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Health Hazards of Benzene Exposure Among Petrol Pump Attendants in North Indian Cities

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Abstract

Benzene exposure is an undisputed occupational risk, notably among petrol pump attendants who come in contact with fuel vapors. Chronic exposure to benzene is linked to several conditions, such as hematological disorders, respiratory issues, and increased cancer prevalence. This research aims to assess the health effects related to benzene exposure amongst petrol attendants in the northern cities of India. A cross sectional study was conducted at each petrol pump in major metro areas of Northern India. The sample size was 773 petrol pump attendants. Air samples for benzene were taken from the working stations and biological samples (blood/urine) from the attendants were examined for benzene metabolites. Self-reported symptoms, occupational history, and compliance to safety measures were captured through questionnaires. SPSS was used to run descriptive statistics and correlation analyses on the data. Initial results show that petrol pumps have high benzene concentrations which are above permissible exposure limits. Other symptoms reported include dizziness, headaches, breathlessness, and tiredness. Long term exposure associated with some hematological aberrations like leukopenia was noted. There is poor safety compliance as there is low adoption of protective wearing of safety clothes and equipment. North Indian petrol attendants are at risk of adverse health outcomes from long term exposure to benzene. Occupational health and safety regulations need to be more stringent, there should be routine medical examination and there should be improved use of PPE to mitigate health risks.

Keywords: Benzene exposure, petrol pump attendants, occupational health, north India, hematological disorders, air pollution

INTRODUCTION

Benzene is an organic compound related to petroleum products, and like all other products of crude oil, it is flammable. It has the sweetest smell among oil products, evaporates quickly and is colorless. Benzene has characteristic features such as a sweet smell, colorless liquid body and highly flammable nature, with the capability of quickly vaporizing when exposed to air. As a Group 1 Carcinogen, fuel attendants have been ranked among the most susceptible occupational groups of benzene fueled inhalation from petrol gas fumes as a result of its widespread use [1]. A wide category of individuals comprising everyone working on petrol stations to more precisely the petrol pump attendants have or are continuously expanding their critical utilization and consumption of benzene fumes perilously making them terribly susceptible to its toxic effects [2].

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Insufficient research proves the link between short term health complications and work performance, while long term exposure is linked to development of severe disorders like respiratory diseases, hematological issues and neurological deficiency. Carcinogenic and non-carcinogenic

impacts related to bone marrow depression including anemia, leukopenia or thrombocytopenia, and growth of AML are linked to long term benzene exposure. While drowsiness, headache, dizziness and respiratory vent irritation can result in severe health consequences [3, 4]. Cerebral neuro-benzene disorders like most mental-physiological derangements are very rare to observe but widespread approaches that aim to treat ailments in the circulatory and the respiratory systems make this a very real phenomenon.

Research has shown that long-term breathing of benzene vapor can lead to cognitive dysfunction, amnesia, and reduced motor skill capabilities [5]. On top of this, Schneiderian smog has been linked to reproductive toxic damage that could impair reproductive ability and cause birth defects [6]. There have been changes noticed regarding immune function as well, with some studies proving that working with benzene leads to immune system damage and makes the worker more vulnerable to diseases and infections [7].

Given the foregone conclusions, not enough investigation has been done on the level of benzene exposure and its health repercussions for petrol pump attendants in the cities of North India. The sphere of these workers' coverage is further complicated by lack of proper monitoring systems and insufficient implementation of occupational health regulations. Like many others, petrol station attendants in India do not use essential protective clothing like masks and gloves, which increases the duration in which they are able to work unwillingly exposed to the elements [8]. Moreover, other variables such as heavy traffic, limited airflow in the fueling stations, as well as long shifts can increase the levels of exposure.

Weather conditions are also problematic in terms of petrol station benzene exposure. Elevated temperatures, like in many of the North Indian cities, can lead to increased benzene volatilization, which increases the risk of the attendant inhaling benzene while working in an uncovered environment.

Also, any changes such as fuel additives or impurities may impact fuel composition which makes estimating exposure complicated [9].

The purpose of this research is to determine the levels of benzene exposure, analyze its associated health effects, and recommend corresponding occupational safety measures. With the help of this study, better safety procedures and intervention methods will be designed to protect petrol pump attendants from the health risks caused by benzene exposure.

LITERATURE REVIEW

Benzene as an Occupational Hazard

Despite the extensive research and knowledge of its effects, Benzene is the primary occupational health risk especially in petroleum refining, chemicals manufacturing and fuel distribution industries. Researches have proven that individuals working in industries with high concentrations of benzene face increased chances of developing chronic health issues including leukemia and other blood disorders [10]. One of the channels of exposure to Benzene includes, breathing its vapors, contact with skin, and in limited cases, consuming contaminated materials [11].

Health Impacts of Benzene Exposure

Hematological Disorders

Constructive and collaborative efforts with colleagues have provided us with insight on this issue and on certain matters that go well beyond our original expectations. The ethnologist must analyze for cross-identities and examine how people relate to nature, as well as class boundary relations among social groups which ethnologists prefer to ignore. From a social constructivist stance, the point is not merely an ontological claim but an epistemic claim which concerns the relations of identities and surroundings. There is overwhelming chemotoxic evidence that describes the destructive nature of benzene which inflicts onto a person’s body opening pathways for complex issues and providing basis for sorrow. Due to prolonged exposure, the user experiences perpetual consequences such as anemia, leukopenia and

bone marrow deficiency. One lifelong problem chemically associated with chronic exposure is acute myeloid leukemia (AML) which more often than not becomes prevalent due to surviving factors of ordinary life like differentiation of white blood cells [12].

Respiratory Complications

Human beings are made and born through social processes whereby every person is intertwined in relationships with others "Preconceived social molds". This is what fuels the disproportionate dispersion of benzene etheric manifestations causing distinctive patterns targeting certain types of workers resulting in unrelenting powerful effects like emphysema and lung inflammation coupled with inefficiency of the lungs. The overarching theory is that making use of fuel induces professionals to very often complain of extreme exhaustion, an occurring cough, shortage of breath, equated with suppression and difficulty of the chest [13]. Lesser prolonged exposure is also thought to lead to chronic inflammatory response to infection of the lungs deeming benzene to have passive violent effects of fueling viral infection over and over again immunologically weaker people [14].

Neurological Effects

'Burnout syndrome' coined by Freudenberger syndrome in 1974 is the specific malaise resulting as a chain response solving other problems that lies in the vigorous demand of contemporary societies attributing smoking causing memory lapses, imbalance bouts and muscular actions which propose a dire threat to popular health. A field study on fuel stations' employees showed that long exposure was positively correlated with lowered thinking abilities attributes to increased frequency of some head injuries like migraines, lethargy and active state of stupor [15]. The function of the brain through poisoning benzene restraints leads to homo so as to incur extremely different and very negative influences with possible long-term overly severe effects on human behavior and thought pattern unlike any controlled undergoing structure [16].

METHODOLOGY

A cross-sectional study was carried out at petrol stations in some of the prominent cities of North India to evaluate the exposure levels and the health risks of benzene among petrol pump attendants. The study comprised a total of 773 petrol pump attendants who were selected from different urban, suburban and rural regions, which makes the sample representative of the population. The research design aimed at determining all possible exposure levels including biological markers, reported signs, and safety measures taken at the workplace.

Air Sampling

Air samples were collected for the quantification of benzene at petrol pump stations for the purpose of gas chromatography mass spectrometry (GC-MS) analysis. Air sampling was done at several sites within a station, including the fuel selling points and the employee lounge zones, so that different benzene levels in the atmosphere could be captured during work hours. Air samples taken could be used to assess the quantity of benzene in the atmosphere and the degree of exposure against set workplace safety measures by OSHA and WHO [17].

Biological Sampling

Blood and urine samples were taken from petrol pump attendants for these biological samples indicate external benzene exposure. These samples underwent an analysis of benzene metabolites, particularly S-phenylmercapturic acid (SPMA), through high performance liquid chromatography (HPLC) [18]. SPMA is a known metabolite biomarker of benzene which means its presence objectively quantifies the amount of benzene a body has been exposed to. The metabolite concentrations were later evaluated against reference values to ascertain whether the attendants had been exposed to toxic levels of benzene.

Questionnaire Survey

Besides the environmental and biological monitoring, structured questionnaires were also used to gather self-reported occupational health and environmental history of the attendants. The questionnaire

contained items on the amount of time worked, number of work hours per day, use of PPE such as masks, and any health complaints, including but not limited to, dizziness, headaches, breathing problems, and fatigue. This information was important to understand how workers perceived their situations in relation to health and enabled identification of associations between symptom and exposure levels.

Data Analysis

All data collected was analyzed in an organized manner by using social statistical software (SPSS). Both descriptive and inferential statistical techniques were applied to determine the relationship between health symptoms and benzene exposure levels. Assisted by two different regression analyses, the impact of benzene concentration and biomarker levels alongside the reported health issues was measured with illness severity. Within the same step, the regarding health issues considered, the biomarkers survey was also performed alongside complying safety regulations, which enabled determining components known to dysregulate the psychosomatic system and crossing the symptom scoring threshold. This analysis shed light on the otorhinolaryngological ailments among petrol station attendants and framed concerns that needed immediate action.

RESULTS AND DISCUSSION

Benzene Exposure Levels

Benzene levels at petrol stations were recorded between 0.5 and 2.5 ppm which is above the PEL limit provided by OSHA [9]. Furthermore, more elevated concentrations were noted in urban centers with heavy vehicular traffic (Table 1).

An analysis of benzene exposure levels at fuel pumps petrol reveals notable differences in exposure across regions, with urban stations exhibiting the highest fuel concentrations. Measurements show that benzene levels in urban fuel stations are between 2.0–2.5 ppm which exceeds the permissible exposure limit (PEL) of 1.0 ppm set by the Occupational Safety and Health Administration (OSHA) by more than two times. It is reasonable to assume that this high concentration is caused by greater vehicle traffic, higher number of fuel intake operations, and confined space within the poorly ventilated metropolitan areas.

In comparison, suburban petrol stations have recorded benzene concentrations within the range of 1.0 and 1.8 ppm. While these values are still dangerous, especially to petrol pump attendants with long exposure to these conditions, they are within touching distance of the permissible limit. The lower levels in such suburban areas are due to lesser traffic congested areas and probably better wind conditions enhancing air circulation.

The lowest reported benzene concentrations of rural petrol stations were 0.5 to 1.2 ppm. Some figures even fell within the limits embraced by OSHA. These areas are likely to experience lower fuel consumption rates along with a smaller number of vehicles, making these open regions less polluted. Hence, they improve the natural ventilation. Still, continuous exposure, even at lower concentrations within range of the permissible limit, could pose long term health risks.

In general, the information brought to light indicates a serious occupational health issue, especially for employees working in urban and suburban stations, where benzene exposure is known to be above safety recommendations. Sources of benzene are everywhere and due to their toxic effect requires immediate action such as improved ventilation, enforcement of personal protective equipment, (PPE), and regular health checks for workers.

Table 1. Benzene exposure levels at petrol pumps.

Location	Benzene Level (ppm)	OSHA PEL (ppm)
Urban Stations	2.0–2.5	1.0
Suburban Stations	1.0–1.8	1.0
Rural Stations	0.5–1.2	1.0

Health Effects among Petrol Pump Attendants

According to the survey, 65% of respondents' problem reported vertigo, 54% experienced headaches, and 48% complained of breathing difficulties. The WBC count from the semi-annual blood tests showed a very low WBC count among those having had more than 5 years of exposure. There was also evidence of chronic exposure resulting in higher incidences of aplastic anemia and pre-leukemia changes.

The symptoms experienced by petrol pump attendants illustrate the alarming effects of benzene exposure on their health. The health symptom reported the most, by two thirds of attendants, was dizziness. This suggests that benzene vapor exposure over time has more acute effects such as impairment of mechanical functions like balance and cognitive skill capabilities. Although common, 54% of workers reported frequent headaches, which can be caused by benzene's impact on the central nervous system resulting in neurotoxic vascular changes.

Respiratory issues were reported by 48% of attendants, corroborating that inhaled benzene impacts the lungs directly. Symptoms such as embarrassing chronic cough, chest tightness, and difficulty breathing for many may be accentuated by exposure to fuel vapors over extended periods of time, especially in poorly ventilated spaces. Fatigue, experienced by 42% of workers, could stem for combined neurophysiological effects of benzene with inhibition of red blood cell production and thus transport of oxygen in the body.

Moreover, 30% of attendants in the study had blood irregularities which are worrisome for benzene's hematotoxic effects (Table 2). Exposure to benzene is known to hinder bone marrow activity, resulting in anemia, leukopenia, and thrombocytopenia. These disorders are detrimental to health and additionally heighten the risk of contracting infections and other major complications.

These findings indicate an even greater need for comprehensive occupational health surveillance, as well as increased enforcement of safety regulations, enhanced protective measures such as the mandatory use of masks and gloves for petrol pump attendants, and education about the dangers of excessive exposure to petroleum products.

Occupational Safety Compliance

Data from observations suggested that participants neglected to adhere to safety protocol, as only 15% of them consistently wore protective gloves and masks. Lack of knowledge and poor enforcement of safety rules greatly contributed to the problem.

The findings on occupational compliance of petrol pump attendant personnel reveal a dangerous non-compliance with protective measures leading to the attendants being highly susceptible to benzene's harmful effects. Attendant glove use was reported with less than 15% frequency which points towards the likelihood of routine and unabated dermal contact to fuel and benzeneous solvents. The risk of systemic toxicity and other chronic health problems is greatly enhanced due to noncompliance with policies owing to the absorption of benzene through the skin.

Table 2. Prevalence of health symptoms among petrol pump attendants.

Health Symptom	Percentage of Workers Affected (%)
Dizziness	65%
Headaches	54%
Respiratory Issues	48%
Fatigue	42%
Blood Abnormalities	30%

Table 3. Occupational safety compliance among petrol pump attendants.

Safety Measure	Usage Rate (%)
Wearing Gloves	15%
Wearing Masks	12%
Regular Health Check-ups	20%
Awareness of Risks	35%

Even lower is the proportion of workers who wear masks, as lack of compliance is recorded with only 12% of the attendants consistently utilizing respiratory protection. Given that risk of benzene exposure is mainly via inhalation, absence of adequate protection increases the chances of a host of non-reversible complications of an increasingly neurological, respiratory, and hematological nature. Strikingly little use of masks reflects a failure to implement basic safety measures alongside inadequate comprehension by the workers of the gravity of damage that sustained contact can bring about.

Only 20% of attendants claimed undertaking regular check-ups which is necessary for timely identification of ailments attributable to benzene. As expected, such low figures are symptomatic of failure of the majority of workers electing not to undergo periodic medical examinations which reduces possibilities of prompt diagnosis and management of health issues like anemia, leukemia, and respiratory illness. Benzene's induced health issues are hardly noticed and unchecked until severe and permanent damage has been done in the absence of continuous health assessments.

Despite the clear danger, the risk of exposure is still not understood by the majority. Only 35% of workers are aware of the risks posed by exposure to vapors from fuel and benzene. Low levels of knowledge remain a critical factor for poor observance of safety standards. In the absence of clear communication regarding the effects of benzene, workers will fail to appreciate the need for personal protective equipment (PPE) as well as health assessment opportunities (Table 3).

The information provided highlights the findings of petrol attendants posing as a stronger example for the lack of safety measures compliance. Stricter workplace safety rules, provision of standard PPE materials, and regular awareness campaigns on safety measures should greatly limit the chances of benzene damage. Moreover, more frequent medical checkups would help improve the treatment of medical issues resulting from exposure.

CONCLUSION AND RECOMMENDATIONS

The study identifies that petrol pump attendants in North Indian cities are suspected of suffering from high levels of benzene and its unwanted impacts, worsened health conditions or hematologic, chronic respiratory diseases, and even neurological conditions. When observing information, attending petrol pumps frequently exceed the limit within the workplace's safety standards, suggesting that necessary precautionary measures have not been established yet. Long term exposure calls for further protective medical measures towards the workers.

Regular Health Screening

To ensure the early diagnosis and treatment of medical issues caused by benzene, routine physical examinations must be required. Autonomic health examinations like blood work and spirometry can aid in the early diagnosis of anemia, leukopenia, and other respiratory problems related to benzene. It is vital for employers to work with other members of the workforce to develop and implement screening policies for their employees. Moreover, enhancing knowledge on the signs of benzene exposure will allow workers to seek medical assistance when necessary, thereby stopping the progression of severe life-threatening complications.

Improved Ventilation

The proper flow of air in petrol pump stations is critical in preventing benzene accumulation. The advanced exhaust and air filtration systems implemented at these stations are likely to reduce concentration levels of the gas, reducing inhalation hazards faced by employees. It is the employers' responsibility to install mechanical ventilation systems and check that open-air stations have adequate airflow. Periodic checks on air quality are also important to ensure banned exposure levels are not exceeded. For locations most at risk that frequently exceed belt lines, additional ventilation measures, such as localized exhaust systems near fuel dispensers, should be used.

Use of Personal Protective Equipment (PPE)

To mitigate exposure to benzene, ensuring proper and constant use of personal protective equipment (PPE) is necessary. At the moment, attendants at petrol stations do not seem to wear gloves, masks, and other protective gear, which makes them susceptible to skin and respiratory intake of these harmful gases. Employers should provide them with good quality PPE, such as resistance benzene gloves, respirators, and coveralls, along with adequate instruction on proper use. In addition, regulatory agencies should monitor compliance with the use of PPE and impose fines for non-compliance. Since most workers do not appreciate the immediate benefits of PPE, some form of educational intervention must be instituted to illustrate its importance for sustaining health in the long run.

Policy Interventions

To safeguard petrol attendants from benzene exposure, there should be a robust system of occupational safety and protection. Government departments ought to establish and enforce policies that set maximum exposure thresholds, require safety instruction, and routine workplace examinations. Employers need to be liable for safe work environments, provision of PPE, and ensuring health examinations for the attendants within set intervals. Furthermore, national campaigns can highlight the risks related to benzene exposure and provoke action from workers and employers toward implementing safer working conditions. Introducing more stringent labor legislation and tougher penalties for breach of laws can help improve occupational health and safety in the fuel retail sector for the better.

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Conflicts of Interest

The authors declare no conflict of interest.

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