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Original Article

Profiling occupational exposure and associated health risks among employees across the petroleum supply chain in Chennai: a cross-sectional study

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ABSTRACT

Introduction: The petrochemical industry poses a significant health risks to its employees due to constant exposure to toxic chemicals generated throughout its complex production processes. This study aimed to identify the presence of occupational health hazards and precautionary measures in petrochemical industry in Chennai.

Methods: A cross-sectional study was conducted among 600 employees from petrochemical industries in Chennai recruited using stratified random sampling techniques. The study was conducted for the period of 18 months from June 2023 to November 2024. The Occupational Health Hazards Standard Assessment tool was used to identify the physical, chemical mechanical, biological, psychosocial health hazards as well as precautionary measures taken across all the sites. A multivariate logistic regression was used to explore impact of occupational health hazards on health using SPSS Software version 27.0.

Results: The study identified chemical health hazards such as solvent, mist, fumes, and gas substances, OR = 3.14, 95% CI [1.92, 5.14] ($p < 0.001$). The poor illumination was identified as a potential physical health hazard in an oil refinery ([OR] = 2.74, 95% CI [1.72-4.35]). The evaluation of precautionary measures, including pre-employment health examinations, a Health, Safety, and Environment (HSE) policy, and an active occupational health and safety system, was significantly implemented ($p < 0.05$) in the oil refinery.

Conclusion: Despite the high level of health risk inherent to the petrochemical industry, this study found a limited presence of health hazards, suggesting that current safety precautions remain effective. However, it is advised to continuously monitor the precautionary measures and safety health systems in the petroleum industries.

Keywords: Chemical Exposure, Health Hazards, Industrial Hygiene, Occupational Health, Petrochemical industry, Workplace safety.

Introduction

Occupational health is an integral component of public health to protect and promote the physical, mental, and social well-being of all employees.[1] Nearly 81% of the deaths were related to non-communicable diseases, while occupational injury-related deaths accounted for about 19% of

total deaths. Ischemic heart disease (350,000 deaths), stroke (400,000 deaths), and chronic obstructive pulmonary disease (450,000 deaths) are the three primary causes of mortality due to air pollution.[2] Only 15% of workers worldwide have accessed occupational health services.[2] Industries, particularly involving chemical processing and heavy machinery, pose a serious threat to employees' health.[3] Among all the industries, petrochemical and oil refineries are well known for their potential environmental pollution and harmful effects.[4]

Petrochemical production has expanded with the rise in energy demand, generating complicated waste products and exposures.[5] Natural gas and crude oil are mixtures of hydrocarbons containing small amounts of impurities that formed millions of years ago and still exist in varying quantities throughout the world.[6] A petroleum refinery transforms, refines, and distills crude oil into valuable products such as gasoline, diesel, asphalt, fuel oils, heating oil, kerosene, and liquefied petroleum gases.[7] Regarding petroleum products, Indian Oil refineries supply the country with kerosene, diesel, and aviation fuel, which account for a significant portion of transportation fuels and gasoline for households. Refineries also produce and supply polymers and petrochemical products such as polymers, cleansers and soaps, chemicals, medications, fertilizers, insecticides, explosives, paints, epoxy resins, flooring, and insulating materials.[8]

A refinery/petrochemical process involving four major steps must be protected against chemical risks: production, inspection, storage, and maintenance.[9] Mishandling chemicals or adding chemical reagents, testing or analyzing the products, unloading, storing, and transferring chemicals from one tank or container to another can all result in accidental exposure.[10] Chemical splashes, which can occur when a tank or pipe explodes under pressure or during the disassembly of pipes or valves, are the primary cause of mishaps.[10] Significant environmental pollutants, such as petrochemical aromatic compounds, can find their way into the environment through a variety of sources, including natural oil seeps, industrial waste products, unintentional spills from oil tankers, wastes from the processing of coal tar, petrochemical industrial effluents and emissions, and more.[11] It is likely that other toxic byproducts of the refining process, such as polycyclic and aromatic hydrocarbons, phenols, metal derivatives, surface-active substances, sulfides, naphthenic acids, and other chemicals, will leach into soils and water bodies. Ineffective purification systems cause toxic compounds found in effluents to build up in water bodies, causing water pollution that is lethal to aquatic and human life.[12]

Typically, there are six categories of work-related health hazards: Physical, mechanical, chemical, biological, behavioral, and psychological.[13] Biological risks (infectious illnesses), physical hazards (noise, radiation, heat, etc.), chemical hazards include solvents, adhesives, paints, poisonous dusts, etc. and ergonomic risk factors (heavy lifting, repetitive movements, vibration) are examples of health hazards.[13] Failing to detect or acknowledge dangers that are present or may have been expected is one of the "root causes" of workplace diseases, accidents, and incidents.[14] Chemical manufacturers issue Safety Data Sheets (SDS), which should be kept up to date and often checked.[15] Risk can be decreased by limiting or eliminating hazards or limiting the amount of harm employees are exposed to.[16]

Workplace health is frequently ignored; however, to prevent and regulate the occurrence of recognized dangers where the oil and gas industry operates, both management and workers must be aware of all known hazards.[17] It is essential to identify potential occupational health hazards among workers, evaluate existing occupational health practices, raise awareness of these hazards, and recommend solutions to prevent and control them.[18] To our knowledge, this is the first study of its kind to identify potential occupational health hazards and evaluate existing precautionary measures in petrochemical industries in Chennai.

Methods

A descriptive cross-sectional study was conducted among employees working in an oil refinery, installation plant, and petrol bunks in Chennai for 18 months from June 2023 to November 2024.

Based on the prevalence of occupational health hazards obtained from the pilot study, the sample size was determined for the study based on the formula,[19]

$$n = \frac{z^2 * p\ (1-p)}{d^2}$$

Thus, after applying the formula 4pq/d2, where p (prevalence) = 14%, q = 86%, and d = 3% (allowable error), the sample size would be 535. With an anticipated non-response rate of 10%, the adjusted sample size was determined to be 589. As a result, a final sample size of 600 is obtained after rounding off. A Stratified Random Sampling technique with a multicentric approach was employed to recruit 600 samples. The petroleum industries in Chennai were explored to recruit participants from an oil refinery in Manali (n = 100), at a storage and filling site, Ennore Coastal Installation plant (n = 200; 14% of total 1400 employment), and from 11 different petrol bunks (n = 300; 14% of total 2100 employment) in Chennai.

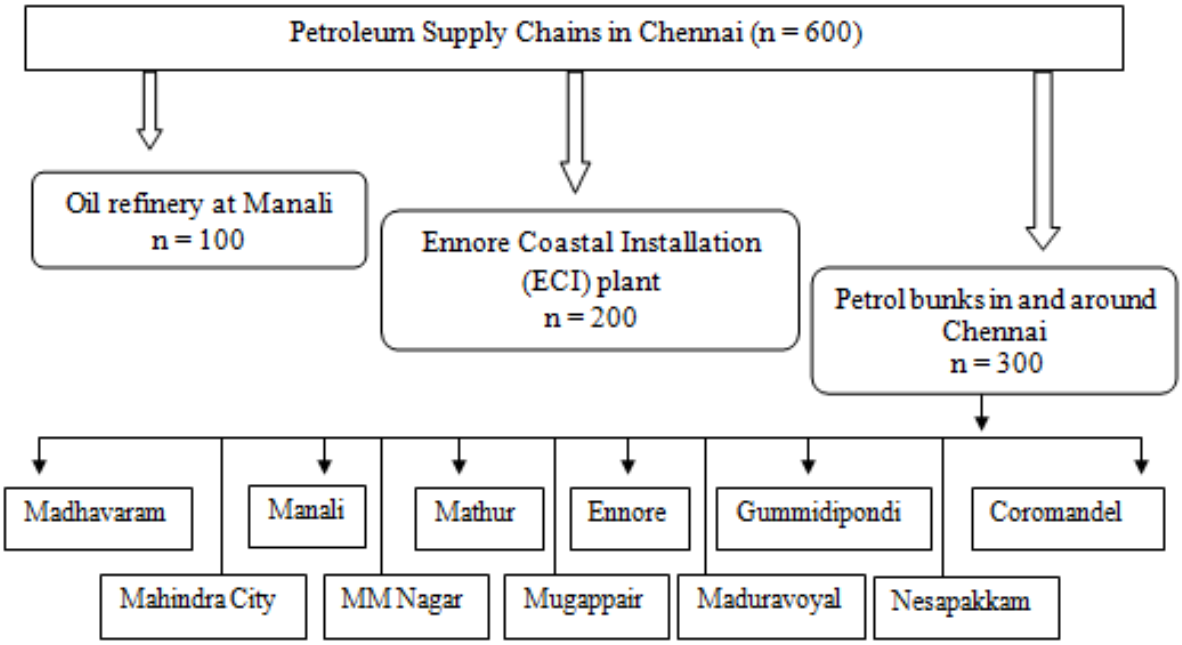

Figure 1: Recruitment of participants

Employees who have more than 1 year of occupational exposure and employees who gave written consent to participate were only included in the study. Employees with hearing, speech, and intellectual disability were not involved in the study. Employees who do office-based jobs were not part of the study.

Socio-demographic details on participants' age, gender, place of work, years of working, personal habits like smoking and alcohol intake, and family history of cancer were collected through individual interviews using a Case Record Form (CRF). The Occupational Health Hazards Standard Assessment tool,[13] with 49 items, identifies the Physical Health Hazards such as noise, vibrations, extreme heat; exposure to harsh chemicals; Mechanical/Ergonomic Health Hazards like standing for long hours and lifting heavy objects; Biological Health Hazards including infectious diseases, and psychosocial health hazards such as workload, stress and harassment at workplace. Forty-nine items also include questions on the precautionary measures taken at the workplace to ensure employee safety.

Each question was assigned with four levels of agreement: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). The ethical clearance certificate was obtained from the Institutional Review Board (IRB) of the SRM University, SRMDC/IRB/2022/MDS/No.702. The study protocol was in accordance with the ethical standards of the Helsinki Declaration, 2013.

The survey data were collected, identified, and organized through Microsoft Excel version 2011. Descriptive statistics were used to manage the data. Multivariate logistic regression with health hazards as the dependent variable and workplaces as the independent variable was used to explore occupational health hazards across all three workplaces, with the petrol bunk serving as the reference group. Omnibus Test of Model Coefficients and Hosmer and Lemeshow Test were used to assess the goodness of fit of the model. The Wald test was employed to evaluate the significance of each predicted variable. The statistical analysis was performed using SPSS Software version 27.0; $p < 0.05$ was considered statistically significant.

Results

Of the 600 participants, 522 (87%) were males and 78 (13%) were females, with mean ages of 37.6 and 37.7 years, respectively. The mean age of all participants was 37.6 ± 10.2 years. Most had a middle school education, followed by a high school education. The majority of participants had worked in the petrochemical industry for 3 to 10 years on average (34%). 50% of them were alcohol users, and 40% were tobacco users. 54.3% of the workers reported moderate physical activity. Moreover, 77.2% had no known medical complications (Table 1).

The reliability of the model resulted in a significant Omnibus test ($p < 0.001$) and a non-significant Hosmer and Lemeshow test ($p > 0.05$), indicating the predicted probabilities are reliable and the overall model fit is good.

Regression analysis performed between the place of work and high noise found that ECI was 2.11 times higher at the petrol bunk ($p < 0.001$). The poor illumination was identified as a potential physical health hazard in an oil refinery ([OR] = 2.74 [1.72-4.35]) with $p < 0.001$ compared to petrol bunks as represented in Table 2. Nearly 49.5% of the participants admitted to having body cramps out of physical health hazards, as seen in Figure 2. The presence of solvent, mist, fumes, and gas substances in an oil refinery was found to have an OR of 3.14 (95% CI [1.92, 5.14]) with $p < 0.001$. The presence of dust particles, metal and metalloid substances in ECI was found to be OR = 3.85, 95% CI [2.64, 5.63] with $p < 0.001$ (Table 3). Corresponding to the chemical health hazards, Figure 3 shows the health effects caused by them. As represented by Table 4, a statistically significant association with reduced odds ratio was found between lifting heavy objects and oil refinery, with OR = 0.32, 95% CI [0.20, 0.53], and ECI with OR = 0.25, 95% CI [0.12, 0.51], causing fatigue (Figure 4). Regarding biological and psychosocial health hazards, lower odds ratios with no statistically significant results were found. In accordance with tables 5 and 6, figures 5 and 6 show less than 40% and 30% health effects, respectively.

The pre-employment entrance health examinations (general, biochemical, fundic, radiological, mental), audiometric, cardiovascular, respiratory, and central nervous system screening were significantly followed in all three workplaces ($p < 0.05$). An active occupational health and safety system was reported to be functional in oil refinery and petrol bunks ($p < 0.05$), but not in ECI ($p = 0.291$), as represented in Table 7.

Table 1: Socio-demographic profile and distribution of test variables among the participants

Groups		N (%)
Gender	Male	522 (87)
	Female	78 (13)
Age (in years)	18-34	265 (44.2)
	35-44	182 (30.3)
	45-64	153 (25.5)
Educational Qualification	Professional	9 (1.5)
	Graduate	103 (17.2)
	Diploma/Intermediate	72 (12)
	High School	99 (16.5)
	Middle School	272 (45.3)
	Primary School	19 (3.2)
	Illiterate	26 (4.3)
Years of working (in years)	<1	83 (13.8)
	1-3	96 (16)
	3-10	204 (34)
	10-20	119 (19.8)
	>20	98 (16.3)
Place of Residence near industries	None	445 (74.2)
	Chemical	72 (12)
	Construction	12 (2)
	Manufacturing	2 (0.3)
	Thermal	50 (8.3)
	Mining	1 (0.2)
	Commercial	6 (1)
	SIPCOT*	7 (1.2)
	Foundries	2 (0.3)
	Agriculture	1 (0.2)
	Textile	2 (0.3)
Smoking	None	363 (60.5)
	Smoke	64 (10.7)
	Smokeless	103 (17.2)
	Both	70 (11.7)
Alcohol	Never	305 (50.8)
	Former drinker	57 (9.5)
	Current moderate drinker	182 (30.3)
	Current heavy drinker	56 (9.3)
Symptoms	None	321 (53.5)
	Difficulty in breathing	23 (3.8)
	Headache	46 (7.7)
	Chronic pain	128 (21.3)
	Allergic reactions	34 (5.7)
	Loss of hearing	1 (0.2)
	Chest pain	7 (1.2)
	Multiple symptoms	40 (6.7)
Rate your health	Excellent	28 (4.7)
	Good	401 (66.8)
	Fair	152 (25.3)
	Poor	17 (2.8)
	Unknown	2 (0.3)

**SIPCOT – State Industries Promotion Corporation of Tamil Nadu*

Table 2: Physical health hazards reported in petrochemical industries

Physical Health Hazards	Place of work					
	Petrol bunk		ECI		Oil refinery	
	AOR (95% CI)	Wald	AOR (95% CI)	Wald	AOR (95% CI)	Wald
High noise level	Ref	13.767*	2.11 (1.40, 3.16)	12.927***	1.13 (0.65, 1.95)	0.184
High temperature		10.395*	1.23 (0.83, 1.79)	1.101	2.14 (1.34, 3.39)	10.392*
Heavy vibrations		3.898	0.67 (0.40, 1.08)	2.658	0.61 (0.31, 1.16)	2.226
Poor illumination		19.317***	1.62 (1.11, 2.35)	6.393*	2.74 (1.72, 4.35)	18.089***
Radiations		11.856*	1.66 (1.09, 2.53)	5.637*	2.28 (1.38, 3.77)	10.379*

*Multivariable Logistics Regression; AOR - Adjusted Odd's Ratio; Omnibus test (p <0.001); Hosmer and Lemeshow test (p > 0.05); *p < 0.05, **p < 0.01, ***p < 0.001 considered as statistically significant*

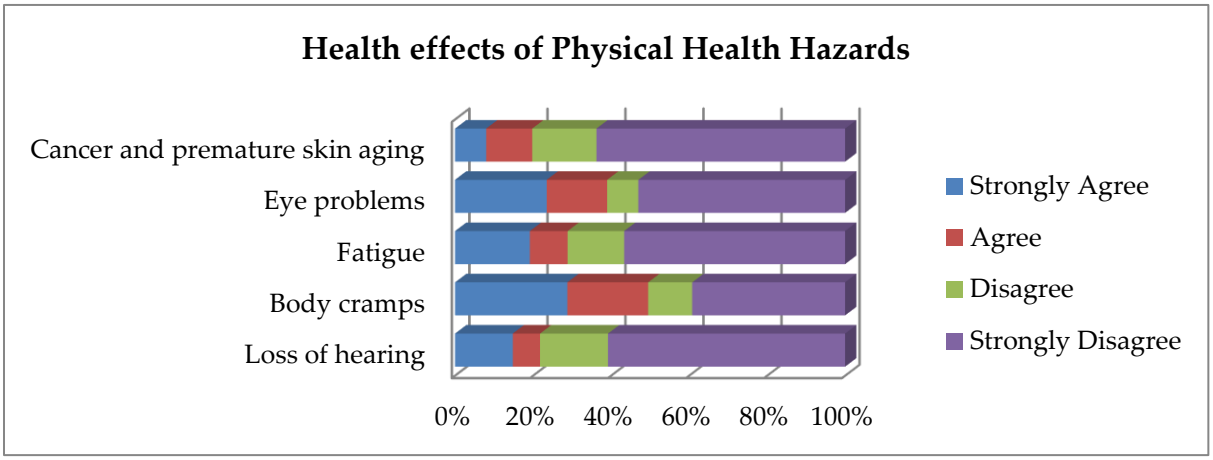

Figure 2: Charting the ill effects reported by employees due to physical hazards

Table 3: Chemical health hazards reported in petrochemical industries

Chemical Health Hazards	Place of work					
	Petrol bunk		ECI		Oil refinery	
	AOR (95% CI)	Wald	AOR (95% CI)	Wald	AOR (95% CI)	Wald
Chemical substances	Ref	27.250***	2.66 (1.84, 3.86)	26.900***	1.74 (1.09, 2.78)	5.562*
Solvent, mist, fume, and gas substances		32.463***	2.37 (1.64, 3.44)	20.880***	3.14 (1.92, 5.14)	20.791***
Dust, particles, metal and metalloid substances		53.563***	3.85 (2.64, 5.63)	48.787***	2.79 (1.75, 4.45)	18.779***
Flammable, poisonous, and corrosive gases		52.458***	3.78 (2.59, 5.51)	47.720***	2.82 (1.77, 4.48)	19.112***
Hazardous chemicals are inhaled, ingested, and injected		22.496***	1.98 (1.37, 2.84)	13.454***	2.62 (1.63, 4,21)	15.773***
Eating where there are chemicals is highly prohibited		32.362***	2.52 (1.74, 3.65)	23.681***	2.90 (1.82, 4.61)	20.076***
Chemical substances should be carefully handled and labeled		42.095***	2.89 (1.96, 4.19)	31.495***	3.27 (2.05, 5.23)	24.553***

*Multivariable Logistics Regression; AOR - Adjusted Odds Ratio;Omnibus test (p <0.001); Hosmer and Lemeshow test (p > 0.05); *p < 0.05, ** p < 0.01, ***p < 0.001 considered as statistically significant*

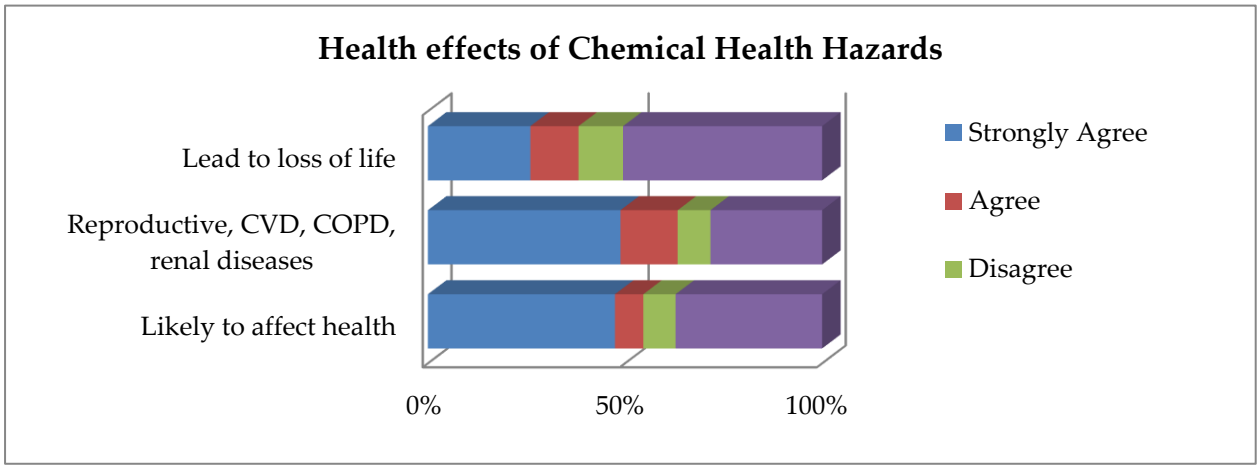

Figure 3: Charting the ill effects reported by employees due to chemical hazards

Table 4: Mechanical/ Ergonomics health hazards reported in petrochemical industries

Mechanical Health Hazards	Place of work					
	Petrol bunk		Oil refinery		ECI	
	AOR (95% CI)	Wald	AOR (95% CI)	Wald	AOR (95% CI)	Wald
Awkward posture	Ref	9.409*	0.61 (0.41, 0.90)	6.228*	0.53 (0.32, 0.89)	5.759*
Working at height		4.728	0.71 (0.47, 1.07)	2.733	0.61 (0.36, 1.04)	3.295
Standing for a long while		1.818	0.78 (0.53, 1.13)	1.767	0.86 (0.54, 1.37)	0.533
Obsolete work		7.029*	0.57 (0.38, 0.87)	7.029*	0.83 (0.51, 1.36)	0.551
Lift heavy objects		28.832***	0.32 (0.20, 0.53)	19.482***	0.25 (0.12, 0.51)	14.202***
Sitting for a longer duration		13.647*	0.50 (0.34, 0.76)	10.896***	0.52 (0.31, 0.88)	6.102*
Monotonous work		3.396	1.24 (0.87, 1.77)	1.367	0.79 (0.50, 1.26)	0.974

Multivariable Logistics Regression;AOR - Adjusted Odds Ratio;

Omnibus test ($p < 0.001$); Hosmer and Lemeshow test ($p > 0.05$)

$p < 0.05$,$p < 0.01$, ***$p < 0.001$ considered as statistically significant*

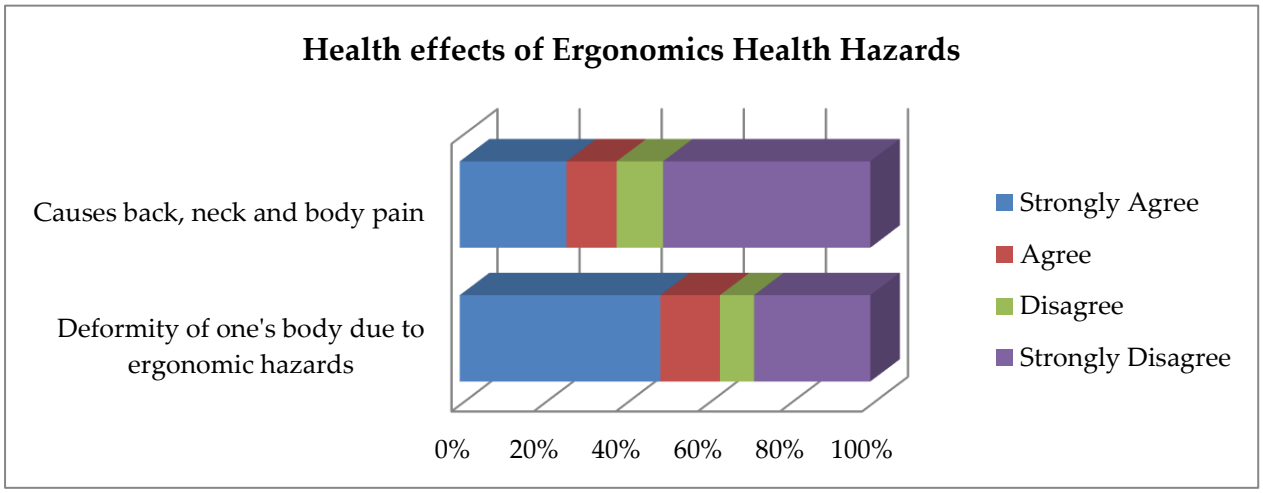

Figure 4: Charting the ill effects reported by employees due to mechanical hazards

Table 5: Biological health hazards reported in petrochemical industries

Biological Health Hazards	Place of work					
	Petrol bunk		Oil refinery		ECI	
	AOR (95% CI)	Wald	AOR (95% CI)	Wald	AOR (95% CI)	Wald
Microbes	Ref	1.384	0.79 (0.52, 1.18)	1.329	0.97 (0.56, 1.60)	0.016
Hazardous waste		1.449	1.19 (0.81, 1.72)	0.783	0.88 (0.54, 1.44)	0.245
Poor environmental hygiene		4.549	0.93 (0.63, 1.38)	0.130	0.55 (0.31, 0.96)	4.493*

Multivariable Logistics Regression;AOR - Adjusted Odds Ratio;

Omnibus test (p <0.001); Hosmer and Lemeshow test (p > 0.05)

p < 0.05,p < 0.01, ***p < 0.001 considered as statistically significant*

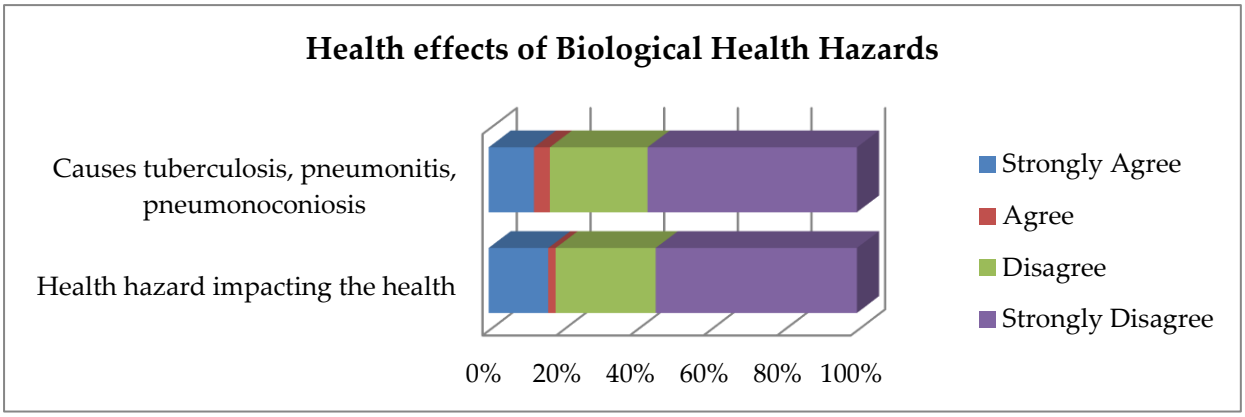

Figure 5: Charting the ill effects reported by employees due to biological hazards

Table 6: Psychosocial health hazards reported in petrochemical industries

Psychosocial Health Hazards	Place of work					
	Petrol bunk		Oil refinery		ECI	
	AOR (95% CI)	Wald	AOR (95% CI)	Wald	AOR (95% CI)	Wald
Challenging workload	Ref	7.063*	1.33 (0.86, 2.07)	1.615	2.00 (1.19, 3.35)	6.975*
Like to be transferred		1.027	1.23 (0.78, 1.91)	0.832	1.22 (0.70, 2.14)	0.530
Isolation		3.807	1.05 (0.64, 1.71)	0.041	0.48 (0.21, 1.05)	3.332
Talked down by my superiors		2.407	1.49 (0.89, 1.50)	2.365	1.13 (0.57, 2.23)	0.126
Aggression and harassment		4.493	0.74 (0.46, 1.18)	1.560	0.51 (2.64, 0.99)	3.882*

Multivariable Logistics Regression;AOR - Adjusted Odds Ratio;

Omnibus test (p <0.001); Hosmer and Lemeshow test (p > 0.05)

p < 0.05,p < 0.01, ***p < 0.001 considered as statistically significant*

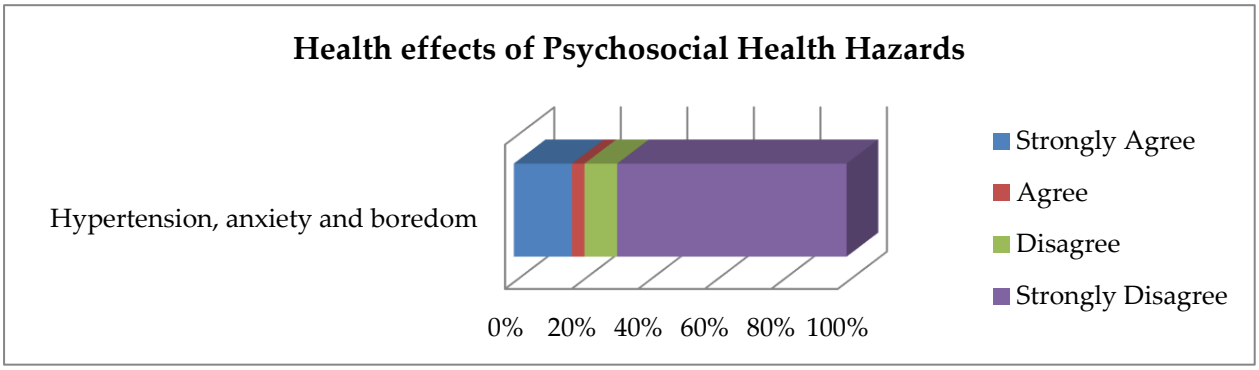

Figure 6: Charting the ill effects reported by employees due to psychosocial hazards

Table 7: Reported precautionary measures undertaken in petrochemical industries

Precautionary Measure	Place of work					
	Petrol bunk		Oil refinery		ECI	
	AOR (95% CI)	Wald	AOR (95% CI)	Wald	AOR (95% CI)	Wald
Pre-employment training	Ref	0.630	1.15 (0.71, 1.86)	0.337	1.24 (0.66, 2.31)	0.472
Pre-employment entrance health examination		8.552*	1.85 (1.02, 3.34)	4.164*	3.26 (1.25, 8.48)	5.906*
Periodical health examination monitoring/surveillance		2.930	0.69 (0.34, 1.40)	1.050	1.94 (0.55, 6.77)	1.086
Personal Protective Equipment (PPE)		12.764*	0.15 (0.05, 0.47)	10.787*	0.66 (0.11, 3.67)	0.223
Training to update and upgrade their efficiency and effectiveness		12.974*	0.14 (0.04, 0.43)	11.699**	0.43 (0.09, 1.98)	1.148
First Aid Box		11.684*	0.23 (0.09, 0.61)	8.828*	2.02 (0.24, 16.98)	0.419
Signed HSE Policy		9.040*	0.33 (0.14, 0.76)	6.764*	1.51 (0.32, 7.13)	0.277
Implementation of the HSE Policy		8.053*	0.33 (0.14, 0.76)	6.764*	1.00 (0.26, 3.76)	0
Considerations for the health and well-being of their employees		9.040*	0.33 (0.14, 0.76)	6.764*	1.51 (0.32, 7.13)	0.277
Active Occupational Health Safety System		8.825*	0.35 (0.15, 0.82)	5.856*	3.06 (0.38, 24.47)	1.113

Multivariable Logistics Regression;AOR - Adjusted Odds Ratio;

Omnibus test (p <0.001); Hosmer and Lemeshow test (p > 0.05)

p < 0.05,p < 0.01, ***p < 0.001 considered as statistically significant*

Discussion

The current study aims to identify the presence of occupation-based health hazards, including physical, chemical, mechanical, biological, and psychosocial hazards, coupled with the precautionary measures taken to overcome the effects of hazards in the Petrochemical industry. Harsh chemicals, a rigid work schedule, and a high-risk environment can have adverse effects on the health of the employees.

Due to cramped working spaces, workers are

frequently exposed to occupational hazards far more than those from the surrounding environment. Environmental matrix monitoring, including water, soil, vegetation, and other components, detects exposure to hazardous materials in the vicinity of petrochemical plants. In the present study, only 29.04% of the workers acknowledged the presence of physical hazards, including high temperature, extreme heat, vibration, inadequate illumination, and radioactive substances. Physical hazards can lead to health risks such as headaches, heart attacks, loss of hearing, skin irritation, and fatigue.[20] 36.1% of participants reported these symptoms. About 49.62% of workers reported the existence of chemical hazards, such as hazardous chemicals that can sometimes be inhaled or ingested over a long period of time. These petrochemicals can lead to reproductive disorders, cardiovascular diseases, respiratory diseases, renal diseases, and cancer.[4,21-24] According to the National Institute of Health (NIH), chemicals produced in the petrochemical industry are known to be endocrine-disrupting, causing hormonal dysfunction.[25] Among the participants, 23.5% are known to have these health conditions and are on medication. 35.55% of the participants admitted to having the presence of ergonomic health hazards, including standing for a long time, leading to chronic body pain. Additionally, the results indicate that 15.6% of participants revealed biological health hazards, including hazardous waste that can even cause Tuberculosis and Pneumonitis. A total of 18.21% of participants reported experiencing psychosocial health hazards and anxiety due to combative behavior from customers.

Compared to the Benson et al. study (2021) conducted in Nigeria's oil and gas industry, the present study found slightly higher levels of ergonomic, physical, chemical, psychosocial, and biological health hazards.[26] The hazards reported in the present study were fewer than those reported in the study conducted by Faith et al. (2014.[13] Studies have shown that workplace stress affects thyroid function and liver function indices of petroleum refining workers.[27] According to the study conducted by Prabu et al., prolonged stress at the workplace can lead to oral health problems.[28] In a study conducted by Konuvonen et al. 2005, workplace stress was strongly associated with smoking.[29] The findings of the present study revealed that approximately 40% of employees reported using tobacco products. This observation may be indicative of occupational stress within the workplace and also underscores a potential risk factor for the development of oral cancer among the workforce.[30]

Mahalkar et al.'s 2022 study outlines the short and long-term health risks involved in the petrochemical industry. The study also emphasized the need for the substitution of every hazardous chemical with non-hazardous ones and the wide use of Personal Protective Equipment (PPE) at worksites.[31] According to the present study, 93.62% of the participants were satisfied with the precautionary measures undertaken by the organization. In total, less than half the participants identified potential health hazards in the field, while 79.3% of the participants never wanted to shift jobs. The findings suggest that participants who show positive attitudes towards their workplace may indicate either relatively high job satisfaction or a lack of awareness about the implications of hazards. However, enhancing focus on workplace safety and financial support can further uplift the quality of life among employees. The findings were in accordance with Langkulsen et al.'s study (2011), indicating that awareness of health risks and chemical hazards among those who worked with toxic chemicals was higher compared to those who did not.[32] Salvador R et al. study (2025) recommended strengthening the labor inspection system by appointing additional inspectors, standardizing inspection protocols, and imposing stricter penalties for violations to ensure effective occupational health and safety.[33]

Mahat el al. 2025, study emphasized the need for continued investigation and research on occupational risks, changing work patterns, work related illnesses and the importance of health care

provision in occupational settings.[34] The main strength of the study is its pioneering nature in exploring the occupational health hazards in the high-risk petrochemical industry in Chennai. The study identifies the industry-specific health issues that compromise the well-being of employees. The study fills a critical gap in the existing occupational health literature. It may serve policymakers and regulatory bodies to address concerns and contribute to the development of a safe and supportive working environment for industrial workers. Thus, this study remains the foundation for refining and reinforcing the health strategies, sustained monitoring, and regular risk assessments.

Despite its contributions, the study has certain limitations. Firstly, the study's generalization may be limited due to its focus on a specific geographic location. Secondly, the data relies on self-reported outcomes, which may be subject to social desirability bias. Thirdly, the nature of the study design prevents establishing a causal relationship between exposure to occupational health hazards and health effects. Further confirmation of these findings across other regions and operational settings would be beneficial in future studies.

Conclusion

Although the petrochemical industry is commonly perceived as high-risk, the study identified that the presence of occupational health hazards was relatively limited to chemical and ergonomic hazards predominantly, followed by physical hazards. The findings suggest that existing safety protocols and precautionary measures may be effective at mitigating significant health risks. However, the presence of even minimal health hazards warrants continued monitoring and preventative strategies.

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References

1. World Health Organization: WHO. Occupational health [Internet]. 2019. Available from: https://www.who.int/health-topics/occupational-health
2. World Health Organization. WHO/ILO: Almost 2 million people die from work-related causes each year. 2021. Available from: https://www.who.int/news/item/17-09-2021-who-ilo-almost-2-million-people-die-from-work-related-causes-each-year .
3. Tupper C, Swift CJ. OSHA Chemical Hazards and Communication. StatPearls – NCBI Bookshelf. 2022. Available from: https://www.ncbi.nlm.nih.gov/books/NBK580552/
4. Domingo JL, Marquès M, Nadal M, Schuhmacher M. Health risks for the population living near petrochemical industrial complexes. 1. Cancer risks: A review of the scientific literature. Environmental Research. 2020;186:109495. Available from: https://doi.org/10.1016/j.envres.2020.109495
5. International Energy Agency. The Future of Petrochemicals: Towards more sustainable plastics and fertilizers. 2018. IEA, Paris. Available from: https://www.iea.org/reports/the-future-of-petrochemicals
6. Robles JO, Almaraz SDL, Azzaro-Pantel C. Chapter 2 - Hydrogen Supply Chain Design: Key Technological Components and Sustainable Assessment. Hydrogen Supply Chains. 2018:37-79.Available from: https://doi.org/10.1016/B978-0-12-811197-0.00002-6
7. Sharma A, Sharma P, Sharma A, Tyagi R, Dixit A. Hazardous Effects of Petrochemical Industries: A Review. Recent Advances in Petrochemical Science. 2017;3(2):555607. Available from: https://doi.org/10.19080/RAPSCI.2017.03.555607
8. Refining-IOCL: Indian Oil Corporation Limited. Ministry of Petroleum and Natural Gas. 2020. Available from: https://mopng.gov.in/en/refining/iocl
9. Speight JG. Handbook of Petrochemical Processes [Internet]. CRC Press. Taylor & Francis Group. 2019.

Available from: https://doi.org/10.1201/9780429155611

10. Mohamadzadeh B, Omidvar B. Explosion in oil, gas, and petrochemical industries. Crises in Oil, Gas and Petrochemical Industries. 2023:175-99. Available from: https://doi.org/10.1016/B978-0-323-95154-8.00007-4
11. Viswanathan B. Chapter 2: Petroleum. Energy Sources: Fundamentals of Chemical Conversion Processes and Application. Amsterdam: Elsevier, 2016. Available from: https://www.perlego.com/book/1832666/energy-sources-fundamentals-of-chemical-conversion-processes-and-applications-pdf
12. Minhooo L. Hazardous Effects of Petrochemical Industries: Systems Study of the Petrochemical Industry. Advanced Chemical Engineering. 2022;12(10):255. Available from: https://doi.org/10.35248/2090-4568.22.12.255
13. Eyayo F. Evaluation of Occupational Health Hazards among Oil Industry Workers: A Case Study of Refinery Workers. OSR Journal of Environmental Science, Toxicology and Food Technology. 2014;8(12):22-53. Available from: https://doi.org/10.9790/2402-081212253
14. Occupational Safety and Health Administration. OSHA: Safety and Health Program Management Guidelines. Draft for Public Comment. 2015. Available from: https://www.osha.gov/sites/default/files/SHPM_guidelines.pdf
15. Occupational Safety and Health Administration. Hazard Communication Standard: Safety Data sheets. 2012. Available from: https://www.osha.gov/sites/default/files/publications/OSHA3514.pdf
16. Occupational Safety and Health Administration. OSHA: Recommended Practices for Safety and Health Programs. 2016. Available from: https://www.osha.gov/safety-management/
17. Occupational Safety and Health Administration. OSHA: Oil and Gas Extraction. Safety Hazards Associated with Oil and Gas Extraction Activities. 2023. Available from: https://www.osha.gov/oil-and-gas-extraction/hazards
18. Benson C, Obasi IC, Akinwande DV, Ile C. The impact of interventions on health, safety and environment in the process industry. Heliyon. 2023;10(1):e23604. Available from: https://doi.org/10.1016/j.heliyon.2023.e23604
19. World Health Organization: WHO. Measurement of and target-setting for well-being: an initiative by the WHO Regional Office for Europe, WHO Regional Office for Europe, Copenhagen. 2013. Available from: https://www.europeansources.info/record/measurement-of-and-target-setting-for-well-being-an-initiative-by-the-who-regional-office-for-europe-second-meeting-of-the-expert-group-paris-france-25-26-june-2012/
20. Woodruff TJ. Health Effects of Fossil Fuel-Derived Endocrine Disruptors. New England Journal of Medicine. 2024;390(10):922-33. Available from: https://doi.org/10.1056/NEJMra2300476
21. Su Z, Fan S, Niu Y, Wu J, Wu Q, Zhou B, et al. The association between occupational noise exposure and hearing loss among petrochemical enterprise workers in Hainan, South China. Scientific Reports. 2025;15:9447. Available from: https://doi.org/10.1038/s41598-025-90023-1
22. Marquès M, Domingo JL, Nadal M, Schuhmacher M. Health risks for the population living near petrochemical industrial complexes. 2. Adverse health outcomes other than cancer. The Science of the total environment. 2020;730:139122. Available from: https://doi.org/10.1016/j.scitotenv.2020.139122
23. Moshiran VA, Karimi A, Golbabaei F, Yarandi MS, Sajedian AA, Koozekonan AG. Quantitative and Semiquantitative Health Risk Assessment of Occupational Exposure to Styrene in a Petrochemical Industry. Safety and Health at Work. 2021;12(3):396-402. Available from: https://doi.org/10.1016/j.shaw.2021.01.009
24. Fassio F, Bussa M, Oddone E, Ferraro OE, Puci MV, Morandi A, et al. Health status of petrochemical workers: a narrative review. Italian Journal of Occupational Medicine and Ergonomics. 2022;44(1):51-58. Available from: https://doi.org/10.4081/gimle.581

25. National Institute of Environmental Health Sciences. Disease Rates Rise With Growing Petrochemical Production. [Internet]. 2024. Available from: https://www.niehs.nih.gov/research/supported/centers/core/spotlight/petrochemical

26. Benson C, Dimopoulos C, Argyropoulos CD, Mikellidou CV, Boustras G. Assessing the common occupational health hazards and their health risks among oil and gas workers. Safety Science. 2021;140:105284. Available from: https://doi.org/10.1016/j.ssci.2021.105284

27. Tian HE, Ma L, Zhou LP, Wang Y. Effects of occupational stress factors on the function of thyroid and liver among petroleum refining and petrochemical workers. Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi. 2018;36(4):295-7. Available from: https://pubmed.ncbi.nlm.nih.gov/29996255

28. Prabu D, Sindhu R, Dinesh D, Shreelakshmi S, Rajmohan M, Bharathwaj VV, et al. Examining the relationship between physiological job stress and sleep bruxism among working and non-working women in North Chennai, Tamil Nadu. International Journal of Dental and Clinical Study. 2022;3(2):8-16. Available from: https://www.ijdcs.com/index.php/ijdcs/article/view/45

29. Kouvonen A, Kivimäki M, Virtanen M, Pentti J, Vahtera J. Work stress, smoking status, and smoking intensity: an observational study of 46,190 employees. Journal of Epidemiology and Community Health. 2005;59(1):63-9. Available from: https://doi.org/10.1136/jech.2004.019752

30. Savitha S, Rajmohan M, Prabu D, Dinesh D, Sindhu R, Nimmy P. Prevalence of Oral Cancer In India: A Systematic Review. Indian Journal of Public Health Research and Development. 2024;15(4):16-24. Available from: https://doi.org/10.37506/1yqne619

31. Mahalkar V, Kumar S, Singhal S. Long term and short-term occupational health risks associated with petroleum industry in India. World Journal of Advanced Engineering Technology and Sciences. 2022;5(2):54–61. Available from: https://doi.org/10.30574/wjaets.2022.5.2.0044

32. Langkulsen U, Vichit-Vadakan N, Taptagaporn S. Safety and health in the petrochemical industry in Map ta Phut, Thailand. Journal of Occupational Health. 2011;53(5):384-92. Available from: https://doi.org/10.1539/joh.11-0091-oa.

33. Salvador LR, Llerena MA, Llerena CA, Gupi M. Occupational Safety and Health in Ecuador: Legal Frameworks, Labor Inspectorate Challenges and Insights. International Journal of Occupational Safety and Health. 2025;15(3):299-313. Available from: https://doi.org/10.3126/ijosh.v15i3.77504

34. Mahat D, Neupane D, Shrestha SK. A decade in focus: occupational health and safety research trends - a bibliometric approach. International Journal of Occupational Safety and Health. 2025;15(2):308-26. Available from: https://doi.org/10.3126/ijosh.v15i2.64809