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Original Article

Knowledge on lead exposure among Paint workers in Kirtipur Municipality, Nepal

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ABSTRACT

Introduction: Lead exposure is a serious threat to public health. Among various occupational groups, paint workers are at increased risk of lead exposure. This study aims to assess the knowledge on lead exposure, identify symptoms of lead toxicity and to estimate the blood hemoglobin level among paint workers in Kirtipur Municipality.

Methods: A cross-sectional study design was used among 108 paint workers having at least 2 years of exposure. The data collection period was from June to August 2024. Data were collected using convenient sampling through interviews. Semi-structured questionnaires were used as a tool for data collection. The study has been approved by ethics committee. Data entry and analysis was done in SPSS. Chi-square test and multivariate logistic regression analysis was done to find the association between lead exposure and age, level of education, number of years of exposure, duration of working hours, took formal training on safety measures etc.

Results: The mean age ± SD of the participants was 37.61 ±9.75 years. The mean years of exposure was 15.27 ±8.87 years, and mean duration of working was 9.39 ±2.07 hours/day. Headache was the most common symptoms of lead toxicity. Only 10 (9.3%) of the paint workers had good knowledge on lead exposure. Those who have taken formal training on hazards and safety measures have good knowledge on lead exposure and the association was also statistically significant (P≤0.001). However, age, work duration, work experience, and education did not show any significant association. Among the participants, 28 (25.9%) were diagnosed as anemic based on hemoglobin levels.

Conclusion: Study shows that only 9.3% of paint workers have good knowledge on lead exposure. So, awareness program on lead exposure and regular training programs on hazards and safety measures should be conducted.

Keywords: Knowledge, Kirtipur Municipality, Lead exposure, Nepal, Paint workers

Introduction

Lead is a toxic metal and its widespread use has resulted in adverse effects on the environment and human health.[1] People can become exposed to lead through occupational and environmental sources. Exposure routes of lead uptake in the workplace include ingestion and inhalation of inorganic lead.[2] In 2019, nearly half of the 2 million deaths due to known chemical exposure were due to lead exposure. Lead exposure is responsible for 21.7 million years lost due to disability and death worldwide due to its long-term deleterious effects on health.[3]

Among various occupational groups, paint workers are at increased risk of exposure to the chemicals used in their workplace.[4] Among various chemicals, lead-based paint is the major source of lead poisoning.[5,6] According to a WHO report, a human could be exposed to lead from paint through different routes, such as paint application, manufacturing, sanding, or removal of paint films.[7] No level of exposure to lead is known to be without harmful effects, but it can be prevented.[3] The inhaled/ingested lead can transport to the heart, bones, intestines, kidneys, reproductive, and nervous systems, causing tissue-specific adverse effects . 8, 9 Various health effects of lead exposure are anemia, loss of memory, nephropathy, neuropathy, encephalopathy, infertility, and even death. Risk of complications increases with duration of exposure and the only best treatment is to be prevented from exposure.[10]
The complexity of standard requirements and the weighting of their importance, it remains ambiguous and varies.

In this context, knowledge regarding various sources, modes of transmission, various health effects, and the use of personal protective devices is very important to prevent the harmful effects of lead exposure, especially on paint handlers. Therefore, this study will be of great help to the concerned authorities in increasing awareness of the hazardous effects of lead exposure on paint workers. Very few studies have been conducted to assess the knowledge related to lead exposure among paint workers in Nepal. The findings of this study might help strengthen the information available so far and encourage policy makers to design effective strategies to minimize the effect of lead exposure in this population. In this manner, this study will help to fill the research gap.

Methods

A community-based cross-sectional study was conducted in Kirtipur municipality among Paint workers with a minimum work exposure of 2 years duration. Kirtipur municipality was a preferred study site as it has numerous small to medium-sized enterprises, including workshops and construction sites where paint workers are commonly employed. The data collection period was from June to August 2024. The sample size was calculated based on a previous similar study, using the prevalence of knowledge of the hazards associated with the job (72.5%), an 8% margin of error, and a 95% confidence interval.[11] The final sample size was 120.

Out of 19 wards in Kirtipur Municipality, 8 wards were selected based on the high number of paint enterprises operating within them. We selected the participants by using a convenience sampling technique. Data were collected around the active working period at the work site where painters were actively engaged in paint handling. Paint workers with at least 2 years of exposure were included in study.

A semi-structured questionnaire and a blood sample were used as a tool for data collection. The questionnaires were self-constructed and included some questions from a previous study.[11] The questions were divided into four parts. The first part consists of socio-demographic profiles of the paint workers. The socio-demographic variables include age, gender, level of education, ethnicity, duration of employment (years), duration of working hours (hours/day) and formal training on hazards and safety measures in the workplace.

The second part consisted of 30 questions about knowledge on lead exposure. It included whether they have heard about lead or not, four questions about lead entering the body through the skin (absorption), inhalation, ingestion and through drinking water. Two questions on whether they eat/drink and smoke cigarettes in the work area or not. Other knowledge related questions are on washing hands before eating, using PPE to protect against lead exposure, correct use of PPE and wearing work clothes at home or not. Three questions are on the availability of facilities for eating, bathing and hand washing in the work area.

Others questions included whether they are aware of the hazards of lead exposure or not, use PPE properly while working with paints, sources of lead, danger of lead to a baby during pregnancy, availability of treatment and whether lead toxicity is preventable or not.

Ten questions on knowledge on lead exposure leading to anemia, impaired IQ, hypertension, low sperm count, abortion, cardiovascular diseases, neuropathy, nephropathy, encephalopathy and even death.

Proper use of Personal Protective Equipment (PPE) was defined as PPE covering the whole body with coveralls, gloves, boots, masks and goggles to protect against lead exposure. Those who answer more than or equal to 15 questions related to knowledge correctly are said to have good knowledge about lead exposure.

The third part consisted of self-reported symptoms of lead exposure, and the fourth part involved collecting a blood sample for the estimation of blood hemoglobin levels.

The questionnaire was first prepared in English. They were translated into Nepali so that participants could clearly understand the questions. In those who were illiterate, they were clearly explained in detail in presence of the relative. To maintain the consistency of the information collected, all the information from the questionnaire was checked on the same day as of the data collection.

For blood hemoglobin estimation firstly, the participants were made to sit comfortably and written consent was taken. Then, a tourniquet was applied to palpate the vein. The site was sterilized using the rectified spirit. At the angle of 30- 45º, the vein was penetrated with skin tight by another hand. The piston of the syringe was drawn slowly to prevent the hemolysis of the blood. Tourniquet was then removed, slowly with another hand. The needle was removed and blood was transferred to the EDTA vials and mixed properly. The specimen was labeled properly with the participant's identification number. The used needle was finally disposed of following health care waste management guidelines. The blood sample was transported in a cold ice bag to the Cutis Path Lab, New Baneshwor, Kathmandu on the same day.

For estimating Hemoglobin concentration Standard value of optical density was calculated by using distilled water in the test tube. For estimating optical density of testing sample, 5 ml drabkin solution was put in the plain tube along with 20-micron blood sample which is to be tested. Then it was mixed well. After 10 minutes reading was noted in clorimetre at 540 nanometre.

For calculating Hb % following formula was used:
Hb% = Optical density of the test sample X Concentration of standard (i.e 15%)/ optical density of standard.

Blood hemoglobin reference value: The cutoff value for males was taken 13 g/dl and for females 12 g/dl.[12]

The validity of the study was ensured through an extensive literature review, taking an adequate sample size and making the tool comprehensive. Before data collection, the questionnaires were validated by subject experts. The tools were pretested in Nagarjun Municipality in 10% of the sample population and revised accordingly. Additionally, participants were briefed on the tool through an information sheet prior to its administration. Trained data collectors conducted face-to-face interviews. The interview forms were reviewed daily for completeness and rechecked by the researcher for accuracy.

All the data were entered into MS Excel, and analysis was performed using SPSS version 16. Descriptive (mean, standard deviation, range, percentage, frequency) as well as inferential statistics (chi-square test) were used to analyze the results. The Chi-square test was applied to see the association between dependent and independent variables. The level of significance was set at $P<0.05$. For multivariate logistic regression, Variable with P value less than 0.2 was further analyzed using logistic regression to minimize the possible confounding factors.

Before starting the study, the proposal was approved by the institutional review committee of the Nepalese Army Institute of Health Sciences (IRC number: 1076). Informed verbal and written consent were obtained from each respondent, and in illiterate participants, thumbprints were taken after reading the consent paper in detail in presence of relative/friend. All respondents were interviewed in private. Any information that could disclose participants identity including names, phone number, and date of birth or national identification number were not included in the questionnaire to protect confidentiality of participants. Participation was fully voluntary, and no payment or other incentives were offered to the participants.

Results

Out of 120, only 108 participated in the study with the response rate of 90%. The mean age of the participants was 37.61 ±9.75 years, ranging from 17 to 69 years. The mean years of employment was 15.27 ±8.87 years, and the mean duration of working in the site was 9.39 ±2.07 hours per day.

Table 1: Demographic profile of the paint workers (n=108)

Variables	Number (Percentage)
Age (years)	**Mean: 37.61 ±9.75**
≤37	53(49.1)
>37	55(50.9)
Level of education	
Illiterate	10(9.3)
Literate	6(5.6)
Primary (1-5)	26(24.0)
Secondary (6-10)	50(46.3)
Intermediate (11-12)	16(14.8)
Ethnicity	
Brahmin	18(16.7)
Chhetri	3(2.8)
Janajati	82(75.9)
Dalit	5(4.6)
Got formal training on hazards and safety measures	
Yes	27(25.0)
No	81(75.0)
Duration of employment (years)	**Mean: 15.27 ±8.87**
≤15	56(51.9)
>15	52(48.1)
Duration of working hour(hours/day)	**Mean: 9.39 ±2.07**
≤9	63(58.3)
>9	45(41.7)

Out of 108 participants, 50(46.3%) had completed a secondary level of education. Majority of them followed Hindu religion (81.4%), followed by Buddhist (13.0%). The primary ethnicity was Janajati (75.9%) followed by Brahmin (16.7%). Only 25% of paint workers took formal training on hazards and safety measures. Around 52% of the participants had worked for less than or equal to 15 years and 48.1% had worked for more than 15 years. Similarly, 58.3% worked for ≤9 hours per day on the site whereas 41.7% worked for >9 hours per day **(Table 1). Table 2** shows the signs of lead poisoning. Among various signs, headache (22.2%) was the most common sign, followed by numbness or tingling sensation in hand and feet (21.3%), eye irritation (18.5%) and joint pain (16.7%).

Table 2: Signs of Lead poisoning (n=108)

Sign of Lead poisoning	Number (Percentage)
Headache	24(22.2)
Numbness or tingling sensation of hands and feet	23(21.3)
Eye irritation	20(18.5)
Joint pain	18(16.7)
Abdominal pain	11(10.2)
Myalgia	11(10.2)
Skin irritation	8(7.4)
Dizziness	8(7.4)
Fatigue	7(6.5)
Constipation	4(3.7)
Nausea/vomiting	3(2.8)
Pain in the teeth	2(1.9)
Weight loss	2(1.9)
Poor sleep	1(0.9)
Loss of appetite	1(0.9)

Table 3: Knowledge of participants about the lead exposure (n=108)

Knowledge statement	Correct n (%)	Incorrect n (%)
Have you heard about lead?	47(43.5)	61(56.5)
Lead enters the body by mouth?	20(18.5)	88(81.5)
Lead enters the body through the skin?	13(12.0)	95(88.0)
Lead enters the body by inhalation?	21(19.4)	87(80.6)
Lead enters the body through drinking water?	7(6.5)	101(93.5)
Should not eat/drink in the work area?	61(56.5)	47(43.5)
Should not smoke in the work area?	40(37.0)	68(63.0)
Do you wash your hands before eating?	95(88.0)	13(12.0)
Do you use any safety measures to protect against lead exposure?	44(40.7)	64(59.3)
Do you know about the correct use of PPE?	36(33.3)	72(66.7)
Should not wear your work clothes home?	89(82.4)	19(17.6)
Facilities for eating in clean area should be available?	108(100.0)	0(0.00)
Hand washing facilities should be available?	108(100.0)	0(0.00)
Facilities for bathing should be available?	108(100.0)	0(0.00)
Are you aware of the hazards of lead exposure?	42(38.9)	66(61.6)
Do you use PPE correctly while working with paint?	23(21.3)	85(78.7)
Do you know about the Source of lead?	8(7.4)	100(92.6)
Is lead dangerous to a baby during pregnancy?	14(13.0)	94(87.0)
Is treatment available for lead toxicity?	5(4.6)	103(95.4)
Is it preventable?	6(5.6)	102(94.4)

Do you know lead exposure leads to anemia?	7(6.5)	101(93.5)
Do you know lead exposure leads to Impaired IQ?	13(12.0)	95(88.0)
Do you know lead exposure leads to Hypertension?	3(2.8)	105(97.2)
Do you know lead exposure leads to Low sperm count?	3(2.8)	105(97.2)
Do you know lead exposure leads to Abortion?	3(2.8)	105(97.2)
Do you know lead exposure leads to CVD?	7(6.5)	101(93.5)
Do you know lead exposure leads to Neuropathy?	4(3.7)	104(96.3)
Do you know lead exposure leads to Nephropathy?	2(1.9)	106(98.1)
Do you know lead exposure leads to Encephalopathy?	3(2.8)	105(97.2)
Do you know lead exposure leads to death?	5(4.6)	103(95.4)

On assessing knowledge, 47 (43.5%) said that they have heard about the lead in the paint. Of the total, 20 (18.5%) said that the lead entered the body through ingestion, 21(19.4%) said through inhalation, 13 (12.0%) by dermal contact and 7(6.5%) through drinking water. Likewise, 61(56.5%) and 40 (37.0%) said that they should not eat/drink and smoke in the work area respectively. Ninety-five (88.0%) of the paint workers said that they wash hands before eating. Only 44 (40.7%) of the paint workers used PPE to protect against lead exposure. Out of 108 participants, only 36 (33.3%) knew about the correct use of PPE to protect against lead exposure. Most painters 89 (82.4%) said that they should not wear work clothes at home. All of the participants 108 (100.0%) said that facilities for eating in clean areas, handwashing and bathing should be available at the workplace site. Almost 42 (39.0%) of the participants are aware of the hazards of lead exposure. Out of 108 participants, only 23 (21.3%) said they used PPE correctly while working with the paints.

Only 8(7.4%) were aware about the sources of lead. Fourteen (13.0%) of the painter's said lead is dangerous to a baby during pregnancy. Only 5 (4.6%) said that treatment is available for lead toxicity. When asked about the various health effects caused due to lead exposure, 13 (12.0%) said it leads to impaired IQ, and 7 (6.5%) said it leads to CVD and anemia **(Table 3).**

The study showed that only 10 (9.3%) of the paint workers have good knowledge on lead exposure. The mean knowledge score was 8.65±3.92, ranging from 4-27.

The multivariate regression analysis revealed that individuals who had received formal training on hazards and safety measures demonstrated significantly greater knowledge regarding lead exposure, with the association being statistically significant ($P < 0.001$). In contrast, variables such as age, duration of employment, total years of work experience, and educational attainment did not exhibit any statistically significant association.

The mean hemoglobin level of the participants was 14.31±1.87 gm/dl, ranging from 10.30-18.20 gm/dl. Out of 108 participants, 28(25.9%) were anemic and the remaining 80 (74.1%) had normal level of blood hemoglobin.

Table 4: Association between selected variables and knowledge on lead exposure (n=108).

Variables	Knowledge on lead exposure					
Age	Poor Knowledge n (%)	Good knowledge n (%)	COR (95% CI)	P-value	AOR (95% CI)	P- value
≤37	49(92.5)	4(7.5)	1.50(0.39-5.64)	0.395	-	-
>37	49(89.1)	6(10.9)				

Mean Knowledge score	8.65 ± 3.92					
Level of education						
Primary and below	37(88.1)	5(11.9)	0.60(0.16-2.23)	0.333	-	-
Secondary and above	61(92.4)	5(7.6)				
No of years of exposure (Years)						
≤15	52(92.9)	4(7.1)	1.69(0.45-6.38)	0.325	-	-
>15	46(88.5)	6(11.5)				
Got formal training on hazards and safety measures						
No	79(97.5)	2(2.5)	16.63(3.26-84.75)	0.001	0.07(0.01-0.35)	0.001
Yes	19(70.4)	8(29.6)				
Duration of working hours in the site(hours/day)						
≤9	55(87.3)	8(12.7)	0.32(0.06-1.58)	0.130	1.71(0.30-9.70	0.543
>9	43(95.6)	2(4.4)				

Table 5: Prevalence of Anemia (n=108)

Hemoglobin level	Number (Percent)
Anemic	28(25.9)
Normal	80(74.1)

Discussion

Lead, a naturally occurring toxic metal, contaminates the environment through activities like mining, smelting, manufacturing, and recycling, and is found in various products such as paints, stained glass, lead crystal glassware, ammunition, ceramic glazes, toys, lead pipes in drinking water systems, and traditional cosmetics like sindoor and kohl.[13] Lead exposure from paints can occur, especially in young children, when they chew on painted surfaces, swallow or inhale lead-contaminated dust, or peel and crack lead-based paint, which leaves chips and dust on surfaces including windows, doors, floors, and furniture.[14] This indicates that people who come into direct contact with lead or lead based products, such as paint workers, are more likely to be exposed to lead.

This study determines the knowledge regarding lead exposure among the paint workers in Kirtipur municipality, Nepal. The mean age of the paint workers was 37 years ranging from 17 to 69 years. This finding was comparable with other studies.[15,16] Majority of paint workers in our study had more than 15 years of experience. This was similar to a study conducted in Japan where the majority of the paint workers had more than 10 years of experience in the painting industry.[16] The mean duration of working in the site was more than 9 hours per day in our study. The prolonged working hours and extended working spans of these paint workers greatly increase their risk of exposure to chemicals derived from paint. Just 25% of paint workers received official training on safety precautions and hazards. This result

contrasted with a research conducted in Japan, where 94.7% of paint workers reported that they had received advice and instruction about the hazardous and destructive elements of paint from senior employees at their places of employment.[16] A range of symptoms, such as abnormal behavior, anemia-like features, signs of encephalopathy (a disorder marked by brain swelling) with increased pressure within the skull, delirium, coma, seizures and headaches are caused by lead poisoning. Chronic exposure can cause depression, numbness and tingling in the limbs, nausea, abdominal pain, loss of coordination, and short-term memory or attention problems.[2,17] Headache was the most common symptom in our study participants followed by numbness or tingling sensation in hands and feet, eye irritation and joint pain.

In this study, 33.3% of the participants knew about the correct use of PPE but only 21.3% of them used PPE correctly while working with the paint. In contrast to this finding, in a study done among construction painters of Chennai, 73% of the workers were aware about the use of PPE but only 6% use PPE correctly during work. Some typical explanations given by the painters for not using PPEs correctly included extreme heat, increased sweating, discomfort during wear, and difficulty breathing.[15]

Only 43.5% of the paint workers in our study had heard of the chemical lead, whereas only 9.3% had good information regarding lead exposure. This result may have been caused by the low level of education of the paint workers, since 9.3% of them are completely illiterate and only 14.8% have received education above secondary level. In a research involving 84 bridge painters in New England, blood lead levels were greater in paint workers with only a high school degree than in those with at least some college education and the blood lead levels for each month that the bridge painter worked increased significantly.[18] The data suggest that lower education levels are associated with both limited awareness and higher blood lead levels. This highlights the need for better educational outreach and training to ensure the safety and health of paint workers. However, in our study, the association between no. of years worked, work duration, level of education and the knowledge on lead exposure was not statistically significant. The reason could be that a sample size of 108 paint workers may not be large enough to detect a statistically significant relationship, especially if the effect sizes are small. The study shows that those who have taken formal training on hazards and safety measures have good knowledge on lead exposure and the association was also statistically significant. (AOR: 0/068, 95% CI- 0.01, 0.35). This highlights how important it is for employers and employees to have better understanding of occupational safety and services through organized educational programs.[15] Conversely, a study conducted in Nigeria highlights a contrasting scenario.[11] While the level of awareness of occupational hazards among the paint workers was relatively high, the majority had not received formal training on occupational hazards and safety.[11] This indicates that despite the high level of awareness, formal training was not the primary source of knowledge in this setting. Workers might be relying on informal sources of information, peer learning, or personal experience, which may contribute to their awareness but may not provide the depth or accuracy needed to mitigate risks effectively.

Lead poisoning causes anemia by inhibiting heme synthesis enzymes, leading to ineffective heme production and microcytic anemia. It also damages red blood cell membranes, making them more fragile and contributing to anemia.[17,19] We also measured the hemoglobin level of the participants. The mean hemoglobin level was found to be around 14 gm/dl and 25.9% were found to have below normal level of blood hemoglobin. A study conducted among 52 paint industry workers in Indonesia had similar findings, where the mean hemoglobin level was around 15 gm/dl and only 7.6% were anemic.[19]

Limitations

Due to the small sample size and the restriction of the study setting to Kirtipur Municipality, the

findings of this research may have limited generalizability. The results may not be representative of broader populations or other geographic areas There is a risk of recall bias because only symptoms that need to be treated are remembered, and some symptoms of lead exposure are similar to symptoms from other common conditions (such as peripheral neuropathy and gastrointestinal disorders). Therefore, it is not possible to confirm that the symptoms experienced were exclusively caused by lead exposure. This could have been avoided if a control group of individuals with the same characteristics but no lead exposure had been included. Since this is a preliminary study, another disadvantage of the research is that we only evaluated knowledge, not practice.

Conclusion

Due to the small sample size and the restriction of the study setting to Kirtipur Municipality, the findings of this research may have limited generalizability. The results may not be representative of broader populations or other geographic areas There is a risk of recall bias because only symptoms that need to be treated are remembered, and some symptoms of lead exposure are similar to symptoms from other common conditions (such as peripheral neuropathy and gastrointestinal disorders). Therefore, it is not possible to confirm that the symptoms experienced were exclusively caused by lead exposure. This could have been avoided if a control group of individuals with the same characteristics but no lead exposure had been included. Since this is a preliminary study, another disadvantage of the research is that we only evaluated knowledge, not practice.

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