture is a contentious notion. A recent study reviewed the qualitative interpretation of the safety culture.[4]

Moreover, safety culture is an important research domain in risk and safety science. Various industry and service sectors show significant interest in, and commitment to, applying its concepts, theories, and methods to enhance organizational safety performance.[4]

However, there is no acknowledged industry-wide definition and dimensions of the safety culture. In addition, there is also no clear difference between safety culture and safety climate. Gaps remain in the literature and there is no universal agreement about the definition or content of safety culture. Previous studies have a clear structure without consensus on the specific dimensions.[5]

The term "safety culture" first appeared in the International Nuclear Safety Advisory Group's report on the the 1986 Chernobyl disaster.[6] The safety culture in organizations has been defined differently in the literature and a collection of these definitions is provided by scholars.[6–8]

In addition, our interest is to achieve, in the Moroccan context, a better understanding of the safety culture determinants influencing occupational accidents in the automotive sector. The automotive industry appears as the most dynamic and most innovative in upstream logistics. It mobilizes a multiplicity of actors, all called to work in the long term, to create mutual benefits. The Moroccan automotive sector is expected to play a significant role in economic growth. The automotive sector's contribution to Morocco's GDP is expected to rise to 24 percent in 2023, meaning it will comprise nearly a quarter of the country's economic activity and income. Due to these developments, Morocco now ranks first in Africa in the automotive industry, surpassing Egypt and South Africa. [9]

In an attempt to address these gaps in the literature, the current study aims to provide an integrative review & identification of the safety culture dimensions contributing to occupational accidents in the automotive sector. To highlight the variables that explain the correlation, we will proceed as follows: in the first point, we will present the literature on the main safety culture dimensions. This will allow us to identify the variables and hypotheses used in our research purpose. A second point concerns the choice of the methodology and the interpretation of results. This work will conclude with a discussion of the implications and limitations of our study and future research.

The purpose of this study is to determine the main safety culture dimensions influencing occupational accidents in the Moroccan automotive sector. The analysis of our problem led us to focus on two areas of research:1) analysis of the safety incidents within the automotive industry in terms of their consequences and factors contributing to the incidents in Morocco, and 2) the nature of relationships between occupational accidents and the safety culture dimensions in the automotive sector in Morocco.

To answer these questions. we make the following assumptions:

H1: There is an impact of safety culture dimensions on occupational accidents.

H2: Employees' attitudes and behavior have a positive impact on occupational accidents

Methods

In this study, the effects of safety culture dimensions on workplace accidents in the automotive industry were examined, and a measurement questionnaire was used with a sample of numerous automotive workers.

Our research consists of 35 of the largest automotive companies in Morocco. Automotive managers were selected as the most relevant to complete the survey for this study. These

responsible managers can be regarded as the essential source of information on the results of the collaboration in which their company is engaged. The choice of the automotive industry is because this sector must now consider new constraints and challenges facing increasingly present (workplace safety conditions. competitiveness and well-being). So the choice of surveying managers in the automotive industry is not neutral. Indeed, in this sector, occupational accidents are considered a strategic issue.

Using SPSS 29 software, the 35 questionnaires were examined with a focus on workplace accidents in the Moroccan automotive industry and the influence of safety culture dimensions on accident occurrences. The hypotheses were tested using descriptive statistics.

The methodology adopted for this study is a systematic literature review of safety culture dimensions. The keywords were: "dimension, safety culture, drivers, components, factors, automotive". In addition. we used Google Scholar to identify additional cross-discipline literature. A total of 110 publications contributed to commentary, theory, or empirical research concerning the safety culture were selected. The searches were conducted in December 2022 by the first author. The selection process is detailed in Figure 1 below:

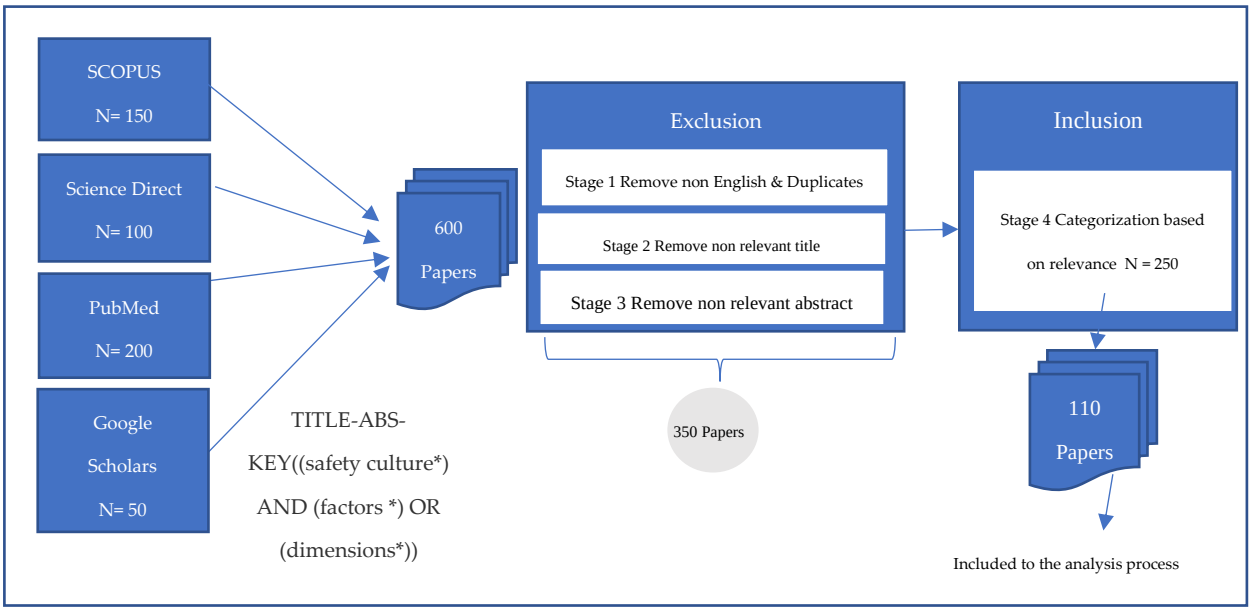

Figure 1: Overview of the selection process

A quantitative research design involving an online anonymous survey was used to elicit the perceptions of respondents on items that measure the relationship between incident and resilient safety culture dimensions in the automotive industry.

The introduction of the survey had the research purpose & objectives. The online survey was open for 2 months in the winter semester of November and December 2022. Relevant demographic data to assist in understanding the population was collected and highlighted in the descriptive data analysis of this paper.

To avoid collecting unnecessary data, potential risks and accidents that happened in the automobile sector were categorized into the 10 major accident types. Descriptive statistical techniques were used to look at the types of accidents, the work environment associated with accidents, the severity of injuries, and occupational groups.

Nineteen (19) variables in the questionnaire and 4 dimensions related to safety culture were identified; four variables each for the organizational dimensions, the individual dimensions, the environmental dimensions, and the psychological dimensions. Additionally, variables were chosen to examine the relationship

between accident incidence and safety culture aspects.

Participants were asked to rate each variable using the scales of "agree = 1" and "disagree = 0." The reliability coefficient for Cronbach's Alpha was calculated to be 0.8.

Table 1: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.800	0.823	68

Results

Figure 2 & Figure 3 represent the size of the companies selected during our research. 45.7 % of the companies have upwards of 1000 employees and 42.86% of these companies have an age between 0-10 years of implementation.

Figure 4 represents the overall respondents & years of experience. Almost 74.3% of the respondents from Environment, Health & safety and 54.3% had almost 8 -12 years of experience and above which can be regarded as the essential source of information on the results of the collaboration in which they are engaged in the accident investigations and the root cause analysis determination.

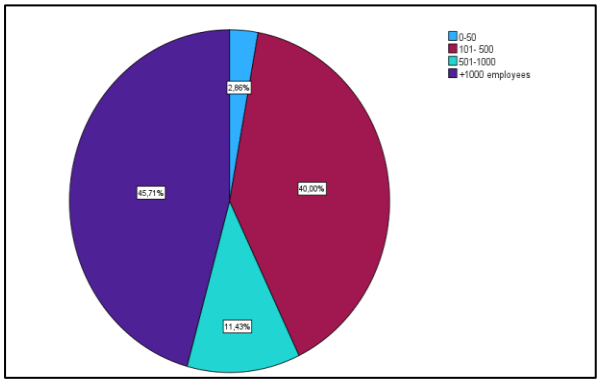

Figure 2: Size of the automotive companies

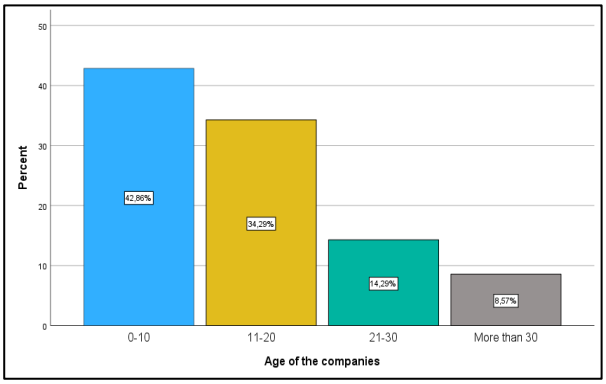

Figure 3: Age of the automotive companies

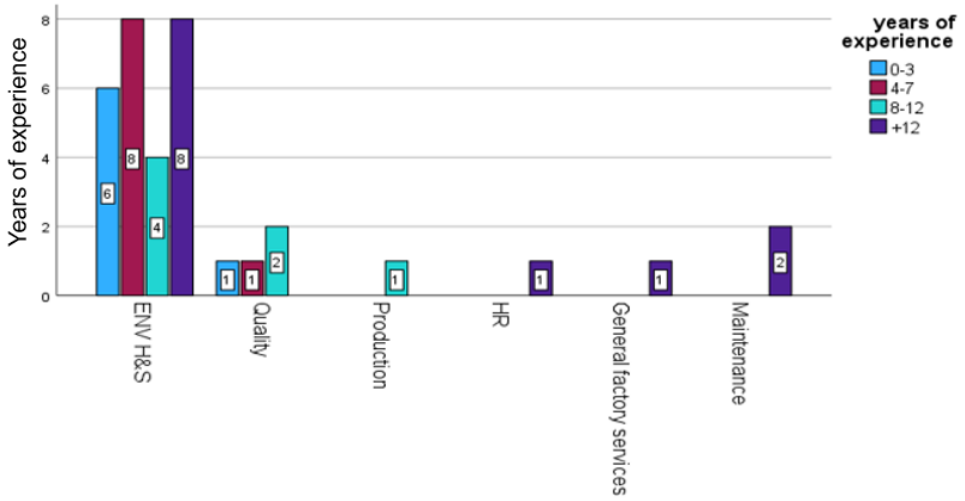

Figure 4: Department of respondents & year of experience in the automotive companies

In addition, Figure 5 represents the period of the large number of accidents in the automotive sector in Morocco. 40.54% of these occupational accidents occurred between 2020 and 2022.

The average number of automotive accidents were examined. Table 2 represents the repetition of the number of occupation accidents per year. 42.9% of automotive companies have between 0-2 accidents per year and 31.4% have between 3-5 accidents per year.

In this study, 10 accident categories, in particular, were shown to be more frequent in the Automotive industry which are listed in Table 3.

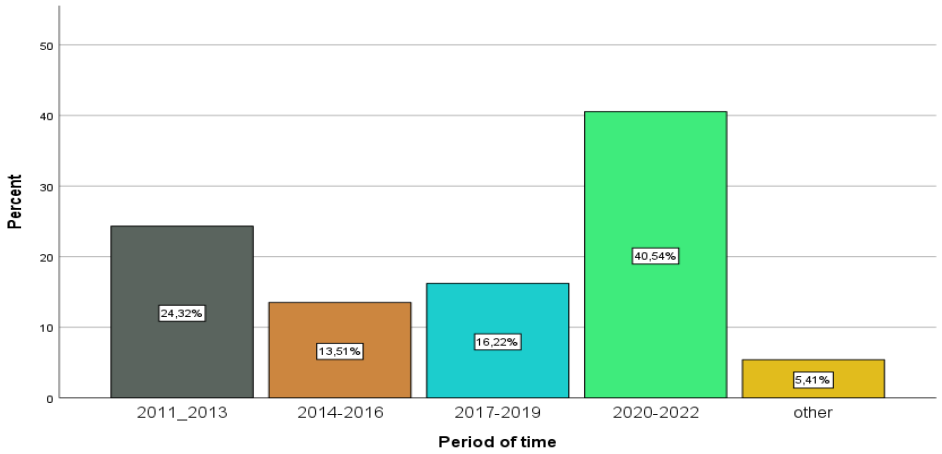

Figure 5: Period of the large number of occupational in the automotive companies

Table 2: number of occupational accident in the automotive companies

Accident per year	Percent
0-2	42.9
3-5	31.4
6-8	17.1
More than 9	8.6

Table 3: Type of occupational accident in the automotive companies

Type of accidents	Percent	Cumulative percent
Cut. stitched by	22.50	23
Hit by obstacle	17.50	40
Internal circulation	13.80	54
Slips trips & falls off from Height	12.50	66
Excessive effort. false movement	8.80	75
Falling objects	7.50	83
Stuck by	6.30	89
Frostbite or burn	6.30	95
Other	2.50	98
Fire. Explosion	1.30	99
Electricity	1.30	100

The analysis of the injuries in Table 4 has shown that the top five injuries represent almost 80% of occupational accidents: 32% of accidents overall resulted in cuts and wounds; 20% of total incidents resulted in body fractures, and sprains and low back pain accounted for nearly 22% of all injuries.

The study looked at the injury body locations. Table 5 shows that 6 body location categories were found to be more frequently occurring. 90 % of accidents were mainly on the hand & fingers (39.7%), foot (28.8%), head, face, neck (12.30%), and eye injuries with 11%.

The automotive industry plays a fundamental role in the Moroccan industry. In this study, we were looking at accidents. Almost 50% of the accidents occurred between the night shift (25.9%) and afternoon shift (23.5%), followed by the morning shift (19.8%) on the weekend (11%) and end of shift (11.1%) shown in Table 6.

Table 4: The severity of occupational accident in the automotive companies

Severity of accident	Percent
Cuts. wounds	31.9
Fracture	20.3
Sprain	10.1
Low back pain	10.1
Brun	8.7
Amputation	7.2
Eye Injury	7.2
Poisoning. asphyxiation	2.9
Other	1.4

Table 5: The body location of occupational accidents in the automotive companies

Body location of the accident	Percent
Hand. Finger	39.70
Foot	28.80
Head. face. neck	12.30
Eye	11.00
Shoulder. upper limb. wrist	6.80
Pelvis. lower limb. ankle	1.40

Table 6: The occupational accident moments in the automotive companies

Time of accident	Percent
Night shift 22H- 6H	25.9
Afternoon shift 14H - 22H	23.5
Morning shift 6H- 14H	19.8
Weekend	11.1
End of shift	11.1
Normal shift 8H- 18H	3.7
Overtime	3.7
Other	1.2

In addition, we studied the operations during the accidents in the automotive industry (Table 7). We see 57.1% occurred during routine operations & 42.9% during non-routine operations.

In Morocco, the automotive sector is crucial and has developed into a complex system. As a result, the research looked at occupations associated with accidents. Table 8 below shows the occupations where automotive industry accidents frequently happen.

Production operators represent almost 40% of injured occupations, followed by Maintenance technicians with 30.6% and warehouse operators with 20.8%.

Furthermore, in this study, we have examined the years of experience of the injured population in the Moroccan automotive industry. As shown below (Table 9), 70.3% of the injured persons have between 0-3 years' experience and 24.3% have between 4-7 years of experience.

Table 7: Type of occupational accident operations in the automotive companies

Accident operations	Percent
Routines operations	57.1
Non-Routines operations	42.9

Table 8: The type of occupational accident occupation in the automotive companies

Accident occupation	Frequency(N)	Percent
Production operator	29	40.3
Maintenance technician	22	30.6
Warehouse operator	15	20.8
Team leader	3	4.2
Contractor	2	2.8
Office Admin	1	1.4

Table 9: injured persons' seniority in the automotive companies

Years of experience	Percent
0-3 years	70.3
4-7 years	24.3
More than 7 Years	5.4

Safety culture dimensions' impact on accident incidence

The establishment of the H1 hypothesis was done to evaluate the effect of the safety culture dimensions on the occurrences of workplace accidents. Table 10 presents outcomes from the examination of the hypothesis H1.

The H1 hypothesis was accepted and the findings established that the primary five safety culture dimensions contributing to occupational accidents in Morocco's automotive industry are first, unsafe employee attitudes /unsafe behaviors.[10–12] Second, a lack of staff participation,[12–14] third, a lack of adequate supervision, [5,10,11,13,15] fourth, the risk perception and fifth, workload.[12]

Additionally, the H2 hypothesis was developed in order to investigate the influence of employee attitudes and behavior on the incidence of occupational accidents. Figure 6 displays the findings from the examination of the H1 hypothesis.

Table 10: Safety culture dimensions contributing to occupational accidents in the automotive companies

Safety culture dimensions	Percent	Cumulative percent
Attitudes or unsafe behaviors	21.1	21.1
participation or involvement of staff	11.9	33.0
Supervision	7.3	40.4
Risk perception	7.3	47.7
Workload	7.3	55.0
Staff competence	6.4	61.5
Safety value vs production	5.5	67.0
Communication	3.7	70.6
Incident reporting	3.7	74.3
OHS management system	3.7	78.0
Training or knowledge of staff	2.8	80.7
Staff awareness	2.8	83.5
Risk management	2.8	86.2
Work conditions	2.8	89.0
Maintenance preventive	2.8	91.7
Resources	2.8	94.5
Management commitment	1.8	96.3
Emergencies	1.8	98.2
Contractor management	1.8	100.0

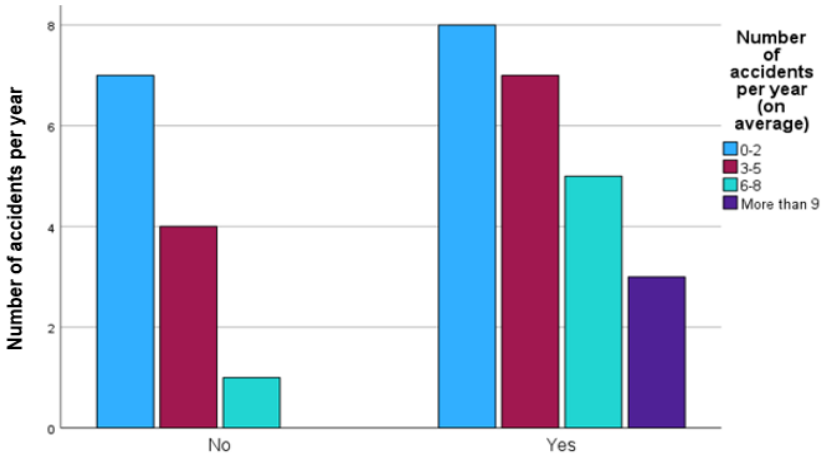

Figure 6: The impact unsafe attitudes or behaviors on the accident's occurrence

Discussion

The findings from this study were based on the evaluation of the safety culture dimensions in previous studies, which were considered and reviewed to establish a basis to understand the safety culture dimensions in the Moroccan Automotive sector in parallel with occupational accidents (Table 10) which is an important area of activity within safety science.[1]

Based on Figure 5, the period of a large number of accidents in the automotive sector in Morocco occurred between 2020 and 2022. In fact, stressful life situations such as pandemics and wars can have numerous negative implications on the mental health and psychological functioning of an individual.[2] This can also impact employee performance in the workplace. Likewise. a recent study examines the influence of safety culture as a

boundary condition for the relationship between work COVID-19 and employee performance.[3]

In fact, to meet the challenges during COVID-19, the safety of employees is of vital importance. Decreasing stress by maintaining a safety culture is necessary for improving employee safety performance.[3]

In addition, it might be observed in Table 8 that the majority of accidents have occurred around the 3 main categories of occupations & areas in the automotive industry: Production, Maintenance and warehouse areas. Almost 50% of the accidents occurred between the night shift and afternoon shift shown in Table 6. Moreover. Table 9 shows that 70.3% of the injured persons are between 0-3 years of experience.

In parallel. safety is impacted by a number of safety culture elements both at the organizational and individual levels.[10]

Several studies have been undertaken to examine safety incidents. A recent study found that safety culture is listed as the top six contributing factors to the US chemical manufacturing industry.[16]

Another study examined incidents across 14 industries. Their analysis of 81 incidents found the most common factors contributing to events were safety culture, emergency preparedness, and mechanical integrity.[17]

Table 10 summarizes the most common dimensions of safety culture. These are based on the review of 31 related papers, including Zhang. Murat Selçuk SOLMAZ and others.[10,15] In parallel. it presents safety culture dimensions contributing to occupational accidents in automotive companies.

According to the findings of this study: Moroccan auto workers' safety culture aspects had a significant impact on their ability to prevent accidents. Workers in the automotive sector are important contributors to a safe workplace. The results of this research on the impact of safety culture factors on occupational accidents have significant general implications. Table 9 demonstrates that accidents frequently include less-experienced individuals, which prompts us to emphasize the significance of safety training and supervision in the automotive industry as one of the causes of the increasing accident rate.

Conclusions

There are several factors affecting safety in the automotive sector in Morocco and safety culture is one of the most important. This study has revealed that safety culture dimensions in the automotive sector have a strong influence on employees in terms of avoiding accidents.

In addition, unsafe behaviors, employee involvement in safety, supervision, individual risk perception and workload are elements of the safety culture and the primary causes of accidents and incidents.

Recommendations: industries and regulators should adopt a safety culture conceptual framework & dimensions, develop guidance on safety culture self-assessment methodologies, conduct a review of how other companies can enhance their safety culture, develop a safety culture toolkit, and develop guidance on safety culture improvement strategies.

Future research on analyzing the possible relations between the study recommendations and proposing a model of a positive safety culture should be completed. In addition, increasing research should be conducted to develop ways and tools to assess an organization's elemental assumptions for capturing a much deeper knowledge of the safety culture.

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Original Article

"Vaai Ganam" - a screening program for early detection of oral potentially malignant disorders and oral cancer among truck drivers in Chennai – A cross-sectional survey

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ABSTRACT

Introduction: Truck drivers, though forming an integral part of a vital trade link for the Indian population, lack basic life insurance and health care benefits offered by other organized sectors in Indian Industries. This paper aims to present the initial findings of the "VaaiGanam" program which proposes to identify tobacco use and the prevalence of Oral potentially malignant disorders (OPMDs) among truck drivers who are stationed or passing via Chennai and provide cessation services by behavioral therapy.

Methods: This cross-sectional study was conducted by a dental screening team who were involved in data collection and screening of the 747 truck drivers who fulfilled the inclusion and exclusion criteria between Jan to Oct 2022. After data collection, oral examinations were done and suspicious lesions were sought for expert opinion. A standard punch biopsy was taken from those lesions requiring confirmation.

Results: Among the 747 subjects who participated in this program, 704 (94.2%) were current users of various tobacco products, with 235 (31.4%) preferring smoking and the rest 469 (62.8%) using smokeless tobacco products. Oral mucosal lesions were recorded in 49 (6.5%) of the study population, mostly among tobacco users. Punch/incisional biopsies were taken among 17 of the 49 subjects and oral dysplasia was histopathologically confirmed in 9 (mild epithelial dysplasia = 5; moderate epithelial dysplasia = 4) subjects.

Conclusion: Truck drivers with tobacco and substance abuse are at high risk of developing oral cancer and hence this study emphasizes the importance of periodic oral cancer screening programs for this vulnerable population to identify potentially malignant oral lesions at an early stage.

Keywords: Malignant lesions, oral cancer, oral potentially, screening, tobacco use, truck drivers

Introduction

Truck drivers have always been the trade link of the Indian population as they help to transfer goods and essentials across this country. In this relatively unorganized sector, 8 million truck drivers are engaged in transporting goods along the second-largest road network in the world. The health status of this at-risk population has been an area of recent focus as many studies have reported a higher health burden among this population.[1,2] Though many risk behaviors could be attributed to this, an altered lifestyle has been cited as a primary risk factor for this excessive disease burden. A focus group of long-haul truck drivers reported that despite a desire to eat healthy food, time constraints and the high cost of maintaining a healthy lifestyle while traveling prevent them from adopting them and resorting to unhealthy behavioral patterns.[3] Other factors inhibiting a healthy lifestyle include excessive non-driving work time spent in areas where there is a scarcity of healthy food, lack of opportunity to seek out food options and engage in physical activity, and the influence of peer groups advocating substance abuse, tobacco, and alcohol use as a means of recreation and bonding. Hence it can be implied that lifestyle choice has also been identified as a factor influencing the health and well-being of truck drivers.[4]

Many of these truck drivers are members of the All India Transporters Welfare Association and All India Road Transport Workers' Federation. Despite being part of an organization, many of them lack basic life insurance and health care benefits offered by other organized sectors in Indian Industries. The primary focus of the association is settling wage disputes and ensuring the timely transport of goods. As a result of undue stress and lack of basic amenities during travel, many truck drivers adopt unhealthy lifestyle practices to overcome their physical and mental fatigue. Of late the governmental authorities have identified this marginalized community and have initiated various health schemes for their welfare. Oral potentially malignant disorders (OPMDs) are defined as "any oral mucosal abnormality that is associated with a statistically increased risk of developing oral cancer".[5] OPMDs present with diverse clinical attributes, such as color variations (white, red, and mixed white-red), morphological changes (plaque/plateau, smooth, grooved, wrinkled, granular, atrophic), and different sizes, involving different anatomical sites in the oral cavity. The habits of betel quid chewing, tobacco smoking, and alcohol drinking, as well as their synergistic effects, are important risk factors for the prevalence of oral cancer and OPMDs.[6,7] The overall malignant transformation (MT) rate of OPMDs to oral cancer is 7.9%.[8]

The Indian Council of Medical Research has recently funded a project "SCOPE – Self Screening and Care for Oral Cancer Prevention and Eradication - A Model for Long Distance Heavy Vehicle Drivers', at Pondicherry, India. With a similar objective, a dental college in Chennai, India along with World Vision, an NGO had developed a program named "Vaai – Ganam" which translates as "Vaai" meaning mouth, and "Ganam" meaning burden in Tamil, the local dialectic. This word was derived from "Vaganam" which translates as vehicle. This program proposes to identify tobacco use and the prevalence of Oral potentially malignant disorders (OPMDs) among truck drivers who are stationed or passing via Chennai and provide cessation services by behavioral therapy.

The participants were subjected to oral examination, and counseling for tobacco cessation. Toluidine blue staining to aid in the early identification of potentially malignant and malignant oral lesions with subsequent histological confirmation with biopsy was an integral part of the program. Appropriate referral and medical assistance were also provided to all participants. This paper aims to present the initial findings of this project with a focus on the prevalence of tobacco use and the associated tobacco-related oral comorbidities among truck drivers in Chennai.

Methods

This cross-sectional study was conducted to assess the effectiveness of an oral cancer

screening program among truck drivers in Chennai city. This study was based on census methods, and all truck drivers who gave their consent during the study period (Jan 2022 to Oct 2022) were recruited and examined. A snowball method of sampling was followed, and the study objectives were explained before obtaining consent in their preferred language and examined at Gas stations on the outskirts of Chennai city. A local non-governmental organization (World Vision) coordinated the logistics for this program along with a dental college.

Ethical clearance to conduct the study was obtained from the Institutional Review Board, Ragas Dental College and consent was obtained from all the study participants who drove trucks for more than one year and have not been a part of any oral screening program within one year.

The dental screening team comprised five doctors (specialists in Public health dentistry and Oral and Maxillofacial Pathology) who were involved in the data collection and screening of the study participants. The team involved in this program received prior training in the screening modalities, data collection methods, and biopsy techniques under the supervision of the specific departments. In this program, the Interns were involved in obtaining consent from the participants and collecting data regarding their demography, tobacco use, alcohol use, and their perception regarding non-health oral ulcers and oral cancer.

The oral examination of the subjects was conducted by postgraduate students using the ADA Type III examination. In the presence of suspicious oral lesions, toluidine blue staining was used as a screening tool. Photographs for all the lesions were taken using a mobile phone with a minimum 10-megapixel camera and transferred to the authors (PDMK and KR) for opinions regarding management. After consensus and consent, a standard punch biopsy was taken from the subject by a faculty member, and the standard procedure was followed for the transportation of the samples and histological examination. Post-operative instructions and medications were provided for the participants for whom biopsies were performed. On average around 30 truck drivers were screened per day and for those requiring confirmation, biopsies were taken. The program was conducted once a fortnight during which the earlier obtained specimens were histologically processed and the findings were reported confidentially to the subject. All subjects who participated in the program received health education messages, with special emphasis on tobacco and alcohol habit cessation using cognitive behavioral therapy by trained professionals. For those subjects with oral potentially malignant or dysplastic histological changes, individual follow-up was done for them to seek professional care at their location of preference.

The data obtained were compiled in a Microsoft Windows Excel file and transferred to IBM SPSS Statistics version 26 for data analysis. Descriptive statistics was used to represent frequencies related to demography and tobacco use.

Results

The present study was conducted among truck drivers in Chennai to assess the prevalence of tobacco use and associated potentially malignant and malignant oral lesions amongst this population. Seven hundred and ninety-five truck drivers were approached for this screening program and 747 with a mean age of 39.8±1.51 years consented to participate. Among them, 704 (94.2%) were current users of various tobacco products, with 235 (31.4%) preferring smoking and the rest 469 (62.8%) using smokeless tobacco products. The latter used predominantly Gutka (54.8%), followed by Paan and Pan Masala [Table 1].

Table 1: Demographic characteristics and prevalence of tobacco use among the study population

Characteristics	**No** of subjects
Male	747 (100%)
Female	0
Mean age	39.8 ±1.51
Smoke tobacco users	235 (31.4%)
Smokeless tobacco users	469 (62.8%)
Non-tobacco users	43 (5.8%)
Types of Smokeless Tobacco users	
Gutkha	257 (54.8%)
Paan	116 (24.8%)
Pan Masala	64 (13.7%)
Khaini	21 (4.4%)
Mawa	11 (2.3%)

Oral mucosal lesions were recorded in 49 (6.5%) of the study population. All the oral mucosal lesions were present in truck drivers with tobacco use except for 5 participants (three with frictional keratosis and two with traumatic fibroma) who presented with no history of habits. Punch/incisional biopsies were taken among 17 of the 49 subjects and oral dysplasia was histopathologically confirmed in 9 (mild epithelial dysplasia = 5; moderate epithelial dysplasia = 4) subjects. Table 2 and Table 3 demonstrate the distribution of tobacco use patterns and the clinical and histological diagnosis of truck drivers with oral lesions.

Table 2: Distribution of Habits with tobacco use among truck drivers (N = 49)

S.No	Oral Lesions in Truck Drivers	Distribution of Habits with tobacco use among truck drivers (n = 49)				
		No Habits	Tobacco +Betel Nut	Tobacco +Paan	Tobacco Chewing	Tobacco Smoking
1	Leukoplakia	-	7	-	4	4
2	Erythroplakia	-	-	-	1	-
3	Erythroleukoplakia	-	-	1	-	-
4	Tobacco pouch keratosis	-	3	-	8	-
5	Smoker's palate	-	-	-	-	2
6	Smoker's melanosis	-	-	-	-	6
7	Frictional keratosis	3	-	-	-	1
8	Traumatic fibroma	2	-	-	-	2
9	Leukoedema	-	1	-	-	-
10	Candidiasis	1	-	-	-	1
11	Fordyce Granules	-	-	-	-	2

Table 3: Histopathological diagnosis of oral potentially malignant lesions among truck drivers

Histopathological Diagnosis (N=17)	Number of Cases
Mild Epithelial Dysplasia	5
Moderate Epithelial Dysplasia	4
Oral Epithelial Atypia	5
Hyperkeratosis, acanthosis, atrophy	3

Discussion

Truck drivers, when compared to other drivers (of bus, rail, delivery, etc) are a neglected subset among the Indian population in terms of risk coverage and health priorities. Literature has shown that this population sustains more injuries, fatalities and illness when compared to other populations. Australian truck drivers have been documented to have a higher health-related insurance claim rate of 70.3 per 1,000 workers.[9] However, no such data is available among the Indian truck drivers as they are under a private body and hence lack an exclusive health insurance package unlike their counterparts (bus, railways) who are under the government sector. An Indian truck driver travels long distances to cover this wide country and plays a vital role in the movement of goods from the producers to the consumers. Typically, because of traffic restrictions during the daytime, truck drivers drive all night on arterial highways of India and usually station themselves on the outskirts of the city, in places known as Dhabas (which offer boarding and lodging facilities) during the daytime. Almost all of them are away from their home and family and may only have an opportunity to meet them at less frequent intervals. This unhealthy lifestyle with a lack of adequate sleep and nutrition[10] identifies this vulnerable population as a risk group for various health challenges. In addition, this population has a high prevalence of substance abuse, including the use of tobacco and alcohol. Karthikeyan S et al,[11] studied the socio-demographic profile of 160 truck and tempo drivers and the prevalence of health problems among them. They reported higher use of tobacco (39% smoke tobacco, 34% used paan, 62% used Chuna, 77% used Gutka) and alcohol (65%) among this population. Many truck drivers think that tobacco is a stimulant and keeps them alert and awake while driving. Alcohol is favored as a substance of ecstasy and recreation to bond with their counterparts. The present study demonstrated that 85% of truck drivers used some of the tobacco products. It has been postulated that altered lifestyle and higher prevalence of tobacco and alcohol use have been associated with obesity, hypertension, and diabetes which in turn increases the likelihood of higher mortality rates among this population.[12]

Tobacco use is a major public health concern in India and its use has been associated with major non-communicable diseases, including oral cancer. It has been estimated that in the year 2011, India had spent close to INR 104,500 crores (US$ 22.4 billion) in private and public spending on tobacco-related illness, which was around 1.14% of its gross domestic product.[13] The Indian government has taken numerous steps to curb the menace caused by tobacco products and the results have also been promising. Compared to the Global Adult Tobacco Survey - 1 (GATS-1) (2009-10), GATS-2 demonstrated a six-point reduction in the overall prevalence of tobacco use and a 17% reduction in current tobacco use. The government envisions, through its National Health Policy to reduce the prevalence of tobacco use by 15% by 2020 and 25% by 2025. As a part of this program, tobacco cessation services are offered to identified risk populations and truck drivers are one such population who need prioritization for cessation services and health care delivery.

Targeted risk group cancer screening programs have always provided positive dividends and have played a vital role in the early identification of lesions. Oral cancer screening programs provide an opportunity to identify potentially

malignant lesions, which, with adequate medical attention and support could delay or prevent malignant transformation. The population-based screening program at Kannur, India had earlier demonstrated the advantages of this program among the Indian population as being cost-effective and able to diagnose cases at an early stage, which in turn had an impact on treatment and patient-survival outcomes.[14] D'Cruz et al conducted a targeted oral cancer screening program among truck drivers in Dhakshina Kannada, India among 964 subjects. Among the screened, 148 (15%) had red/white lesions of which 23 lesions were ulcerated and had indurated borders. Tissue biopsy was performed for these 23 (15.6%; 23/148) suspicious ulcerated lesions of which 2 were confirmed for oral squamous cell carcinoma and 21 (14%; 21/148) had dysplasia.[1] In a study conducted by Choudhury et al in April 2021 among bus drivers from Karnataka, India the prevalence of Leukoplakia and Oral Submucous Fibrosis were 44.92% and 37.68% respectively.[15] The present study was conducted among 747 truck drivers, among whom 49 (6.5%) had red/white lesions. Tissue biopsies were taken for 17 suspicious lesions of which 9 had dysplasia. The difference in the study results could be attributed to the difference in the population and the screening method used. The truck drivers included in this study were from diverse states of India and none were residents of the state from where the study was conducted. Further, our study used toluidine blue staining for screening of oral lesions and subsequently, biopsies were taken for those lesions that stained positive. The authors have demonstrated 88% sensitivity of this technique in an earlier study done among a rural population in Southern India.[16] The study conducted by D'Cruzet et al used exfoliative cytology using the oral rub and rinse technique, which had considerably lesser sensitivity values.[17] Despite these contrasting results, several Cochrane reviews[18] and Indian studies[19] have endorsed the advantages of opportunistic oral screening using visual and tactile examinations for high-risk tobacco and alcohol users for early case detection.

Conclusions

Truck drivers with tobacco and substance abuse are at high risk of developing oral cancer. Periodic oral cancer screening programs for this vulnerable population help to identify potentially malignant oral lesions at an early stage. Clinical and histopathological examination of suspicious oral potentially malignant disorders with appropriate follow-up of truck drivers prevent their progression to oral cancer.

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Original Article

Assessment of knowledge, attitude, and practices of biomedical waste management among health care workers in a tertiary care hospital, Chengalpattu, Tamilnadu, India

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ABSTRACT

Introduction: Bio-medical waste (BMW) means any solid and/or liquid waste including its container and any intermediate product, which is generated during the diagnosis, treatment, or immunization of human beings or animals. Inadequate and inappropriate knowledge of handling healthcare waste may have serious health consequences and a significant impact on the environment. Thus, the study aims to assess the knowledge, attitude, and practice of biomedical waste management among healthcare workers from different strata in the hospital.

Methods: This was a cross-sectional study involving 383 participants conducted between June 2022 to October 2022. A structured, close-ended, self-administrated questionnaire was used to collect the data. The data were analyzed using R studio and presented as frequencies and percentages. The association between different variables was analyzed by the chi-square test.

Results: Most of the doctors (41.3%) and nurses (41.5%) had very good knowledge of Bio-Medical Waste Management (BMWM) but only 23.1% of laboratory technicians and housekeeping staff 18.2% showed very good knowledge. All the participants had a very good attitude (69.2% to 82.6%) towards BMWM but it needs some improvement concerning reporting needle stick injuries and taking post-exposure prophylaxis (PEP). More than 80 % of participants were immunized against Hepatitis B and followed the appropriate practice of BMWM except for wearing adequate personal protective equipment (PPE) while handling BMW. Knowledge and good attitude were observed to increase with experience.

Conclusion: From the study, it is identified that knowledge regarding BMWM is inadequate among the healthcare professions. It is concluded that there should be adequate training among the HCWs about BMWM like video lectures, symposiums, quiz programs, and role play that can help them update their knowledge.

Keywords: Biomedical Waste Management, Health care workers, Knowledge, attitude and practice study, Needle stick injury, Post-exposure prophylaxis.

Introduction

Biomedical Waste Management (BMWM) begins from the initial stage of generation of waste, segregation at the source, storage at the site, and proper disinfection of waste and finally ends at proper disposal of waste.[1] Since health care workers (HCWs) are the first in line in managing biomedical waste (BMW), and all the health care workers irrespective of cadre handle it, everyone in the chain needs to have adequate knowledge of BMWM and appropriate practice concerning the same. Inadequate and inappropriate knowledge of handling of healthcare waste may have serious health consequences on all the people involved in the management of the waste and cause an impact on the environment.[1,2]

The knowledge, attitude, and practices (KAP) of HCWs regarding BMWM play a crucial role in its proper management. Its mismanagement not only affects the hospital personnel but also the general population at large.[3] Many studies have been conducted in different parts of India.[4,5] In a study conducted in Allahabad, India, it was identified that all the hospitals lack periodical training regarding BMWM.[6] The same was observed in a similar study conducted in Saudi Arabia wherein it was found that the training on BMWM is inadequate in many hospitals and it is suggested that HCWs should get trained by different education modules.[7] However, considering the importance of the BMWM, the number of studies conducted is less, and information regarding this should be periodically accessed in different parts of the country regularly.[8] So, it is important to know about the present status of BMWM, that is, the knowledge about it, its attitude towards it, the practices followed, at the grassroots level, and the problems they are facing in the whole process, to bring in appropriate measures to decrease mistakes and their consequence.[9]

This study is conducted to throw light on the sources of errors and mistakes in various aspects of BMWM. The study aimed to assess the knowledge, attitude, and practices concerning BMWM in a tertiary care hospital in the Chengalpattu district of Tamil Nadu.

Methods

This was a cross-sectional study of knowledge, attitude, and practices (KAP). The study was conducted in tertiary care hospital, in Chengalpattu district, Tamil Nadu among doctors, post-graduates, interns, staff nurses, laboratory technicians, and housekeeping staff. The data was collected between June 2022 to October 2022, using a previously validated structured self-administered questionnaire by Basavaraj *et al* and an observational checklist reviewing the literature and international BMW management guidelines.[10] The questionnaire evaluated the socio-demographic information of HCWs, their knowledge related to BMW management, BMW management practices of BMW professionals (HCPs); and their attitudes towards BMW management.

The study was approved by the Institutional Research Committee and Institutional Ethical Committee (SP No 3/July/22). The required sample size was calculated as 383, anticipating a population proportion of 50%, a confidence interval of 95%, and a relative precision of 10% (of 50%).[11] The participants were recruited in the study by a simple random sampling method in which each individual in the sampling frame was assigned a number and selected by an online random number generator.[12] Each participant was given written informed consent mentioned with the purpose of the study and consent was obtained. Respondent confidentiality was maintained using anonymity. All the healthcare workers working in the hospital, who handle biomedical wastes at any level, and have given written consent, were evaluated with the questionnaire included in the study.

The knowledge section contains ten questions, each question has a 'Yes' or 'No' answer option. One mark was assigned for the correct response and zero for the wrong response. Total scoring ranged from 0 to 10. Scores of 0-2 were considered as very poor knowledge, 3-4 as poor knowledge, 5-6 as average knowledge, participants with scores of 7-8 had satisfactory knowledge and 9-10 had excellent knowledge regarding BMWM.

Ten questions were included in the attitude section, and responses to each question were documented on a 5-point Likert scale as follows: strongly agree (5-point), agree (4-point), neutral (3- point), disagree (2-point), and strongly disagree (1-point). The total score ranged from 8 to 50. A score of 10 was considered as a very poor attitude, 11-20 had a poor attitude, 21-30 had an average attitude, 31-40 had a good attitude, and above 41 had a very good attitude towards BMWM.

The practice section comprised 10 items, and each item comprised two responses: Yes (1-point) and No (0-point). Practice items total score ranged from 0 to 10. A score below 2 indicated very poor practice, a score of 3-4 poor practice, 5-6 was average practice, 7-8 was good practice, and 9-10 was very good practice toward BMWM.

The data that was obtained from the questionnaire were entered into Microsoft Excel. These data were analyzed by using RStudio-2023.03.1-446. The descriptive statistics were done in the form of frequencies and percentages. The chi-square test was done to find the association between the categorical variables.

Results

A total of 383 participants were included in this study. The majority of people belonged to the age group 21-30 (75.7%) followed by 31-40 years (12.8 %), 11-20 group (5 %), 41-50 (3.7%) group and above 50 (2.9 %) group. In this study, 244 (63.7%) were females and 139 (36.3%) were males.

Regarding the occupational status of HCWs majority of the participants were doctors who accounted for 281 (73.4%) and 65 (17 %) were nurses, the remaining were laboratory technicians and house-keeping staff with 26 (6.8%) and 11 (2.9%) respectively (Table1).

Table 1: Demographic variables of the participants in Biomedical Waste Management (BMWM)

Demographic variable	Category	Frequency and percentage (N=383)
Age group	11-20	19(5 %)
	21-30	292(76.3%)
	31-40	50(12.8%)
	41-50	11(3 %)
	>50	11(2.9 %)
Gender	Male	139(36.3%)
	Female	244(63.7%)
Category of HCWs	Doctors	281(73.3%)
	Nurses	65(17 %)
	Lab technician	26(6.8%)
	others	11(2.9%)

The study revealed that 80% of nurses had undergone training in BMWM while only up to 50 % of participants belonging to other groups had said they had got training in BMWM. About 65.5% of the laboratory technicians and housekeeping staff did not know how to identify biohazard symbols. People from all the sectors (90-100%) agreed that segregation is the most important aspect of BMWM and followed color coding for segregation. Surprisingly in this study, we found that 95-100% of all the groups agreed that wearing Personal Protective Equipment (PPE) reduces the risk of infection. More than half of the participants (35-45%) from all categories were not aware of the maximum storage time of untreated wastes in the hospital. However, more than 70 % of the participants of all categories knew about the disposal methods (Table 2).

Table 2: Knowledge of the participants in Biomedical Waste Management (BMWM)

SN	Knowledge on BMWM	Doctors (N= 281) %	Nurses (N=65) %	Laboratory Technicians (N=26) %	House-keeping staff (N=11) %	p-value
1.	Have you undergone any training in BMW management?	155.1(55.2%)	53(81.5%)	11(42.3%)	7.9(72.7%)	0.010
2.	Is there any hazard associated with BMW management?	226(80.4%)	43(66.2%)	15(57.7%)	6(54.5%)	0.013
3.	Do you know the symbol for biohazard?	262(93.2%)	54(83.1%)	17(65.4%)	7(63.6%)	0.010
4.	The most important aspect of BMW management is the segregation	274(97.5%)	63(96.9%)	23(88.5%)	11(100%)	0.079
5.	PEP can be taken at anytime	191(68%)	50(76.9%)	21(80.8%)	6(54.5%)	0.194
6.	Do you know about the color coding system for segregation?	269(95.7%)	58(89.2%)	26(100%)	10(90.9%)	0.097
7.	General wastes are to be collected in yellow bin	196(69.8%)	58(89.2%)	18(69.2%)	8(72.7%)	0.015
8.	Wearing PPE reduces the risk of infection	271(96.4%)	61(93.8%)	25(96.2%)	10(90.9%)	0.665
9.	Maximum storage time for untreated waste is 2 days or 48 h	190(67.6%)	25(38.5%)	11(42.3%)	6(54.5%)	0.010
10.	Yellow bag is treated by incineration	230(81.9%)	47(72.3%)	21(80.8%)	6(54.5%)	0.066

In this study, it was observed that doctors and nurses have better knowledge regarding hazards associated with BMW, the importance of BMW segregation and the incineration of biomedical waste than the other HCWs. Among the HCWs 281 (41.3%) doctors and 65 (41.3%) nurses had the very good knowledge category However, only 26 (23.1%) lab technicians and 11 (18.2%) housekeeping had the statistically significant and very good knowledge category ($p<0.05$). (Table 3).

An analysis was done to find out whether experience has any influence on the knowledge of BMWM. The results do not show any statistically significant result ($p>0.05$). (Table 4).

Table 3: Knowledge of HCWs of different strata in Biomedical Waste Management (BMWM)

Occupation	Knowledge					P value
	Very Poor (%)	Poor (%)	Average (%)	Good (%)	Very Good (%)	
Doctor	0	4(1.4%)	32(11.4%)	129(45.9%)	116(41.3%)	0.005
Nurse	1(1.5%)	1(1.5%)	10(15.4%)	26(40%)	27(41.5%)	
Laboratory Technician	0	0	10(38.5%)	10(38.5%)	6(23.1%)	
House-Keeping Staff	0	0	5(45.5%)	4(36.4%)	2(18.2%)	

Table 4: Relation between experience and knowledge

SN	Experience in years	Knowledge Group (%)					p-value
		Very Poor	Poor	Average	Good	Very Good	
1	11-20	0	4(1.1%)	57(15.1%)	173(45.4%)	145(38%)	0.938
2	21-30	0	20(5.3%)	61(15.8%)	101(26.3%)	201(52.6%)	
3	31-40	0	0	43(11.1%)	127(33.3%)	213(55.6%)	
4	41-50	0	0	0	191(50%)	191(50%)	
5	Above 50	0	0	0	0	383(100%)	

The majority of the HCWs thought that BMWM was an important issue. More than 95 % of the participants agreed that BMWM is a teamwork. About 95% of the participants agreed that proper disposal of BMWM prevents infection transmission and in this study, 95 % of the HCWs felt that BMWM should be included in the curriculum and taught to all the people who handle waste. The result shows 82.6% of favorable attitude towards BMWM and 17% shows unfavorable attitude towards BMWM. All of them had very good attitudes towards segregation and color coding and felt that occupational safety is equally important as others' safety. However up to 50 % of participants from all the categories thought that reporting needle stick injury is a work burden (Table 5).

The results further showed that there is no statistically significant ($p>0.05$) difference in the attitude among the different HCWs (Table 6).

Table 5: Attitude of the participants towards Biomedical Waste Management (BMWM)

SN	Attitude of healthcare workers on BMW management	Doctors (N= 281) %	Nurses (N=65) %	Laboratory Technicians (N=26) %	House-keeping Staff (N=11) %
1.	Proper BMW management is an issue	228(81.1%)	59(90.8%)	24(92.3%)	10(90.9%)
2.	Safe BMW management needs teamwork	278(98.6%)	63(96.9%)	26(100%)	10(90.9%)
3.	General public health can be adversely affected by BMW	236(84%)	55(84.6%)	20(76.9%)	9(81.8%)
4	Is needle stick injury/sharp injury a concern	276(98.2%)	64(98.5%)	24(92.3%)	11(100%)
5.	BMW should be segregated at the point of origin	259(92.2%)	59(90.8%)	22(84.6%)	11(100%)
6.	Do you think BMW management and handling should be a compulsory part of the curriculum	270(96.1%)	60(92.3%)	25(96.2%)	11(100%)
7.	Proper BMW disposal can prevent infection transmission	273(97.2%)	59(90.8%)	25(96.2%)	10(96.9%)
8.	Reporting of needle stick injuries is an extra burden on work	168(59.8%)	36(55.4%)	13(50%)	5(45.5%)
9.	Color code bag use for waste segregation is a must	273(97.2%)	59(90.8%)	25(96.2%)	9(81.8%)
10.	For persons involved in BMW handling occupational safety is a must	273(97.2%)	58(89.2%)	25(96.2%)	9(81.8%)

Table 6: Attitude of HCWs of different strata towards Biomedical Waste Management (BMWM)

Occupation	Attitude			p-value
	Average (%)	Good (%)	Very Good (%)	
Doctor	0	49(17.4%)	232(82.6%)	0.208
Nurse	1(1.5%)	15(23.1%)	49(75.4%)	
Laboratory Technician	0	8(30.8%)	18(69.2%)	
House-Keeping Staff	0	2(18.2%)	9(81.8%)	

In this study, we compared the attitude of participants with their experience. It was observed that there is no statistically significant ($p>0.05$) difference in the attitude among the different (Table 7).

More than 70 % of the participants followed appropriate practices according to the BMWM guideline but more than half of them did not wear PPE every time they handled BMW. Up to 75% of the HCWs knew the protocol for reporting needle sticks or sharp injuries and followed Post post-exposure prophylaxis (PEP) after needle stick injury. More than 80 % of them had been immunized against Hepatitis B. Close to 55 % of the participants did not know how to prepare 1 liter of 1% sodium hypochlorite solution from available 5% strength (Table 8). By comparing the greater number of studies best practices was noted in nurses, followed by housekeeping, doctors and lab technician.

Table 7: Relation between experience and attitude

S.N.	Experience in years	Attitude Group (%)			p-value
		Average	Good	Very Good	
1.	11-20	1(0.3%)	4(20%)	15(79.7%)	0.966
2.	21-30	0	31(10.5%)	261(89.5%)	
3.	31-40	0	11(22.2%)	39(77.8%)	
4.	41-50	0	0	11(100%)	
5.	Above 50	0	0	11(100%)	

Table 8: Practice of Biomedical Waste Management (BMWM) of the participants (N= 384)

SN	Questions on Practice of BMWM	Practice		
		Always (%)	Sometimes (%)	Never (%)
1.	Do you wear PPE while handling BMW?	157(41%)	183(47.8%)	44(11.2%)
2.	Do you segregate BMW at the point of into different categories?	286(74.7)	79(20.6%)	18(4.7%)
3.	Do you use puncture-proof plastic containers to collect waste sharps?	291(76%)	72(18.8%)	20(5.2%)
4.	Do you follow color coding for the segregation of waste?	343(89.6%)	37(9.7%)	3(0.8%)
5.	Do you maintain a record for BMW at the point of origin?	222(58%)	104(27.2%)	57(14.9%)
6.	Do you have a system for reporting injuries and accidents?	284(74.2%)	79(20.6%)	20(5.2%)

SN	Questions on Practice of BMWM	Practice		
		Always (%)	Sometimes (%)	Never (%)
7.	Have you been immunized against Hepatitis B?	315(82.2%)	32(8.4%)	34(8.9%)
8.	Do you follow PEP after needle stick injury or percutaneous injury?	305(79.6%)	66(17.2%)	12(3.1%)
9.	Do you put non-infectious wastes in black containers?	170(44.6%)	93(24.3%)	119(31.1%)
10.	Do you know the method to prepare 1 L of 1% Sodium hypochlorite from available 5% strength?	168(43.9%)	90(23.5%)	126(32.9%)

Discussion

This study was conducted to assess the knowledge, attitude, and practice of Biomedical Waste Management among health workers, in a tertiary care hospital, in Chengalpattu, Tamilnadu.

BMWM at any level is always a team work and it involves common and clear goals and coordination among HCWs of all the strata. However, the knowledge about BMWM and training given to HCWs of different strata are significantly different. This makes it difficult to bring coordination among all HCWs in managing BMWs. Therefore, by evaluating the knowledge, attitude, and practice concerning BMWM across different strata of HCWs, the points of mismanagement can be brought into light easily and, appropriate and efficient strategies to correct them can also be devised.

Many studies regarding BMWM in India have given information on the magnitude of the lack of adequate knowledge and appropriate practices among HCWs due to lack of awareness and improper implementation, but there is less information on the points of mismanagement.[9,10,13] In the wake of the COVID-19 pandemic, the BMW generation has been skyrocketing which adds to the already existing burden of waste management. Improper BMWM not only increases the transmission of infections like HIV, HBV, HBC, etc. but also pollutes air, water, and soil.[13] There is a lack of awareness about rules which reflects in inadequate and improper BMWM.[14]

Knowledge about biomedical waste management rules among doctors and nurses was high but was low among housekeeping staff. It was similar to the study where nurses had more training than other groups.[15] Similarly, 30% of participants from all the strata were not clear about the color coding of containers and waste segregation. This is in contrast with the study conducted where all the participants had very good knowledge about it.[10] Half of the participants from all categories were not aware of the maximum storage time of untreated wastes in the hospital. This was in contrast with the study where participants from all categories knew about the storage time.[15] This warrants proper training, evaluation, and periodic retraining of all the HCWs irrespective of their cadre.

This study assessed the knowledge attitude with their experience of HCWs of different strata and showed more experience gives more knowledge. In an overall view, the attitude of the participants was satisfactory but needs improvement in some areas. It is appreciable that more than 95 % of them thought BMWM was teamwork and felt it was important to teach it to everyone. In this study, we compared the attitude of participants with their experience, among them 100% of the people with more than 30 years of experience had a very good attitude.

As far as practices are concerned, 70% of the participants followed appropriate practices according to the BMWM guideline. The study showed that 70-80 % of the participants followed appropriate practices in case of segregation of BMW and reporting of needle stick injuries. This is better than the results of the study conducted in

West Bengal where only 52.8 % of the participants followed segregation before disposal.[16]

However, it is alarming that 50 % of participants of all strata thought reporting needle stick injury is a burden. It differed from the study wherein all of the participants except doctors and most of the nurses felt that it was a burden.[17,18] Many such injuries might not be reported or underreported due to this attitude. Interventions should be made to make the protocol of reporting needle stick injury less cumbersome and simpler to all the HCWs and appropriate PEP must be made available to them as soon as possible.

It can be observed that 50 % of participants did not maintain BMW records. Measures to incorporate record maintenance are imperative to ensure timely clearance of the wastes and reduction of infection transmission. Also, 56 % of the people did not know the method to prepare 1 liter of 1 % sodium hypochlorite solution with available 5 % strength. This percentage is less than the one shown in the study where all the nurses and more than 70 % of the other groups knew the preparation of 1 liter of 1 % sodium hypochlorite.[10]

Strict and supportive supervision by the Hospital Infection Control Committee of the process is required to pick up ignorance and unreported wrong practices among HCWs of all levels. The committee is expected to, give standard operating protocol concerning BMWM and reporting of needle stick injuries, and conduct training programs on BMWM. This is a proven fact because facilities that have separate BMWM committees have shown effective BMWM and, fewer sharp and needle stick injuries.[19,20]

The studies have stated that increasing awareness about the hazards associated with improper BMWM paired with regular training of all HCWs on BMWM, is the key to moving towards a more efficient BMWM.[10,18] Appropriate educational programs and strict execution of BMWM guidelines help to bridge the above-stated gap between knowledge and implementation.[18] Periodic well-structured training, followed by evaluation and retraining is the sole strategy to cut down on improper BMWM.[21] Structured training helps to increase participation and also makes it easier for the participant to learn the concept and its importance in less time.[22, 23, 24]

Conclusions

From the study, we were able to get a detailed insight into various aspects of BMWM among HCWs in this tertiary care hospital. We can conclude that the participants have adequate knowledge about the color coding system and segregation but need more training on the same and the related aspects like needle sick injury, PEP, storage of BMW, and its disposal. This is required more among the laboratory technicians and housekeeping staff as their knowledge is comparatively less and also, they handle BMW more frequently than doctors and nurses. It is concluded that there should be adequate training among the HCWs about BMWM like video lectures, symposiums, quiz programs, and role play that can update their knowledge.

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Original Article

Prevalence and determinants of sickness absenteeism among healthcare workers in a tertiary hospital in southwestern Nigeria

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ABSTRACT

Introduction: Sickness absenteeism is a global problem that affects almost all forms of workers, especially healthcare workers. This study assessed the prevalence and determinants of sickness absenteeism among healthcare workers in a tertiary hospital in Southwest, Nigeria.

Methods: An institutional-based, cross-sectional study was conducted among 360 healthcare workers in a Tertiary Hospital in Southwest, Nigeria from October to December 2022. A pre-tested interviewer-administered, semi-structured questionnaire was used to elicit information from the respondents who were selected using a stratified sampling technique. Bivariate analysis and binary logistic regression analysis were performed to identify the predictors of sickness absenteeism using SPSS version 25.0. The significance of associations was determined at p-value < 0.05.

Results: The mean age ± SD of the respondents was 34 ± 7.15 years. The prevalence of sickness absenteeism among the health workers was 21.0%, while the causes of sickness absenteeism were malaria (51%), body pain (18%), and diarrhea (5%). Family obligation (AOR: 2.1, 95% CI: (1.20, 3.53), P=0.009) and the job type (AOR: 2.7, 95% CI: (1.05, 6.83), P=0.038) were the only predictors of sickness absenteeism.

Conclusion: About one-fifth of the respondents had one spell of sickness keeping them away from work due to illnesses such as malaria, diarrhea, and body pain. Preventive interventions should be instituted by stakeholders based on the identified factors to reduce the prevalence of sickness absenteeism among these populations.

Keywords: Determinants, Healthcare workers, Nigeria, Prevalence, Sickness absenteeism

Introduction

Work absenteeism occurs when an employee does not show up at work as expected which may be due to any cause.[1] Absence from work due to illness/disease is called sickness absenteeism (SA).[1] According to the International Labour Organization (ILO) sickness absenteeism results when an employee does not show up for work for a period of one or more days (or shifts) when assigned for a day of work.[2] Globally, the ILO estimates that some 2.3 million individuals are affected by work-related accidents or diseases every year; this corresponds to over 6000 deaths every day.[3] Sickness absence is an employee's indicator of individual health and well-being and his potency to work, hence it is a major public health issue.[1,4,5] It is a growing global occupational

health problem that interferes with productivity, service quality, and the workload of other employees.[4,6] Absenteeism is associated with extra costs, discontinuity of service, loss of productivity and other economic effects that result in increased expenditure to the employee, employer and the government at large.[4,6] Absenteeism is a growing problem among the healthcare workforce.[7] Healthcare workers (HCWs) form a critical element for the efficient delivery of quality health services to a community.[8] HCWs are exposed to various health hazards, including the risk of contracting various infectious diseases, in their occupational settings.[8] Health problems in HCWs could adversely impact productivity, work efficiency, patient safety and quality of patient care.[8]

Sickness absenteeism can be scheduled (planned leave and approved leave examples are annual leave and maternity leave) or unscheduled (unplanned leave examples are sick days, disability, or workers compensation leave and partial shift absences).[9,10] It can also be short-term SA (<4 days absence) or long-term SA (≥4 day absence).[1] Short-term SA are caused by mild to moderate, less serious illnesses while more serious illness usually causes long-term SA.[1]

Increasing rates of SA have been reported among health professionals because of the nature of the caring professions, adverse working conditions, long working hours, decreased autonomy and insufficient support from their colleagues and supervisors.[11] Estimates suggest that around 7% of healthcare workers experience at least one sick leave episode per week.[12] Hence the study aimed to investigate the prevalence and determinants of sickness absenteeism among healthcare workers in a tertiary hospital in Southwestern Nigeria.

Methods

An institutional-based, cross-sectional study design was done among healthcare workers in Ekiti State University Teaching Hospital (EKSUTH), Ado-Ekiti, Nigeria over two months (October to December 2022). The Hospital had the following departments: Community Medicine, Internal Medicine, Surgery, Obstetrics and Gynecology, Pediatrics, Dental, Ear, Nose and Throat, Mental Health, Family Medicine, Anesthesiology, Physiotherapy, Accident and Emergency, Radiology, Ophthalmology, Nursing, Laboratory, Maintenance among others. The Hospital during the study period comprised about 1,350 healthcare workers which included 205 Doctors, 320 Nurses and 50 Laboratory Scientists, 146 health assistants, 56 administrative officers and others.

The study population was the HCWs in Ekiti State University Teaching Hospital, Ado-Ekiti (EKSUTH). The study included all HCWs (6 Strata: Doctors, Nurses, Laboratory scientists, Health Assistants, Administrative Officers and others) aged 18 years and above, who gave informed consent and were gainfully employed and working for at least 6 months at EKSUTH, Ado Ekiti. However, the study excluded HCWs who were on annual leave or those posted outside the Hospital during the period of study.

The sample size was determined using Fisher's method, $n = Z^2pq/d^2$

where,

n = minimum sample size;

Z = standard normal deviate at 95% Cl = 1.96;

p = Prevalence of sickness absenteeism (54.6%) among health workers from a previous study done in Benin City, Nigeria;[13]

q = complimentary probability = 1-p;

d = acceptable margin of error estimated (5%)

n = 380.9 ≈ 381

For a population less than 10,000, final sample estimate will be calculated using

$N_1 = n/(1+n/N)$[14]

where

N_1 = desired sample size when pop < 10,000,

n = desired sample size when pop >10,000,

N = estimated population size = 1350

$N_1 = 381/(1+381/1350) = 297.19 \approx 300$

Considering a non-response rate of 10%, a sample size of 330 was arrived at, however, 360 healthcare workers were sampled for the study.

The sampling technique adopted was a stratified

sampling technique in which the HCWs were grouped into 6 strata, and a proportional allocation was used to determine the number of participants chosen from each stratum. At the level of the stratum, a list of HCWs in different groups was collected from the Hospital registry and then a systematic random sampling was used to select participants. Hence the sample interval was derived from the total population of the group divided by the desired sample size. Afterward, the first respondent was selected by simple random sampling using the table of random numbers, and using the sample interval the subsequent participant was chosen till each desired sample size was reached for each stratum.

A pretested, 46-item, semi-structured interviewer–administered, adapted questionnaire,[5,15,16] was used with sections 1-4 which included socio-demographic characteristics, the prevalence of sickness absenteeism, causes of sickness absenteeism and workplace factors respectively. Questions on the prevalence of sickness absenteeism in the past 6 months were asked to reduce the recall bias. A reliability test (Cronbach alpha = 0.72) and face and content validity were done by an occupational health expert. Six trained research assistants distributed and collected the questionnaire from the selected eligible participants.

The study variables were independent and dependent. Independent variables include socio-demographic characteristics (age, gender, marital status, health status, and educational level) and workplace /institutional factors (routine of work, job satisfaction, health worker autonomy, workload, employment sector, facility location, teamwork, and size of the organization, absence policy, accommodation, remuneration, and the work conditions) while the prevalence of sickness absenteeism among health workers and the type of diseases causing sickness absenteeism (SA) were the dependent variables.

Data collected was checked on the field by selected supervisors to avoid missing or incomplete data. Data entry and analysis was done using SPSS version 25.0. Descriptive analysis was done by presenting data in frequency tables, charts, percentages, and summary statistics. Bivariate analysis (Chi-square test) and binary logistic regression analysis were performed to identify the predictors of sickness absenteeism. Odds ratio with 95% CI was generated and the significance of associations was determined at *p*-value ≤0.05.

The ethical clearance was obtained from the Research Ethics Committee (EKSUTH/A67/2022/10/003), and the respondents were informed about the research objective and protocols. Both written and verbal informed consent were taken while confidentiality was maintained.

Results

There was a total of 360 participants, half of the respondents (50%) were aged between 30-39 years, with a mean age of 34 ± 7.15 years. The majority of the respondents (59.7%) were female, Christians (87.2%), married (65.8%) and had tertiary education (74.2%) and about two-thirds (62.5%) of the respondents had 1-4 children. Regarding the other personal factors relating to sickness absenteeism about two-thirds of the respondents (65.6%) have had minor physical ailments in the past, while only a few (6.9%) have had chronic conditions. About two-thirds of the respondents (69.2%) have families to look after. About half of the respondents (46.4%) had high family obligations. Furthermore, about one-third of the respondents (34.4%) had high psychological stress while about half (48.3%) had high financial stress.

In addition, the occupational factors of the respondents revealed that about two-thirds of the respondents (64.6%) were permanent staff while the remaining one-third (36.4%) were casual staff. Furthermore, the respondents were a mix of different occupations- doctors (15%), nurses (20.3%), health assistants (11.1%), laboratory technicians (8.3%), administrative officers (4.4%) and others (40%) included tailor, pharmacist, plumbers, engineer, and electrician. About half of the respondents (55.6%) had worked for 1-5 years and three-quarters of participants (76.1%) worked

1-8 hours per day. The majority of the respondents have had both pre-employment (77.8%) and period medical examination (59.4%) done in the past. Also, about three-fourths (72.8%) of the respondents had shift duties or call duties however, slightly above half of the respondents (56.4%) had flexible work schedules.

As shown in Figure 1, the prevalence of sickness absenteeism among the respondents was 21%. A large proportion of the respondents were absent from work through illnesses such as malaria (51%), body pain (18%), and diarrhea (5%) as shown in Figure 2.

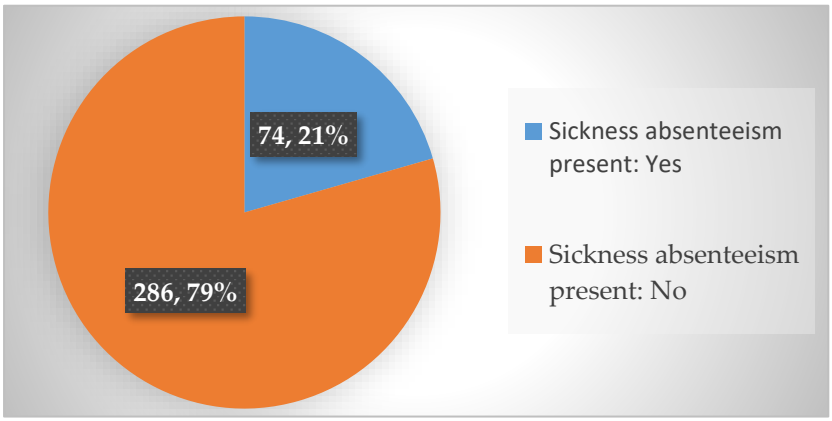

Figure 1: Prevalence of sickness absenteeism among tertiary health workers in Southwestern, Nigeria (n=360)

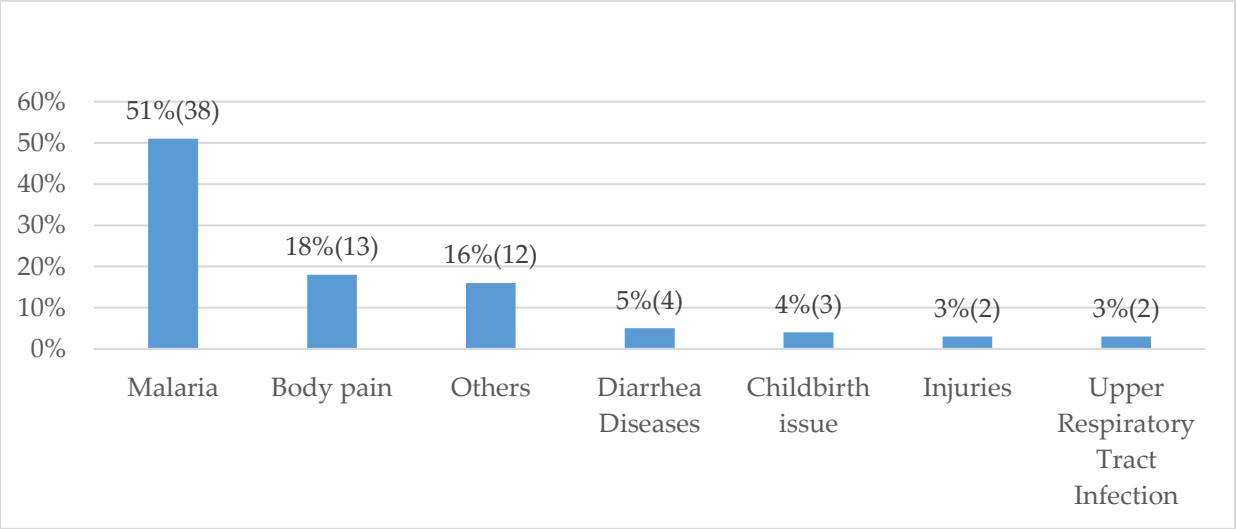

Figure 2: Common causes of sickness absenteeism among tertiary health workers in Southwestern Nigeria (n=74).

Table 1 shows the relationship between the socio-demographic characteristics of the study participants and the prevalence of sickness absenteeism. Family obligation was the only statistically significant factor (p=0.011), associated with sickness absenteeism, while the other factors were not statistically significant.

The bivariate analysis between the occupational factors and the prevalence of sickness absenteeism was revealed in Table 2. The only statistically significant factor was job type with p=0.011. However, all other factors were not statistically significant.

Table 1: The relationship between socio-demographic/personal factors and prevalence of sickness absenteeism among tertiary healthcare workers in Southwestern Nigeria (n=360)

Variable (n=360)	Yes (n=74)	No (n=286)	Total (%)	X^2	p-value
Age group (in years)					
20-29	22(20.4)	86(79.6)	108(30.0)	0.528*	0.913
30-39	38(21.1)	142(78.9)	180(50.0)		
40-49	13(20.6)	50(79.4)	63(17.5)		
50 and above	1(11.1)	8(88.9)	9(2.5)		
Gender					
Male	31(21.4)	114(78.6)	145(40.3)	0.101	0.751
Female	43(20.0)	172(80.0)	215(59.7)		
Marital status					
Single	20(16.8)	99(83.2)	119(33.1)	3.426*	0.180
Married	52(21.9)	185(78.1)	237(65.8)		
Separated/Divorced	2(50.0)	2(50.0)	4(1.1)		
Highest level of Education					
Primary	0(0.0)	1(100.0)	1(0.3)	3.595*	0.464
Secondary	14(23.7)	45(76.3)	59(16.4)		
Tertiary	50(18.7)	217(81.3)	267(74.2)		
Post-graduate	9(29.0)	22(71.0)	31(8.6)		
Others	1(50.0)	1(50.0)	2(0.5)		
Number of children					
0	23(17.4)	109(82.6)	132(36.7)	2.071*	0.558
1-2	29(24.2)	91(75.8)	120(33.3)		
≥3	22(20.4)	86(79.6)	108(30.0)		
Family obligation					
High	44(26.3)	123(73.7)	167(46.4)	6.399	**0.011****
Low	30(15.5)	163(84.5)	193(53.6)		
Working two jobs					
Yes	18(25.0)	54(75.0)	72(20.0)	1.089	0.297
No	56(19.4)	232(80.6)	288(80.0)		
Psychological stress					
Yes	31(25.0)	93(75.0)	124(34.4)	2.288	0.130
No	43(18.2)	193(81.8)	236(65.6)		
Financial stress					
Yes	39(22.4)	135(77.6)	174(48.3)	0.712	0.399
No	35(18.8)	151(81.2)	186(51.7)		

*LR=likelihood ratio, **Statistically significan

Table 2: The relationship between occupational factors and prevalence of sickness absenteeism among tertiary healthcare workers in Southwestern, Nigeria (n=360)

Variable (n=360)	Yes(n=74)	No (n=286)	Total (%)	X^2	p-value
Job type					
Doctors	17(31.5)	37(68.5)	54(15.0)	14.931*	**0.011****
Nursess	6(8.2)	67(91.8)	73(20.3)		
Health Assistant	10(25.0)	30(75.0)	40(11.1)		
Laboratory technicians	10(33.3)	20(66.7)	30(8.3)		
Administrative officers	2(12.5)	14(87.5)	16(4.5)		
Others	29(19.7)	118(80.3)	147(40.8)		
Number of Years of service					
1-5	45(22.5)	155(77.5)	200(55.6)	5.950*	0.203
6-20	29(19.0)	124(81.0)	153(42.5)		
>20	0(0.0)	7(100.0)	7(1.9)		
Working hour per day					
1- 8 Years	57(20.8)	217(79.2)	274(76.1)	0.043	0.836
Above 8 Years	17(19.8)	69(80.2)	86(23.9)		
Pre-employment check-ups					
Yes	55(19.6)	225(80.4)	280(77.8)	0.643	0.423
No	19(23.8)	61(76.3)	80(22.2)		
Periodic medical check-up					
Yes	44(20.6)	170(79.4)	214(59.4)	0.000	0.998
No	30(20.5)	116(79.5)	146(40.6)		
Shift duty or call duty					
Yes	60(22.9)	202(77.1)	262(72.8)	3.242	0.072
No	14(14.3)	84(85.7)	98(27.2)		
Work schedule					
Flexible	38(18.7)	165(81.3)	203(56.4)	0.961	0.327
Rigid	36(22.9)	121(77.1)	157(43.6)		
Workload at work					
High	27(22.3)	94(77.7)	121(33.6)	2.988*	0.224
Moderate	43(18.8)	186(81.2)	229(63.6)		
Low	4(40.0)	6(60.0)	10(2.8)		
Physical working environment					
Supportive	60(22.1)	212(77.9)	272(75.6)	1.540	0.215
Unsupportive	14(15.9)	74(84.1)	88(24.4)		

*LR=likelihood ratio, **Statistically significant

Table 3 revealed that among the job types, nurses were the only significant predictors of sickness absenteeism (AOR: 2.7, 95% CI: (1.05, 6.83), P=0.038). Sickness absenteeism was 2.7 times higher among nurses than any other tertiary HCWs.

Similarly, high family obligation was also a significant predictor of sickness absenteeism (AOR: 2.1, 95% CI: (1.20, 3.53), P=0.009). HCWs who had high family obligations were 2.1 times more likely to experience sickness absenteeism than other HCWs.

Table 3: Binary logistic regression analysis of the determinants of sickness absenteeism among tertiary healthcare workers

Factors	Adjusted OR (95% Confidence Interval)	p-value
Job type		
Doctors	0.5(0.26-1.06)	0.074
Nurses	2.7(1.05-6.83)	**0.038****
Health Assistant	0.8(0.35-1.84)	0.600
Laboratory technicians	0.4(0.18-1.02)	0.056
Administrative officers	1.8(0.38-8.30)	0.471
Others	1	
Family obligation		
High	2.1(1.20-3.53)	**0.009****
Low	1	

**Statistically significant

Discussion

This study assessed the prevalence and determinants of sickness absenteeism among HCWs, so that preventive intervention may be recommended. A large proportion of the respondents had tertiary education which showed that the respondents were enlightened enough to contribute their informed opinion to the study.

This study revealed that about one-fifth of the respondents (21.0%) experienced sickness absenteeism. This finding is slightly higher than that of a study by Al-Shammari, et al., in Saudi Arabia which revealed sickness absenteeism prevalence of 16% and 9% for both contract and non-contract healthcare workers respectively.[17] Although, the two studies used a cross-sectional study design, the prevalence in this present study was over 6 months as compared to the 2 years used by the other study.[17] However, a study by Lar, et al., in Plateaus State, Northern Nigeria revealed a sickness absenteeism prevalence of 28.7% among healthcare workers.[18] Additionally, another study carried out in a tertiary hospital in Ethiopia showed that the majority, 52.6% of the workers were absent during the preceding year.[19] The low absenteeism prevalence in this present study relative to these studies may be because healthcare workers are better informed about how to maintain their health and are therefore less likely to fall ill. Working in a health institution also allows for early treatment of diseases before they become severe enough to prevent one from working. This might also be due to the issue of underreporting due to fears of administrative sanctions. There is usually an internal arrangement among these workers in which they cover up for each other when one is absent.

The main causes of sickness absenteeism in this study were malaria (51%), body pain (18%), diarrhea disease (5%) and childbirth issues (4%). This finding was consistent with studies by Mekonnen, et al.,[19] and Johnson, et al.[20] which

showed that the causes of spells of sickness absenteeism were malaria, musculoskeletal issues, childbirth issues/maternity leave and diarrhea.[19,20] These similarities may have occurred because the study areas were similar (sub-Saharan African countries). In contrast, a study carried out in Benin[13] among hospital staff had a different finding which revealed that family problems accounted for 18.7%, attendance at examinations 12.7%, marriages and burials 5.2% and transportation problems 1.2% of absenteeism within the previous year.[13] Similarly, research carried out in Jos State Specialist Hospital revealed that family responsibilities, attending to sick family members, and working long hours were the major factors that contributed to absenteeism.[18] In our study, illness was the major contributory factor to absence from the workplace, which affected employees' ability to work effectively. Generally, the worker while playing the sick role is required to take time off to rest and receive treatment.

In this study, high family obligation was a significant predictor of sickness absenteeism prevalence as it showed a significant positive relationship. This might be due to the workload of providing basic needs (such as food, housing, clothing), high financial stress with increasing family dependents also coupled with high workload demand at work, all of which could result in sickness/injury and consequently absence from work. This is similar to a study conducted in a State Hospital in Plateau State in which parental responsibilities showed a positive correlation with sickness absenteeism.[18] In contrast, a study carried out in South Africa, revealed there was no significant relationship between family obligation and sickness absenteeism.[21] Most studies reported that SA was more prevalent in females than males.[19,22,23] However, our study revealed no significant relationship between gender and SA prevalence which was not statistically significant. This was similar to a study done in Tehran and Bangladesh[1,16] which showed that among health workers no significant difference in SA rates between men and women.

In this study, job type showed a positive significant relationship with sickness absenteeism. The nurses were more likely to be absent from work than other HCWs which could have resulted from the complexity and stressful nature of their work. This can result in illnesses/diseases, and consequently absence from work which might be due to extra responsibility for relatively more educated and skilled workers in an era of brain drain, as also suggested by other studies.[1,22] Similarly, Mollazadeh, et al., revealed that job type was the only factor that had a significant correlation with sickness absenteeism.[1] Similarly, Kivimaki, et al., found that physicians had lower rates of short-term and long-term sickness absence compared to the nurses in Finland.[24] In contrast, a study in the United Kingdom by Ritchie, et al., reported that medical staff and auxiliary staff had the highest rates and duration of absence.[22]

Recall bias could have occurred while taking the history of sickness absenteeism, however, the period of recall was shortened to six months to reduce it.

Conclusions

This study concluded that about one-fifth of the respondents had one spell of sickness due to illnesses such as malaria, diarrhea, and body pains, which were the most common cause of sickness absenteeism from work. Furthermore, the two significant factors associated with sickness absenteeism were high family obligations and job type (commoner among nurses). Based on the results of this study, it is essential to proffer the following recommendations to foster positive change toward sickness absenteeism among health workers and hospital management. Regular assessment of absenteeism and its prevention should be carried out by hospital management. Due attention must be accorded to certain occupations (nurses) in terms of the prevention and early treatment of sickness and injuries.

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