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Identification of hazardous substances and occupational morbidity associated with steel and power industry workers in Odisha, India

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ABSTRACT

Background: The steel and power industry workers reported high prevalance of workplaceinjury and illnesses. The study aimed to identify occupational morbidity and workplace injuries in the steel and power industry. The study also assessed various hazardous substances and factors associated with occupational morbidity.

Methods: A cross-sectional study was carried out in a highly industrialised district of Odisha. The survey was conducted using a structured interview schedule in the steel and power industry of Angul, Odisha. The study identified hazardous conditions of male industrial workers ($N = 425$) in power and steel industry by adoping Probability Proportion to Size (PPS) sampling method. The occupational morbidity were illnesses such as chronic obstructive lung diseases, injuries, back pain, skin diseases, hearing impairment, heat stroke, cancer, and respiratory illness. Information about hazardous substances and occupational morbidity has been collected from health professionals (doctors and clinical staff) through in-depth interviews. Univariate and multivariate binary logistic regression was used to analyse various factors of occupational morbidity.

Results: The majority of workers experienced injuries, musculoskeletal pain and body pain. Other occupational diseases like heat stroke, itching, fever, electric shock, eye problem, hearing problems, and respiratory diseases were identified from the study population. The study found that demographic variables like technical education, occupation, and household income were associated with occupational morbidity among steel and power industry workers.

Conclusion: The knowledge of occupational hazards is influenced by socio-demographic variables, which could be intervened with short-term and long-term programs to reduce occupational morbidity.

1. Introduction

The steel and power industry is one of the growing industries in India. The industry engages a huge section of the workforce due to the increasing demands for power and steel products. Currently, India is in the second position in producing steel after China. International LabourOrganisation (ILO) estimated that India is becoming the number one steel-producing country by 2030.[1] The state of Odisha is affluent in Iron ore and coal mines, which established many steel and power plants in public and private sectors in India.[2] Estimation reported that 0.95 million employees work in various steel industries in India.[1]

As per the International Labour Organization (ILO) report, 2.8 million deaths occur due to injuries and occupational diseases every year. The estimation shows more than 374 million workers suffer from non-fatal injuries and workplace accidents.[3] Around 6000 death were recorded every single day. According to the Centres for Disease Control and Prevention (CDC), hearing loss is the most prevalent occupational ailment in the United States. Workers who are frequently exposed to asphyxiants, heat, metals, solvents, or high noise are prominent for hearing loss. In India, silicosis, musculoskeletal injuries, pneumoconiosis, chronic obstructive pulmonary illnesses, asbestosis, byssinosis, pesticide poisoning, heat stroke and hearing problems are the main occupational morbidity.[2] The report has mentioned that India alone contributes 30% of industrial fatalities worldwide. The government of India clearly mentioned the guideline for occupational health and safety in the steel industry. A report mentioned that 'nothing is more important than occupational safety & working conditions of the people at work'.[4]

The steel and power industry found several illnesses, such as chronic

Abbreviations: ILO, International Labour Organisation; CDC, Centers for Disease Control and Prevention; CGP, Coal Gasification Plant; CPCB, Central Pollution Control Board of India; NTPC, National Thermal Power Corporation; DRI, Direct Reduced Iron; PPS, Probability Proportion to Size.

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obstructive lung diseases, injuries, back pain, skin diseases, hearing impairment, heat stroke, cancer, and respiratory illness.[2] Estimation shows that 17 million non-fatal occupational morbidity and 0.045 million fatal injuries occur yearly.[5] A study found dust, noise, and heat were the major hazardous substances for occupational morbidity in steel industries. The study also mentioned myopia, hearing impairments, weakness, hypertension, and respiratory illness as common occupational morbidity.[2]

Many studies found a positive relationship between a hot environment and occupational illness in steel industries, which leads to fatigue, loss of concentration, reduced psychomotor performance, heat cramps, and heat stroke.[6,7] A survey found low back pain is one of the most common diseases among steel industry workers. This is prominent among young workers aged below 45 years.[8,9] Low back pain is the second most common cause for visiting doctors and further leads to surgery. The pain results in neurological and musculoskeletal disorders.[10] Steel and iron manufacturing industries in Ethiopia show that occupational injuries such as dislocation, suffocation, fracture, abrasion, and burn injuries are highly prevalent. Most of the workplaces in steel industries are identified with more exhaustion, sprain, dislocation, heat stroke, and multiple fractures among workers.[11] An assessment of manual handling work in the iron and steel industry mentioned the high prevalence of musculoskeletal disorders. The occupational risks were associated with carrying heavy-weight metals and equipment at the workplace.[12] A survey reported that workers exposed to ergonomic risks, repetitive movements, and painful positions at the workplace leads to occupational morbidity. Occupational accidents have been found in the loading, lifting, moving, and carrying heavy metals at the workplace. The manual handling of metals and tools results in fatigue, back pain, shoulder pain, neck pain, and injuries of arm.[13]

The steel and power industries consisted of coke ovens, furnaces, broilers, plate mills, bar mills, and CGP. Such kind of hazardous workplace exerts pressure on workers to bear extreme heat, high noise, chemicals, dust, and vibration. Further, this leads to workers' sickness, absenteeism and quit job.[14,15] The increased work-related morbidity rate influences productivity and the burden of work-life balance.[16] Blast furnaces are considered one of the hazard-prone worksites in steel industries. A study found that inadequate ventilation systems caused extreme heat and temperature increases in the furnaces area.[17] It has been found that the workers from blast furnaces and process broilers were suffering heat-related diseases and experienced heavy sweating, fatigue, insomnia, and discomfort in muscle.[18,19] The workers engaged in CGP and coke ovens were exposed to carbon dioxide, benzyl, tar, and carbon monoxide gas. This has resulted in occupational morbidities such as skin diseases, discolouration and carcinoma of lips, and periodontal diseases.[20,21] Therefore, the study found that steel and power industry workers are prone to occupational morbidity, which affects the worker's oral health and quality of life.[16]

Based on the evidence from the literature and the increasing prevalence of occupational health hazards, the present study tries to identify the magnitude of occupational diseases and workplace injuries in the steel and power industry. Work-related morbidity and improvement in the work condition need to be estimated in steel and power industry workers. The study assessed the factors associated with occupational morbidity among steel industry workers. Therefore, the study identified various hazardous substances and assessed occupational morbidity patterns in the steel and power industries. The association between hazardous substances/agents and occupational illness has been recognised in this study. Along with these, the study also measures the trends of work-related morbidity in the different worksites.

2. Materials and methods

2.1. Study design and setting

A cross-sectional study was carried out in a highly industrial district of Odisha. The study was conducted in the steel and power industrial premises in Angul district, Odisha. The industry is a major private steel and power industry which aspires to become India's largest integrated steel production unit. The industry has come up with huge capital investment and acquired 6400 acres of land in Banarpal and Chhendipada block of Angul district in 2006. The industry has employed many human resources from various parts of India. The survey was conducted from June 2019 to April 2020. A study jointly conducted by the Indian Institute of Technology, Delhi (IIT-D) and Central Pollution Control Board (CPCB) defined Angul district as among the top 10 most polluted Indian cities, where the pollution level reached a very alarming level.[22] A study from National Thermal Power Corporation (NTPC), Angul, shows that workers are exposed to carbon dioxide, mercury, sulfur dioxide, and nitrogen oxide, resulting in cough, shortness of breath, wheezing, rapid shallow breathing, asthma problems, airway irritation, inflammation, nasal cognition, illness, cold, and heat stroke.[23] The occupational morbidity from the steel and power industry in Angul district found workplace accidents, slips and falls, chemical-related diseases, ergonomic injuries, Heat stroke and hearing loss.[2]The study setting needs to identify hazardous substances and occupational morbidity to better understand occupational health hazards.

2.2. Sources of data

The study considered the male industrial workers (N = 425) as a male-centric occupation, and males were found to be more prone to occupational morbidity with hazardous substances.[24,25] The age of industrial workers was between 18 and 60 years. Most of the study respondents worked on contractual appointments through various manpower agencies. The respondent has been selected from various work sites such as coke oven, power plant, blast furnace, bar mill, plate mill, process broiler, oxygen plant, CGP, and DRI. Women workers and workers engaged in hospitality were excluded from this study. The small numbers and imbalanced representation of the overall sample size could not be comparable. Occupational health physicians and clinical staff were interviewed to identify occupational morbidity and hazardous substances. The occupational health centre and ESI hospital were visited to interview physicians and clinical staff.

2.3. Sampling

Various literature surveys have been done to determine the prevalence of occupational morbidity among industrial workers. A similar characteristic, such as work-related morbidity among Iron and steel industry workers in central India, was found at 60% in a study.[16] Therefore, the study took (P = 0.6) as a proxy to calculate the sample size using the formula $n = Z^2 P (1-P)/d^2$ given by Daniel, 2011.[26] The following assumptions have been taken, such as the Z statistic for a confidence level of 95% (Z value is 1.96). The expected prevalence or proportion (in a proportion of one; if 20%, P = 0.2), and precision (in a proportion of one; if 5%, d = 0.05) were followed. The sample size calculation has considered 0.15% for non-responses. Probability Proportion to Size (PPS), the calculated sample (N = 425) selected from the various clusters (Power plants, Bar mills, Process broilers, Coal Gasification Plant, Direct Reduced Iron, Steel Melting Shop, Switch word, Rolling mills, Coal Handling Plant, Cock-Oven, Switch Word, Blast Furnaces, Oxygen Plant and Plate mill) of workers. The study found a pre-determined number of workers in each selected unit. Approximately 3500 unorganised/contractual workers worked in various worksites during the survey (Labour welfare department, 2019). As per the above-calculated sample size, 12% of the study respondents were interviewed from the pre-determined number.

Another unstructured interview guide was also prepared for occupational health professionals such as physicians, nurses, and the clinical staff. The various hazardous substances and occupational health hazards were identified. Four occupational health physicians (OPD, Surgery, and two medicine specialists), four nurses, and three paramedical staff from the occupational health centre were interviewed.

2.4. Tools construction

A structured interview schedule was designed to collect the primary data from the steel and power industry workers. This is focused on assessing various occupational hazards and work-related morbidity. In the first phase, the interview schedule underwent a pilot survey with 51 respondents; further, the reliability of each variable was tested. The tool has been segregated into four sections. Socio-demographic profiles and work-related behavioural variables were provided in the first section. Information about the knowledge of occupational health hazards and various hazardous substances, such as chemicals, dust, fumes, scrubs, silica, radiation, etc., was presented in the second section.

Further, the interview schedule followed 27 items of common causes of workplace injuries and occupational illness, as per the ILO guideline given by 'The Code of Practice on Safety and Health in the Iron and steel industry.[27] Identification of various occupational morbidities has followed the final section. Industrial accidents, workplace injuries, and morbidity patterns are also assessed in this study. An in-depth interview guideline with an appropriate probe list was used to collect information from occupational health professionals.

2.5. Statistical analysis

The gathered data was quantified, verified, and coded by a referred coding key. The collected data were entered into the statistical package for social sciences (SPSS. 25). The demographic characteristics include age, education, technical education, occupation, types of work, number of work hours, household income, and distance from the health institutions were considered as control variables. Univariate analyses such as frequency and percentage distribution, standard deviation, and means described the respondent's characteristics. A data section was analysed with $\chi2$, which evaluates the degree of association with the control variable and occupational morbidity. Finally, the multivariate binary logistic regression model was used to determine the effect of the outcome variable on the control variable with considering a 95% Confidence Interval (CI). The quantitative data has been triangulated with the facts established from the qualitative information. Various factors of occupational morbidity were confirmed with the evidence from biological monitoring, medical examination, and health assessments of works.

Ethical approval

The study has taken ethical clearance (SL. No. 2018–19/19) from the Institutional Review Board (IRB), Tata Institute of Social Sciences, Mumbai. The participants are given informed consent forms explained by the researcher before starting each interview. The researcher explained the study's objectives to all targeted populations in their local language. The interested eligible participant signed written informed consent. Data confidentiality and anonymity were appropriately maintained throughout the study. It has ensured that the identity of participants and the respected industry should not become in the study reports and any further scientific publications.

3. Results

The demographic and behavioural characteristics of respondents are presented in Table 1. The mean age of the respondents was 34.27 years. About 58% of the workers were from a secondary educational background. Most (55.3%) of the workers got technical education, and 23.5% were highly skilled. The mean household income of the workers was 14425.88 INR, whereas the majority (60.7%) of the worker's household income was up to 14000 INR. Nature of work presented 55.3% of respondents work overtime and shift work, and nearly 70% have knowledge about hazardous substances. Nearly 49% of workers perceived the job feature as risky and prone to morbidity and mortality. The proportion of always-used PPEs was 52.2% remaining were used partially. Around 45% of respondents do not have any knowledge about occupational morbidity (Table 1).

Table 1
Socio-demographic and behavioural characteristics of respondents (N = 425).

Variables	Frequency	Percentage
Age		
Up to 30Year	247	58.1
31–40 Year	137	32.2
40 and Above	41	9.6
Mean Age (SD)	**34.27 (6.102)**	
Education		
Up to 10	247	58.1
10 to 12	137	32.2
Graduation	41	9.6
Technical Education		
Not getting	190	44.7
Getting	235	55.3
Occupation		
Semi-skilled	325	76.5
Highly Skilled	100	23.5
Household Income		
Up to 14000	258	60.7
14001 and above	167	39.3
Mean Income (SD)	**14425.88 (5528.638)**	
Work Nature		
Overtime Time and Shift work	235	55.3
General	190	44.7
Work Hour		
Above 8 h	239	56.2
Up to 8 h	186	43.8
Knowledge on Occupational morbidity		
Yes	234	55.1
No	191	44.9
Knowledge hazardous agent		
Yes	297	69.9
No	128	30.1
Perceived job feature		
Risk	208	48.9
Non risk	28	6.6
Some time risk	189	44.5
Acknowledge occupational Morbidity		
Yes	406	95.5
No	19	4.5
Used of PPE		
Always Used	222	52.2
Some time Used	203	47.8

Note: Household Income of workers presented in Indian rupees (USD 100 = INR 7764.05; EUR 100 = INR 8334.80). Currency Conversion date: 08.06.2022.

3.1. Knowledge about hazardous substances in the workplace

The results presented the respondent's self-reported knowledge about hazardous substances at the workplace in Table 2. Around 30.3% of respondents reported exposure to chemical substances, 88.6% to dust and fumes, and 63.6% to silica and scrubs. Three-fourths of the respondents reported heat and temperature, 51.5% hot and heavy metals, and 40% knew electric shock. Nearly 54% of respondents recognised noise and vibration, and 32% of lasers and radiation as workplace hazardous substances. Only 8.8% of respondents identified airborne pollutants and 27.6% acid mists. One-fifth of the respondents considered asbestos as a workplace hazardous substance.

3.1.1. Evidence from the health professional

The study explores the knowledge about hazardous substances and occupational morbidity from the occupational health centre. Occupational health physicians follow the health assessment process of workers. Various factors responsible for occupational morbidity were noted from

Table 2
Knowledge of workplace hazardous substances (n = 297).

Hazardous substances	Number	Percentage (%)	Hazardous substances	Number	Percentage (%)
Chemicals	90	30.3	**Electric Shock**	119	40.1
Dust and Fumes	263	**88.6**	**Lasers and Radiation**	95	32.0
Silica and Scrubs	189	63.6	**Noise and Vibration**	160	53.9
Coal Ash	108	36.4	**Acid Mists**	82	27.6
Heats and Temperatures	224	**75.4**	**Airborne Pollutants**	26	**8.8**
Hot and Heavy Metals	153	51.5	**Asbestos**	61	20.5

the worker's knowledge. The knowledge about hazardous substances has assisted the quantified data in taking appropriate conclusions. The narration on the lack of knowledge about hazardous substances and occupational morbidity is given below.

"I observed most of the workplace injuries occurred due to a lack of knowledge about hazardous substances. Workers' knowledge of such exposure agents (Chemicals, ash, acids, level of sound, and micro-particles of silica and asbestos dust) was very low. It has been found that inadequate technical knowledge led to workplace accidents at the bar mill worksite last year. Less knowledge of handling tools and equipment also results in many industrial accidents.Lack of technical knowledge and less skill by the newly joined workers were a prominent group for the workplace accidents".(OPD doctor, Occupational Health center)

Lack of knowledge about hazardous substances and inadequate technical knowledge were found among the study respondents. The observation of the occupational health physician sounded the same. The knowledge about such hazardous substances as coal ash, radiation, airborne pollutant, and asbestosis was significantly less. The worker's knowledge of hazardous substances was responsible for workplace accidents and injuries.

3.2. Knowledge about various factors of occupational morbidity

The knowledge about various factors of occupational morbidity is presented in Table 3. Most of the respondents (90.6%) had knowledge of slips, trips, and falls from the same level, and 91.6% reported falling from a height. Extreme temperature (94.3%) and fire explosion (92.4%) were reported as factors of morbidity in the workplace. One-third of the respondents were known that manual handling and repetitive works are the most common factors for workplace injuries. Inhalable agents such as gases, vapours, dust, and fumes were reported by (60%). Similarly, the same proportion also reported ergonomics as a prominent factor. Three-fourth of the respondents knew about radiation (non-ionizing, ionizing), and 65.3% for noise and vibration as the responsible factors for occupational morbidity.

3.2.1. Evidence from the health professional

The physician recognises the sources of risk and hazardous substances at the workplace. The identification of various factors has to be done by the occupational health physician. The primary obligation is to address the root cause of workers' ill health and anticipation of work-related diseases and injuries. The clinical staffs of occupational health centres diagnose the most common causes of occupational hazards. Various factors of hazardous substances and occupational exposure agents are given below.

"We found the workers from DRI and blast furnaces worksites were injured due to falling objects from a height and same level. Limited workspace and high noise are responsible for respiratory diseases and hearing problems. Work with extreme temperatures and contact with hot metals was found to cause heat stroke and burn injuries from plate mill and bar mill workers.The workers working with chemicals like alkalis, acids, and solvents suffer from various skin diseases. The steel manufacturing process assigned heavy vibration works, a prominent factor for joint and muscle pain. We found the long work with vibration work responsible for musculoskeletal disorders".(Doctor and nursing staff surgery,Occupational Health Center).

Physicians from the OPD department identified various occupational hazards in industrial workers. The hazardous worksites were listed by clinical staff, and the physician was given below.

"A group of workers from the power plant, bar mill, plate mill, CGP, process broiler, and blast furnaces was taken for biological monitoring. The workers have been chosen to evaluate their work-related risks and hazards.Periodical health check-ups and medical screening have been conducted every six months. Special health check-ups have been conducted regularly among the workers engaged in hazardous jobs. It has been found that various occupational risks are related to the respiratory system and musculoskeletal diseases among workers. Heat cramps and itching has been detected in the employees working in power plant, bar mill, plate mill, and switch words".(Doctor, Medicine specialist and clinical staff).

Table 3
Acknowledge the various factors of occupational morbidity (n = 406).

Factors for Occupational Morbidity	Number	Percentage	Factors for Occupational Morbidity	Number	Percentage
Slips, trips and fall from same level	368	**90.6**	Fire and explosion	377	**92.4**
Fall from Height	372	**91.6**	Extreme temperatures	383	**94.3**
Unguarded Machinery	279	68.7	Radiation (non-ionizing, ionizing)	305	75.1
Falling objects	278	68.5	Noise and vibration	265	65.3
Engulfment	93	22.9	Electrical burns and electric shock	273	67.2
Working in confined spaces	198	48.8	Manual handling and repetitive work	135	33.3
Moving machinery, on-site transport, forklifts and cranes	65	16.0	Exposure to pathogens (e.g. legionella)	55	13.5
Exposure to controlled and uncontrolled energy sources	54	13.3	Failures due to automation	19	**4.7**
Exposure to asbestos	24	**5.9**	Ergonomic	142	59.6
Exposure to mineral wools and fibers	40	9.9	Lack of OHS Training	318	78.3
Inhalable agents (gases, vapours, dusts and fumes)	242	59.6	Poor of working organization	273	67.2
Skin contact with chemicals (irritants (acids, alkalis), solvents and sensitizers)	173	42.6	Inadequate accidents prevention and inspection	311	76.6
Contact with hot metal	325	80.0	Inadequate emergency first-aid and rescue facilities	266	65.5
Lack of medical facilities and social protection	292	71.9			

Note: Above 27. Items were taken from the ILO guideline by the 'Code of practice on safety and health in the iron and steel industry.[27].

Many hazardous substances exist in the workplace of the steel and power industry. The incidences like falls from height, slipping in the workplace, limited space, extreme temperature, and fire explosions were the most common factors in the industry. Many other exposure agents, such as asbestos, inhalation agents, radiation, electric shocks, noise, and vibration, lead to serious occupational morbidity among steel industry workers.

3.3. Various occupational morbidity at the workplace

Various occupational morbidities are presented in Fig. 1. More than 60% of respondents experienced injuries at the workplace. About 51.3% reported body pain (pain in joints, muscles, limbs, and back). Heat stock (48.3%) and itching (44.3%) were identified from various workers working in the steel industry. One-fourth of workers were exposed to electric shock, and 36.7% suffered from fever during work. Eye problems (19.3%) and accidents with tools and equipment (23%) were found in the workplace.

3.3.1. Evidence from medical examination and health assessment of workers

Clinical staff and doctors from the occupational health centres were assessed about occupational morbidity. Biological monitoring processes evaluated all the hazardous substances and occupational morbidity. The workers involved in the most hazardous work and exposure to more hazardous substances were chosen for biological monitoring. The safety management team has recorded the number of hazardous substances. It has been assessed repetitively every day after work. The body fluids were tested to identify various exposure agents and morbidity at the workplace. Anonymity and confidentiality guidelines have been followed in case found of any stigmatised diseases. An occupational health physician was states

> *"The collected sample was examined to identify past and post-toxic agents and harmful effects. We found that many blood and urine samples indicate lead exposure. Exposures to various chemical substances are affecting the skin and gastrointestinal diseases. The evaluation of biological monitoring found asbestosis, silicosis, and pneumoconiosis responsible for increased respiratory diseases. Further, it is assumed that it could be the root cause of developing cancer and other chronic illnesses". (Doctor, Medicine specialist and clinical staff).*

Biological monitoring has confirmed the hazardous substances responsible for serious occupational hazards. Workers' legal rights and informed consent have been informed about the seriousness of the hazardous substances. The policy of anonymity and confidentiality was followed in case of any diseases related to stigma in the workplace as well as in society. Early detection of hazardous substances through biological monitoring warns to take adequate preventive measures.

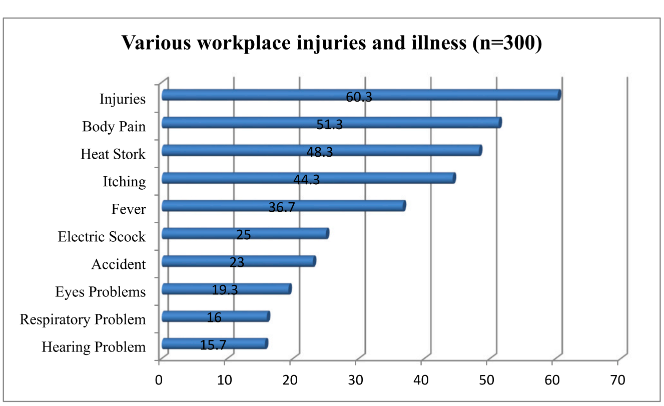

Fig. 1. Employee felt in various occupational illness and injury.

3.4. Prevalence and determinant of occupational morbidity as per the background characteristic

The prevalence of occupational morbidity among respondents aged up to 30 years was 84.1%. Workers having up to 10th standard education (91.9%) had a higher prevalence of occupational morbidity in comparison to 12th standard (47.4%) and graduated (19.5%). Similarly, the prevalence of occupational morbidity was found to be high (98.9%) among the workers not getting technical education as compared to those getting technical education. Further, semi-skilled workers (86.5%) had more prevalence of occupational morbidity than highly skilled workers. Work nature and the number of working hours are also associated with the occupational morbidity of steelworkers (Table 4).

The multivariate model shows (Table 4) that the predicted variable, such as technical education, occupation, and household income, was significantly associated with occupational morbidity. Respondents who did not get technical education had 22.32 times (95% CI [4.668–106.801]) more likely to be felt with occupational morbidity than those who got technical education. Semi-skilled workers were 4.95 times (95% CI [2.092–11.721]) more likely to felt in occupational hazards than highly skilled workers. Occupational morbidity was more likely among workers with up to 14000 INR monthly household incomes (AOR 5.82, 95% CI [2.401–14.115]).

Table 4
Prevalence and determinant of felt in occupational morbidity as per selected background characteristic of respondents (N = 300).

Felt Occupational Morbidity			Multivariate model		
Predicated variable	Yes	No	P-value	Adjusted OR	CI [95%]
Age					
Up to 30Year	95 (84.1)	18 (15.9)	.155	2.237	[.738–6.777]
31–40 Year	157 (64.1)	88 (35.9)	.860	1.088	[.426–2.779]
40 and Above®	48 (71.6)	19 (28.4)			1.00
Education					
Up to 10	227 (91.9)	20 (8.1)	.775	.827	[.225–3.037]
10 to 12	65 (47.4)	72 (52.6)	.880	1.088	[.364–3.247]
Graduation®	8 (19.5)	33 (80.5)			1.00
Technical Education					
Not getting	188 (98.9)	2 (1.1)	**.000**	**22.329**	[4.668–106.801] ***
Getting ®	112 (47.7)	123 (52.3)			1.00
Occupation					
Semi-skilled	281 (86.5)	44 (13.5)	**.000**	**4.951**	[2.092–11.721] ***
Highly Skilled®	19 (19)	81 (81)			1.00
Household Income					
Up to 14000	245 (95.0)	13 (5.0)	**.000**	**5.822**	[2.401–14.115] ***
14001 and above®	55 (32.9)	112 (67.1)			1.00
Work Nature					
OT and Shift	146 (62.1)	89 (37.9)	.710	1.164	[.522–2.594]
General®	154 (81.1)	36 (18.9)			1.00
Work Hour					
Above 8 h	216 (90.4)	23 (9.6)	.116	2.087	[.833–5.230]
Up to 8 h®	84 (45.2)	102 (54.8)			1.00

Note: Significance level: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$, ® denotes the reference category.
CI denotes for Confidence Interval, OR denotes for Odds Ratio.

4. Discussion

The steel and Power industries are considered a hazard-prone manufacturing sector. Various literature presented the number of non-fatal and fatal injuries increased in the steel industry. The morbidity pattern of the Indian steel and power industry was not much explored. The present study identifies various factors associated with occupational morbidity among steel and power industry workers. It has revealed that 60.3% of the respondents experienced various body injuries during work. The prevalence of body injuries is less than 78.2%[11] and much higher than 28.1%.[28] Some Indian studies found a very less prevalence, 21.5% in Andhra Pradesh,[28] 10.2% in Karnataka,[15] and 28.1% in West Bengal[28] than the present study.

The study argued that more knowledge about hazardous substances is responsible for less occupational morbidity in steel and power industries. The present study was found to be in contrast with the previous evidence. Respondents have good knowledge about hazardous substances such as dust and fumes (88.6%), Heat and Temperatures (75.4%), Silica and Scrubs (63.6%), Hot and Heavy Metals (51.5%), and Noise and Vibration (53.9%). Still, the prevalence of occupational injuries is high. The present study argues that slips, trips, and falls from heights and same level, unguarded machinery, falling objects, fire and explosion, noise and vibration, radiation, and extreme temperature were the significant factors for occupational morbidity. Similarly, many studies acknowledge the similar factors responsible for occupational morbidity among steel, iron, and power industry workers.[29–34]

Occupational morbidity such as heat stroke (48.3%), itching (44.3%), and body pain (51.3%) were found among steel and power industry workers. Relatively heat storage found a significant occupational injury among the workers working in blast furnaces and process broilers.[31] The evidence supports that exposure to silicosis and asbestosis dust is responsible for itching and body arch.[35] Biological monitoring of the body sample found that asbestosis, silicosis, and prenuoconosis were the root cause of developing cancer among steelworkers. A study from the steel industry in Italy found brain cancer occurred from blast furnaces workers.[36] Similarly, the workers involved in such occupations as welding and oiling in the steel industry were found to develop lung cancer.[37]

Biological monitoring of the respondents found that hazardous substances like lead, chemical substances, asbestosis, silicosis, and prenuoconosis are responsible for increasing the possibility of cancer. It has been found that exposure to asbestos was accountable for lung and gastrointestinal tract cancer and mesothelioma. Arsenic and chemical substances are associated with liver, skin, and lung cancer. Radiation was strongly associated with leukaemia and bone and lung cancer. The study also proved that hazardous substances contribute to significant factors in the etiology of cancer.[38] Work in limited spaces with loud noise in blast furnace and plate mill workers were found to be experiencing hearing problems. Nearly 16% of the respondents reported a hearing problem, supported by qualitative evidence from the occupational health of physicians. A systematic review by Basu et al., 2022[39] reported the same finding that high sound level is associated with hearing loss in industry workers, where the morbidity was higher among steel industry workers.

The demographic factors provided prevalence and determinants of respondents' felt in occupational morbidity. The present study shows that respondents not getting technical education were (22.32) times more felt of occupational morbidity than those getting technical education. Similarly, a study found that the workers who did not get technical education were 2.52 times more felt in work-related injuries and illnesses in the steel industry.[28] The semi-skilled workers felt (4.95) time more in occupational morbidity as compared to the respondents having highly skilled. A study reported the same accruing less skill and education is a higher risk for occupational accidents in Ethiopia.[11] A district-wise analysis by Skill Gap Assessment for Odisha reported that demands of skilled workers are dabbled by 2026.[40] The demand for skilled workers in the study area Angul district also is high in the report. So the lack of skill-related occupational morbidity will tackle fulfil the demand for skilled workers in Odisha. Identification of occupational morbidity is the prime focus for addressing the root cause of occupational health hazards.

5. Conclusion

Most workers experienced injuries and musculoskeletal pain/body pain from the study population. Other occupational diseases like heat stroke, inching, fever, electric shock, eye problems, hearing problems, and respiratory diseases were identified in this study. Among the responsible factors are slips, trips, falls from the same level, fire and explosion, electrical burns and electric shock, noise and vibration, temperature and contact with hot metals for occupational morbidity. The study also found the knowledge base on hazardous substances resulted in occupational morbidity. Demographic variables like technical education, occupation, and household income were strongly associated with occupational morbidity among steel and power industry workers.

The study findings may help in developing a safety management strategy for workplace prevention and occupational safety program. The ultimate expected outcome of the study is to suggest measures for reducing industrial accidents and workplace injuries. It would help various stakeholders of steel industries make a strategy for stable industrial health and reduce the degree of substance exposure. The study would facilitate the policy-makers, industry authorities, government bodies, and occupational health professionals to take satisfactory actions for the health and well-being of steel and power workers.

Author contributions

Mr. Parthsarathi Dehury worked on conceptualization of the topic, litrature survey, data collection, analysis of data, and wrote the manuscript.

Prof. K Anil Kumar provided technical support, ideates the topic, editing assistance, litrature survey and writing manuscript through out the project.

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Declaration of competing interest

There is no conflict of interest in this study.

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