International Journal of Occupational Safety and Health

ISSN: 2091-0878 (Online) ISSN: 2738-9707 (Print)

Original Article

Work-related injuries and stress among iron and steel fabrication workers in Bhubaneswar, Odisha: A cross-sectional study

Parimita P[1], Debata I[2], Nayak S[2], Behera BK[2]

[1]Dharanidhar Medical College and Hospital, Keonjhar, Odisha 758002, India

[2]Kalinga Institute of Medical Sciences, Kushabhadra Campus, 5, KIIT Rd, Bhubaneswar, Odisha 751024, India

Corresponding author:

Ipsita Debata,
Associate Professor, Department of Community Medicine, Kalinga Institute of Medical Sciences, Kushabhadra Campus, 5, KIIT Rd, Bhubaneswar, Odisha 751024.
Tel.: +91 9972483237,
E-mail: drdebataipsita@gmail.com
ORCID: https://orcid.org/0000-0002-8012-2811

Date of submission: 08.11.2023
Date of acceptance: 07.08.2024
Date of publication: 01.10.2024

Conflicts of interest: None
Supporting agencies: None
DOI:https://doi.org/10.3126/ijosh.v14i4.59821

ABSTRACT

Introduction: Any personal injury or death due to an occupational accident is classified as an occupational injury by the International Labor Organization. The metal fabrication work in automotive, aerospace, and electronic manufacturing industries can be physically and mentally exhausting. Limited research is available on work-related injuries and stress among iron and steel fabrication workers in Odisha. This study was conducted to determine the prevalence of work-related injuries, the associated risk factors, and the stress levels among the iron and steel fabrication workers in Bhubaneswar city.

Methods: A cross-sectional study was done from November 2020 to June 2022 in eligible and consenting iron and steel fabrication workers, selected by multistage random sampling. Data was collected by a pretested questionnaire and the Workplace Stress Scale. Data was analyzed using IBM Statistical Package for Social Sciences v23. Descriptives, chi-square test, and logistic regression were used for interpretation. A p-value < 0.05 was considered statistically significant.

Results: Out of 386 male workers, the majority (80.83%) were 18-40 years old. Around 76.33% had at least one episode of injury in the past year. Injury to fingers (79.33%) was most common. The most common type was cuts (80.33%) and the major source was handheld tools (81%). Marital status, education, occupation, and work conditions were significantly associated with injury (p = 0.001). Around 39.39% had severe stress levels.

Conclusion: We identified the hazardous working conditions increasing the risk of injury among workers. Creating awareness regarding safety measures can avert such injuries.

Keywords: Iron and steel workers, personal protective equipment, Work-related injuries, Work-related hazard, Workplace Stress Scale

Introduction

Any personal injury, illness, or death brought on by an occupational accident is classified as an occupational injury by the International Labour Organization. These injuries could be non-fatal or fatal (if the victim passes away within a year of the accident).[1] In 2021 alone, seven accidents were

reported on average each month in India's manufacturing sectors, resulting in the deaths of over 162 people. Most of the victims are low-wage workers or immigrants, whose families cannot afford to hire an attorney to defend them.[2]

Large plants, heavy machinery, and transportation of substantial amounts of material make the steel and iron industries inherently dangerous. High levels of noise, temperatures as high as 1,800°C, vibration, corrosive or toxic substances, airborne pollutants that can be breathed, chemical hazards like fumes and vapors, and a high rate of occupational injuries are all present for workers.[3] Injuries to the eyes are caused by welding arc rays and metal chips in the steel industry. Mild to severe ocular injuries may pose a threat to one's vision.[4]

Because iron and steel manufacturing processes, material handling, and other associated functions are so complex, workers in these industries are more likely to suffer nonfatal illnesses and injuries.[5] Workplace injuries negatively impact a worker's standard of living by adding to their ever-increasing burden. These wounds, whether they are transient or permanent, have a detrimental psychological effect on the person.[6,7] The World Health Organization (WHO) states a healthy workforce and a positive work environment as two of a country's most valuable resources. Furthermore, a healthy workplace has a positive impact on the economic development of any nation by raising productivity, enhancing the quality of products, motivating employees, increasing job satisfaction, and improving the general standard of living for workers and society.[8]

Studies on the working conditions and work-related injuries among the city's iron and steel fabrication workers, as well as those elsewhere in the state of Odisha, have not been conducted. Hence this study was conducted to determine the prevalence of work-related injuries, the associated risk factors, and the stress levels among the iron and steel fabrication workers in Bhubaneswar City, Odisha.

Methods

This cross-sectional community-based study was carried out by the Department of Community Medicine, Kalinga Institute of Medical Sciences, among adult male workers of iron and steel fabrication workshops in Bhubaneswar from November 2020 to June 2022. Ethical clearance was obtained from the Institutional Ethical Committee (ref. no. KIMS/KIIT/IEC/455/2020). Based on a study by Berhan E, taking the prevalence (p) of work-related injuries as 64.57%, at 5% of absolute precision (d) and 95% of the desired confidence level, the sample size was calculated using the formula n= Z2pq/d2 (where n: sample size, Z= 1.96 at 95% CI, q=1-p). An additional 10% of the sample was added to adjust attrition.[9] The final sample size was 386. Consenting male workers, > 18 years old, working in iron and steel fabrication units for a minimum of one year, and who have been employed permanently were included in the study. The Bhubaneswar Municipal Corporation (BMC) has divided Bhubaneswar into three geographical zones (North, South East, and South West).[10] Multistage random sampling technique was applied to select a total of nine fabrication workshops (three from each zone). The eligible workers were selected from these workshops by proportional allocation using the random table method (199 workers from the North zone, 91 workers from the South East zone, and 96 workers from the South West zone). The data was collected in the waiting room of the factory during the break hours of the workers. The time and place were pre-decided in collaboration with the factory supervisors. Data on socio-demographic details, comorbidities, work conditions, and work-related injuries were collected by a pretested and semi-structured questionnaire. The level of stress among these fabrication workers was assessed using The Workplace Stress Scale, which was developed by The Marlin Company, North Haven, CT, and the American Institute of Stress, Yonkers, NY. It is a self-report scale to measure the level of workplace stress at workplace. It consists of eight items that measure workplace stress as low, mild,

moderate, severe, and potentially dangerous levels based on a 5-point Likert scale.[11] The collected data was compiled and analyzed using IBM Statistical Package for Social Sciences v23. Categorical data was interpreted in frequencies and percentages and the chi-square test was used to measure association. The binomial logistic regression was applied by categorizing the dependent variable into 'Injured' and 'Not Injured'. A p-value < 0.05 was considered statistically significant.

Results

Out of 386 sampled male workers, 312 (80.83%) belonged to 18-40 years of age. Around 159 (41.19%) had studied till high school, 228 (59.07%) workers were semi-skilled, 194 (50.26%) were single and the majority, 374 (96.9%) were Hindu by religion. Around 57.25% of workers had work experience between 1-5 years, followed by 42.23% with work experience of 6-10 years.

In this study, the prevalence of at least one work-related injury in the past year was 77.72%.

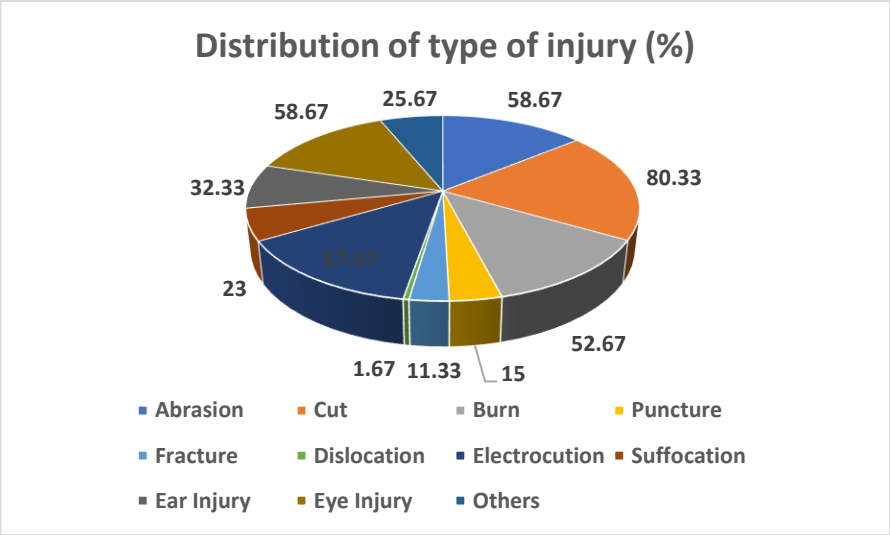

Fig 1: Distribution of type of injury in the workers

Around 229 (76.33%) workers had a work-related injury in more than one incident. The body parts of iron and steel fabrication workers with the highest frequency of work-related injuries were their fingers (238, 79.33%), hands (217, 72.33%), and eyes (176, 58.66%). The least affected body parts were the chest, tooth, and upper leg, as seen in 6% (18), 4.33% (13), and 4 % (12) of workers respectively. The most frequent injury types were cuts (241, 80.33%), abrasions (176, 58.67%), and electrocution (173, 57.67%). None of the workers reported any instances involving poisoning or amputations. The different types of injury have been depicted in Figure 1.

Handheld tools accounted for 81% (243) of the total injuries, followed by injuries due to splintering objects (187, 62.33%) and electrical shock (178, 59.33%). The different sources of injury are depicted in Figure 2.

Among the workers, 62.17% (240) reported having a musculoskeletal disorder, 12.9% (50) had diabetes mellitus, 12.69% (49) had hypertension, and 6.99% (27) had trouble sleeping. According to this study, workers between the ages of 18 and 40, having single marital status, Hindu by religion, and who had finished their high school education were more likely to sustain injuries. The association was also statistically significant as depicted in Table 1.

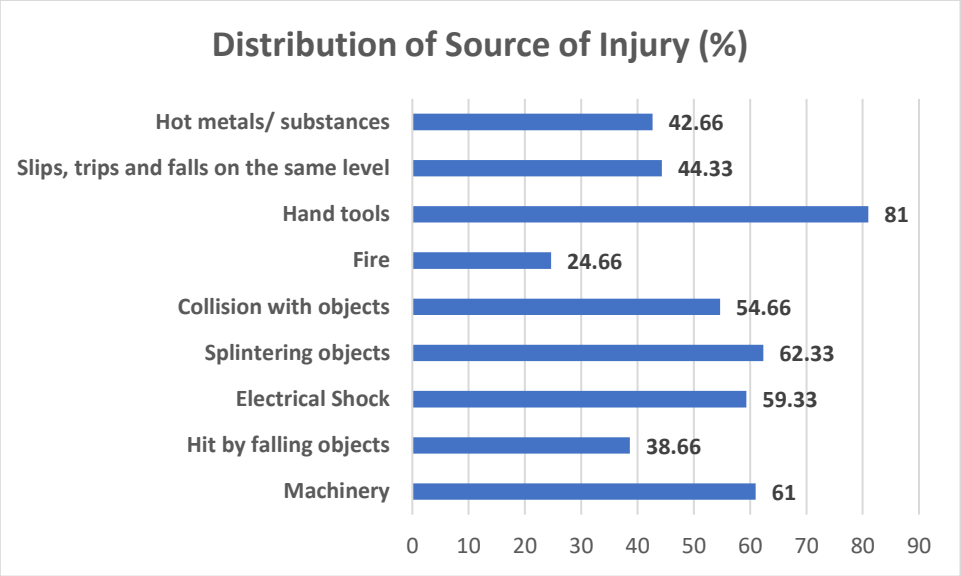

Fig 2: Distribution of sources of injury in the workers †

†Multiple responses

Table 1: Association between injury and socio-demographic profile of the study participants

Variables	Injured (n=300) N [%]	Not injured (n=86) N [%]	Chi-Square (p-value) *
Age (years)			1.17 (0.279)
18-40	239 (79.67)	73 (84.88)	
41-60	61 (20.33)	13 (15.12)	
Marital Status			2.74 (0.001)
Single	167 (55.67)	27 (31.39)	
Married	133 (44.33)	59 (68.61)	
Education			
Graduate	14 (4.67)	15 (17.44))	28.1 (0.001)
Intermediate	87 (29)	29 (33.72)	
High school	122 (40.67)	37 (43.02)	
Middle school	56 (18.66)	5 (5.82)	
Primary school	21 (07)	0 (0)	

*p<0.05 considered statistically significant

A highly significant (p=0.001) association was found between the risk of injury and work experience, weekly hours worked, workplace supervision, safe working conditions, training, and machine maintenance (Table 2).

In the present study, the prevalence of severe stress among iron and steel workers was 39.39%. Figure 3 depicts the distribution of levels of stress amongst the study participants.

Table 2: Association between injury and work environment variable

Variables	Injured (n=300) N [%]	Not injured (n=86) N [%]	Chi-Square (p-value) *
Work Experience (in years)			
1-5	201 (67)	20 (23.26)	54.1 (0.001)
6-10	97 (32.33)	66 (76.74)	
>10	2 (0.67)	0	
Working hours per week			
≤48	270 (90)	45 (52.33)	63.2 (0.001)
>48	30 (10)	41 (47.67)	
Supervision present			
Yes	95 (31.67)	68 (79.07)	61.6 (0.001)
No	205 (68.33)	18 (20.93)	
Work conditions safety			63.6 (0.001)
Yes	99 (33)	70 (81.39)	
No	201 (67)	16 (18.61)	
Training conducted			
Yes	69 (23)	70 (81.39)	98.9 (0.001)
No	231 (77)	16 (18.61)	
Machine maintenance is done regularly			
Yes	44 (14.67)	63 (73.25)	115 (0.001)
No	256 (85.33)	23 (26.75)	

*p<0.05 considered statistically significant

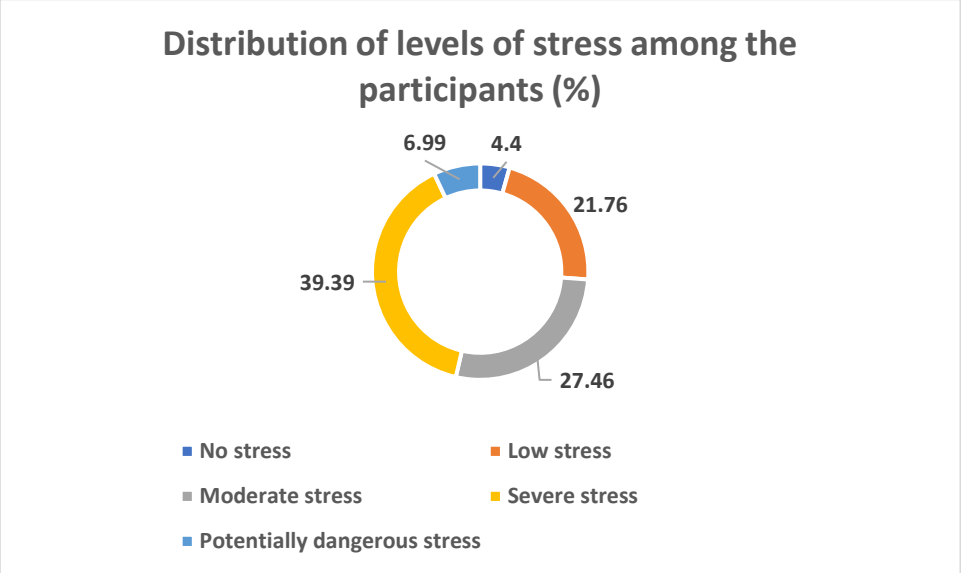

Fig 3: Distribution of sources of injury in the workers

The analysis of the behavior of workers at the workplace, as outlined in Table 3, showed a significant association between the occurrence of injury and stress at the workplace (p = 0.003), the use of PPE (p = 0.001), and the consumption of alcohol during work hours (p = 0.005).

After applying binomial logistic regression, the association of injury with different variables has been outlined in Table 4. It was found that married workers [AOR=0.23 (95 % CI: 0.08-0.62)], had work

experience of one to five years [AOR=3.03 (1.02-9.01)], had not undergone training [AOR=5.14 (95% CI: 1.22-21.59)], and workers in factories where machines were not regularly maintained [AOR=13.26 (95 % CI:4.23-41.53)] had significantly higher odds of being involved in world related injuries than their counterparts (single, six to ten years work experience, had undergone training, and machines were regularly maintained).

Table 3: Association between injury and behavior of workers at the workplace

Variables	Injured (n=300) N [%]	Not injured (n=86) N [%]	Chi-Square (p-value) *
Stress at workplace			
Yes	187 (62.33)	38 (44.19)	9.05
No	113 (37.67)	48 (55.81)	(0.003)
Sleeping disorder			
Yes	17 (5.67)	10 (11.63)	3.65
No	283 (94.33)	76 (88.37)	(0.056)
Use PPE (Personal Protective Equipment)			
Yes	223 (74.33)	83 (96.51)	20
No	77 (25.67)	3 (3.49)	(0.001)
Consume alcohol			
Yes	103 (34.33)	16 (18.60)	7.75
No	197 (65.67)	70 (81.40)	(0.005)
Use mobile at work site			
Yes	106 (35.33)	26 (30.23)	0.773
No	194 (64.67)	60 (69.77)	(0.379)

*p<0.05 considered statistically significant

Table 4: Predictors of work-related injuries in the study participants by binomial logistic regression

Variables with Categories	AOR (95 % CI)	p-value*
Marital Status		
Married (ref ‡)		
Single	0.23 (0.08-0.62)	0.04
Work experience(years)		
6-10 (ref)		
1-5	3.03 (1.02-9.01)	0.045
Training given		
Yes (ref)		
No	5.14 (1.22-21.59)	0.025
Machines always maintained		
Yes (ref)		
No	13.26 (4.23-41.53)	0.001
Use PPE		
Yes (ref)		
No	1.10 (0.25-4.88)	0.895
Consume alcohol		
No (ref)		
Yes	0.36 (0.12-1.08)	0.070

Working hours per week		
≤ 48 (ref)		
> 48	2.25 (0.82-6.18)	0.113
Work conditions safe		
Yes (ref)		
No	3.17 (0.86-12.04)	0.090

‡ ref: Reference Group, *p<0.05 considered statistically significant

Discussion

In the present study, the majority of the workers, i.e., 80.83% belonged to the age group between 18-40 years. A similar finding was reported by Simiyu et al where 78% of workers were between 18-40 years old.[12] Around 50.26% of workers were single in our study. Studies by Tagurum YO et al and Joshi M et al also reported similar findings.[13,14]

The prevalence of work-related injury among iron and steel industry workers in this study was 77.72% during the last 12 months. This rate was higher than the prevalence rate reported by Berhe A. et al which was 58.2% and Jain Akansha A. et al which was 61.5%.[15,16]

Around 229 (76.33%) workers had a work-related injury in more than one incident. Joshi M et al and Mulugeta N et al reported 37% and 51.6% of workers who sustained more than one episode of injury in the last 12 months respectively.[14,17] The study population, data collection techniques, methodological variations, and workplace factors, such as the degree of awareness among construction workers regarding disease prevention and hazard control and the availability of workplace safety services, could all be contributing factors to the discrepancies observed in the study results.

The body parts of iron and steel fabrication workers with the highest frequency of work-related injuries were their hands (72.33%), fingers (79.33%), and eyes (58.66%). A study by Onawumi AS et al found wrists/hands (21.9%) as the most commonly affected body part.[18] The most commonly injured body part in the study done by Rajak R et al was the upper head (23.24%), arm/shoulder (14.08%), and hands/fingers (12.68%).[19]

Hand tools accounted for 81% of the total injuries. Injuries from manual labor and repetitive tasks, which affected 73% of study participants, were the next most common source of injury. A study by Mulugeta N et al reported machinery (26.15%) and hand tools (21.79%) as the most common source of injury.[17] Habtu Y et al also found machinery (41.7%) and splintering objects (38.3%) as a source of injury in their study.[20] The most frequent injury types were electrocution (57.67%), abrasions (58.67%), and cuts (80.33%). A study by Kumar SG et al reported abrasion and laceration (98.6%) to be the most frequent injury.[21] This might be the result of inadequate machine and hand tool maintenance and safety measures. Another explanation might be that the employees are not using their PPEs appropriately or sufficiently. To prevent these kinds of injuries, the quality of the PPEs being used may also be very important. Workplace injuries may also be caused by elements in the workplace, such as improper waste disposal and disorganized raw material storage.

Cuts by sharp objects (37.32%), dislocation and fracture (30.28%), and burns (19.01%) were the most frequent types of injuries in a study by Rajak R et al.[19] Similar findings have also been reported by various other studies.[22-24] The nature of the work being done by the employees, their awareness of injuries, the standard of PPE they use, the work environment, and the observance of safety protocols at their place of employment are just a few of the variables that could be responsible for these variations in the study results.

Among the workers, 62.17% reported having a musculoskeletal disorder, 12.9% had diabetes mellitus, 12.69% had hypertension, and 6.99% had

trouble sleeping. This was consistent with the findings of the studies done in Brazil, Ethiopia, and Mumbai.[25,26]

In our study, the majority of the workers, i.e. 78.24% used some type of PPE while working. The reason cited by the workers for not using PPE was because they were either uncomfortable or were not provided by the employers. A similar finding was reported by Mulugeta et al and Adje DU et al and a better finding was reported by Tagurum YO et al.[13,17,27] According to guidelines provided by the Indian Ministry of Steel, all industries must make sure that their workers are wearing the proper personal protective equipment (PPE) to protect them from industrial hazards.[28]

There was a significant association between the occurrence of injury with marital status and education ($p = 0.001$). A study by Borkakoti S et al also reported a significant association of injury with the age and educational status of the workers.[29] A study by Mulugeta et al found the association of injury to be statistically significant with age, marital status, and educational status.[17]

In our study, the prevalence of severe stress among iron and steel workers was 39.39%, followed by moderate stress levels at 27.39%. A mere 4.4% of workers did not have any form of stress. These findings were consistent with the results of studies done by Keerthi K et al and Onawumi AS et al.[18,30] These workers may be under stress for a variety of reasons, such as difficult physical working conditions, lengthy workdays, frequent accidents, and associated risks, hazardous working environments, etc. Additionally, many workplaces lack health benefits and job security, which may put employees at risk for stress.

The association between injury was found to be statistically significant with stress level at work, consumption of alcohol, and non use of PPE ($p < 0.05$). Similar findings were also reported by Kumar S G et al.[21]

However, the study by Akansha JA et al did not find any statistically significant association between injury and non-use of PPE.[18] The non-use of PPE in our study might be due to the reasons cited above that PPEs were either uncomfortable or were not provided by the employers. Drinking alcohol can raise the chance of getting hurt by making the workers take more risks or by making it harder to see and react to dangers. A similar inference was also reported by Tsawatsupa et al.[31]

On analyzing the predictors for work-related injuries, it was noted that single status of workers (AOR=0.23, 95 % CI: 0.08-0.62), workers with work experience between 1-5 years (AOR=3.03, 95 % CI: 1.02-9.01), untrained workers (AOR=5.14, 95% CI: 1.22-21.59), and non-maintenance of machines (AOR=13.26, 95 % CI:4.23-41.53) were significantly associated with work-related injuries. Married people experienced higher levels of stress because they had more domestic responsibilities. Workers in these industries are frequently primarily unskilled or poorly trained, and they pick up safety protocols as their work experience increases. Workplace machines must receive timely and routine maintenance to prevent worker injuries.

In an Ethiopian study, after controlling for confounding variables, individuals with 11 to 20 years of work experience [AOR=7.88 (95%CI: 2.60-23.90)] and those with less than 10 years of work experience [AOR=3.62 (95%CI: 1.21-10.82)] demonstrated a significant correlation with occupational injury in the multivariable analysis.[17] According to a study by Rajak R et al, there was a significant correlation between work-related injuries and non-technical education (adjusted odds ratio [AOR]: 2.52), higher exposure in hazardous and polluted areas (AOR: 2.85), alcohol consumption (AOR: 2.47), and inadequate knowledge of occupational health and safety (AOR: 0.65).[19]

Limitation: Because of the cross-sectional design of the study, it was impossible to determine causality. The self-reported data of the respondents, which may be impacted by recall bias, was used to determine the prevalence of occupational health issues. There may have been an underestimation of the overall prevalence that

was caused by employees who were on leave or injured workers who were at home when the data was being collected. It was outside the purview of this study to investigate the addictions and determine whether or not the study participants were working while under the influence. Any physical injuries brought on by workplace accidents that occurred within the previous 12 months were considered occupational injuries and accidents for this study. Consequently, more study is required to understand the type and severity of injuries.

Conclusions

The chance to gain insight into the working conditions of the workers in the iron and steel industries was made possible by this study. Worker accidents and injuries were highly prevalent, according to the study. We discovered that a wide range of significant factors, including behavioral ones, contribute to workplace accidents, injuries, and stress levels. To ensure workers' safety and safe working conditions, proper monitoring and recommendations are warranted from the Government (Labor Union and Ministry of labor and employment). Educational awareness sessions on various aspects of work safety need to be planned for the workers at regular intervals by trained health professionals. An integrated strategy with national and unit-level industries can help combat the burden of work-related injuries.

Acknowledgments

The authors fully acknowledged the factory workers who gave their valuable time to participate in the study.

References

1. Occupational Safety and Health Statistics (OSH) [Internet]. ILOSTAT. Available from: https://ilostat.ilo.org/resources/concepts-and-definitions/description-occupational-safety-and-health-statistics/
2. Shukla A. Workplace accidents: Inside India's 'factories of death' [Internet]. BBC News. 2022. Available from: https://www.bbc.com/news/world-asia-india-62631699
3. Malik HJ, Cheema KJ; Preliminary survey to assess the health status of iron and steel industry worker. Pakistan Journal of Science. 2010 Mar 1;62(1):17-21. Available from: http://repository.pastic.gov.pk/jspui/handle/123456789/18988
4. Ademola-Popoola DS, Akande T, Ayanniyi A. Ocular health status and practices among the workers of a steel rolling mill in Nigeria. Central European Journal of Occupational and Environmental Medicine. 2005 Oct 11;11(3):163–8. Available from: https://www.researchgate.net/publication/234064100_Ocular_Health_Status_and_Practices_among_Workers_of_a_Steel_Rolling_Mill_in_Nigeria
5. Jovanovic J, Arandelovic M, Jovanovic M. Multidisciplinary aspects of occupational accidents and injuries. Facta Univ. ser: Working and living environmental Protection. 2004 Aug 25;2(4):325-33. Available from: http://facta.junis.ni.ac.rs/walep/walep2004/walep2004-12.pdf
6. Tadesse T. Assessment of prevalence of work-related injuries among small and medium scale industrial workers in north Gondar zone, Amahara regional state. Addis Ababa University. 2005. Available from: https://catalog.ihsn.org/index.php/citations/50837
7. Gifary OA. International labour standards a global approach preliminary version [Internet]. Academia edu. 2019. Available from: https://www.academia.edu/39218247/International_labour_standards_A_global_approach_Preliminary_version
8. Global strategy on Occupational Health for all: The way to health at work [Internet]. World Health Organization. World Health Organization. 1995. Available from: https://www.who.int/publications-detail-redirect/global-strategy-on-occupational-health-for-all-the-way-to-health-at-work
9. Berhan E. Prevalence of occupational accident; and injuries and their associated factors in iron, steel, and metal manufacturing industries in Addis Ababa. Cogent Engineering. 2020 Jan 1;7(1):1723211. Available from:

https://doi.org/10.1080/23311916.2020.1723211

10. Corporation BM. Bhubaneswar Municipal Corporation [Internet]. BMC. Available from: https://www.bmc.gov.in/

11. The Work Place Stress Scale (WSS). The Marlin Company, North Haven, Connecticut and The American Institute of Stress, Yonkers, New York. 2001. Available from: https://www.stress.org/wp-content/uploads/2011/08/2001Attitude-in-the-Workplace-Harris.pdf

12. Simiyu SW, Cholo W. Dynamics of occupational injuries among metal workers in KamukunjiJua Kali Market, Nairobi, Kenya. Dynamics. 2016 Dec;1(12):1-7. Available from: https://www.researchgate.net/publication/329443346_Dynamics_of_occupational_injuries_among_metal_workers_in_Kamukunji_Jua_Kali_Market_Nairobi_Kenya

13. Tagurum YO, Gwomson MD, Yakubu PM, Igbita JA, Chingle MP, Chirdan OO. Awareness of occupational hazards and utilization of PPE amongst welders in Jos metropolis, Nigeria. Int J Res Med Sci. 2018 Jul;6(7):2227-33. Available from: https://doi.org/10.18203/2320-6012.ijrms20182808

14. Joshi M, Dhakal G, Shrestha S. Occupational Health Problems, Workplace Environment and Utilization of Personal Protective Equipment among Welders of Banepa Municipality. International Journal of Occupational Safety and Health. 2020 Jul 20;10(2):100-7. Available from: https://doi.org/10.3126/ijosh.v10i2.30175

15. Berhe A, Yemane D, Gebresilassie A, Terefe W, Ingale L. Magnitude of Occupational Injuries and Associated Factors among Small-Scale Industry Workers in Mekelle City, Northern Ethiopia. Occupational Medicine and Health Affairs.2015 Apr 8;3(3):1-6. Available from: https://doi.org/10.4172/2329-6879.1000197

16. Akansha JA, Nandkeshav AR, Kalpana KM, Mohan DK. Work Related Injuries and Some Associated Risk Factors among Workers in Iron and Steel Industry. Sch J App Med Sci. 2015;3(2E):901-5. Available from: https://www.saspublishers.com/article/8112/download/

17. Mulugeta N. Assessment of Magnitude of Occupational Injuries And Associated Factors Among Micro-Enterprise Metal Workshop Workers In Addis Ababa, Ethiopia. National Academic Digital Repository of Ethiopia. 2019. Available from: https://doi.org/10.20372/NADRE/13549

18. Onawumi AS, Dunmade IS, Ajayi OO, Adebiyi KA, Omotosho AO. Investigation of work-related health hazards prevalent among metal fabrication workers in Nigeria. European Journal of Engineering and Technology. 2016;4(4):1-10. Available from: https://www.idpublications.org/wp-content/uploads/2016/05/Full-Paper-INVESTIGATION-OF-WORK-RELATED-HEALTH-HAZARDS-PREVALENT.pdf

19. Rajak R, Chattopadhyay A, Maurya P. Accidents and injuries in workers of iron and steel industry in West Bengal, India: Prevalence and associated risk factors, International Journal of Occupational Safety and Ergonomics. 2021 Dec 31;28(4):2533-40. Available from: https://www.tandfonline.com/doi/full/10.1080/10803548.2021.2012021

20. Habtu Y, Kumie A, Tefera W. Magnitude and Factors of Occupational Injury among Workers in Large Scale Metal Manufacturing Industries in Ethiopia. OALib. 2014 Nov 19;01(08):1–10. Available from: https://doi.org/10.4236/oalib.1101087

21. Kumar SG, Dharanipriya A. Prevalence and pattern of occupational injuries at workplace among welders in coastal south India. Indian journal of occupational and environmental medicine. 2014 Sep;18(3):135. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4292199/

22. Verma A, Das KS, Maiti J, Krishna OB. Identifying patterns of safety-related incidents in a steel plant using association rule mining of incident investigation reports. Saf Sci. 2014 May 13;70:89–98. Available from: https://doi.org/10.1016/j.ssci.2014.05.007

23. Mazaheri MA, Hidarnia A, Ghofranipour F, et al. Occupational injuries in Isfahan steel company during 2001–2006. Eur J Sci Res. 2009;31(4):546–52. Available from: https://www.researchgate.net/profile/Maryam-Amidi-Mazaheri-2/publication/237124883_Occupational_Injurie

s_in_Isfahan_Steel_Company_During_2001-2006/links/589adc38a6fdcc32dbdf136c/Occupational-Injuries-in-Isfahan-Steel-Company-During-2001-2006.pdf

24. Barreto SM, Swerdlow AJ, Schoemaker MJ, Smith PG. Predictors of first nonfatal occupational injury following employment in a Brazilian steelwork. Scand J Work Environ Heal. 2000 Dec ;26(6):523–28. Available from: https://doi.org/10.5271/sjweh.577

25. Yadav A, Agarwal S. Occupational health and level of awareness among welders. Journal of the Social Sciences. 2020 Oct;48(4). Available from: https://www.researchgate.net/profile/Shalini-Agarwal-5/publication/347511839_Occupational_health_and_level_of_awareness_among_welders/links/5fdf68f892851c13fea94845/Occupational-health-and-level-of-awareness-among-welders.pdf

26. Davuluri P, Kadam D, Shinde R, Borgaonkar C, Dhoundiyal A. Determinants influencing the health status of welders in a sub-urban slum of Mumbai, Maharashtra, India. International Journal of Community Medicine and Public Health. 2016 Oct;3(10):2712–5. Available from: https://doi.org/10.18203/2394-6040.ijcmph20163352

27. Adje DU, Anyalebechi CJ, Williams FE. Safety measures in the workplace: a case study of Federal Road Safety Corps (FRSC) vehicle plate manufacturing plant, Ojodu – Lagos, Nigeria. International Journal of Occupational Safety and Health. 2024; 14(2):247–58. Available from: https://doi.org/10.3126/ijosh.v14i2.52192

28. Safety Guidelines for Iron and Steel Sector. Ministry of Steel. Nov 2019 [Internet] [cited Nov 2022]. Available from: https://steel.gov.in/en/safety/safety-guidelines-iron-steel-sector

29. Borkakoti SK, Wahid MA. Health Problems of Unorganised Urban MSME Workers of Nagaon, Assam. Journal of Advances and Scholarly Researches in Allied Education. 2019 May;6(16):1424-31. Available from: https://www.researchgate.net/publication/337543913_Health_Problems_of_Unorganised_Urban_MSME_Workers_of_Nagaon_Assam

30. Keerthi K. Occupational stress among employees in Shri Amman Steel and allied industries (Pvt) Limited, Trichy. International Journal of Applied Management Research. 2011 Dec 18;3:795-97. Available from URL: https://mpra.ub.uni-muenchen.de/39846/1/MPRA_paper_39846.pdf

31. Tsawatsupa B, Yiengprugsawan V, Kjellstrom T, Berecki-Gisolf J, Seubsman S, Sleigh A; Association between heat stress and occupational injury among Thai workers: findings of the Thai cohort study. Industrial Health. 2013;51(1): 34-46. Available from: https://doi.org/ 10.2486/indhealth.2012-0138