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Occupational Lead Exposure: Assessing Blood Lead Levels, Health Impacts and Risk Practices among Automobile Technicians in Quetta, Pakistan

Faiza Akhtar[1], Manzoor Hussain[2], Safdar Shah Khan[3], Tahir Aslam[4], Rizwan Akhtar[5], Aks-E Taqveen[6]

[1]Department of Environmental Science, Balochistan University of Information Technology, Engineering and Management Sciences, Quetta, Pakistan.

[2]Department of Environmental Science, Balochistan University of Information Technology, Engineering and Management Sciences, Quetta, Pakistan

[3]Department of Environmental Science, General Muhammad Musa Government Postgraduate College, Quetta, Pakistan

[4]Assistant Professor Thoracic Surgery, Fatima Jinnah institute of Chest Diseases, Quetta, Pakistan

[5]Department of Pathology, Multan Medical and Dental College & Ibn-e-Siena Hospital, Multan, Pakistan

[6]Medical Officer, Doctors International Hospital, Rawalpindi, Pakistan

Corresponding Author:

Dr Tahir Aslam,

Assistant Professor Thoracic Surgery, Fatima Jinnah Institute of Chest Diseases, Quetta, Pakistan

Email ID : drtahiraslam@gmail.com

ABSTRACT

Lead contamination in automotive garages poses a severe and overlooked occupational health risk in Quetta. Pakistan. The study applies mixed-methods to investigate blood lead levels (BLLs) and associated risk factors among technicians in Quetta City by using biological sampling and survey questionnaires (covering socioeconomics, demographics, and health risks). Biological sampling (n=100) revealed alarmingly high BLLs, ranging from 6.7 to 24.9 µg/dL. Questionnaire data identified prevalent health symptoms, such as anima, musculoskeletal pain, hypertension, fatigue, lack of appetite, constipation, and headache. Risk assessment identified key exposure routes: inhalation of lead particulates, direct handling of battery waste, and crucially, poor hygiene leading to ingestion via hand-to-mouth activities (e.g., sucking petrol, placing tools in the mouth). Poor personal hygiene and unsafe workplace practices exist in the garages. Major reasons that were identified as primary exposure pathways were breathing in lead-contaminated air, working with acid-leaded batteries and their waste, use of leaded petrol for cleaning and washing the mechanical parts, etc., and major inhalation occurs in technicians by using frequent hand-to-mouth activity i.e. sucking of leaded petrol and putting the lead contaminated tools into mouth, etc. At the end of the study, a policy brief outlining was drawn to combat the health deterioration in the technicians.

Keywords: *Blood Lead Level, Occupational Health, Risk Assessment, Hygiene conditions, Policy directions on Lead Management, Occupational and Environmentally Exposed Automobile Technicians to Lead, Lead Pollution in Quetta*

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1. INTRODUCTION

Lead intoxication is considered a public health problem worldwide, and its consequences are more severe in developing countries (1-3). Lead intoxication occurs when people are exposed to lead, such as breathing in lead-contaminated air, swallowing or touching dust containing lead particles, having leaded fluid drinks, etc. (4,5). In living organisms, lead enters the body through inhalation, ingestion, and dermal effects (6,7). The absorption of lead in the body depends on the size of the particle and its concentration. Approximately 90 percent of small-sized lead particles of diameter less than 2.5 micrometers are readily absorbed through the alveoli into the blood (8,9). The health effects of lead toxicity factors depend upon the person's age, sex, diet, lifestyle, dose intake, exposure time, type of interaction, health condition, etc. (10-12). The WHO estimates that about 2.8 billion labor force are suffering from job-relevant health problems (13,14), in which the

share of Lead infected occupational exposure was more than 0.9% (15). Another study released by the Institute for Health Metrics and Evaluation (16) reported that 900,000 deaths were accrued due to lead exposure. Today, at the global level, lead is considered a toxic element and a generator of health issues for communities (2,17).

In Pakistan, there is a dearth of information about lead toxicity. High levels of lead concentration are found in all the major cities of Pakistan. The Lead concentration in Quetta City was about 4.058 $\mu g/m^3$ (18), which is very high compared to other cities worldwide. Living and working in a lead-contaminated environment are causing toxic effects on the population of Quetta City. The automobile technicians working in garages are one of the occupation groups that are continuously exposed to lead intoxication and facing health problems (19-21). Numerous activities are done by automobile technicians by using lead and its products such as acid lead batteries, lead fumes, lead dust, lead-containing paint mist, etc. All these activities involve the use of lead and cause occupational lead intoxication (22-24). Therefore, the time need is to thoroughly revise the out-dated laws to protect vulnerable technicians.

2. METHODS

The study is exploratory research and mixed-methods paradigm was adopted to find the blood lead levels as well as their subsequent health effects on technicians. The automobile technicians were divided into four categories: auto-frame mechanics (denters = 24%), auto-mechanics (26%), auto-electricians (26 %), and auto-paint sprayers (24 %). In the study, small size and common yard-type garages were taken, where three to four technicians share a joint place; all jobs are performed in the joint yard, working side-by-side all day. The data on the garages was obtained from the Industries Department of Balochistan, Pakistan. The random sample size was calculated from the standard formula given by Krejcie and Morgan (25). The conducted research study provides us with the health effects of automobile technicians in Quetta City.

2.1 Blood Sampling and Analysis

Blood sampling and analysis were done by following the method adopted by Kira et al. and Ahmad et al. (22,26). Venous blood samples were withdrawn from each automobile technician by certified professionally trained medical laboratory personnel. The blood samples were collected using Lithium Heparin Tubes and transported from the Pick point to Laboratory in the ice box. Samples were prepared in triplicate and analyzed within 1 week of collection. The prepared samples were refrigerated (4°C) before lead quantification by graphite furnace atomic absorption spectrophotometry (Perkin Elmer, AAS-PEA-700). All medical waste, for example, used swabs, and gloves, was collected into plastic bags and disposed of properly.

2.2 The Questionnaire

A pre-tested questionnaire was administered physically to collect personal information via medicinal technicians at the time of blood sampling. Constituting the present occupation period, age, protective apparatus, and condition of personal hygiene. The automobile technicians are less or uneducated so a trained instructor from their community was hired to conduct and administer the questionnaires. The total sample size of n = 50 automobile technicians for the research study was taken and the sample size for the unexposed group was 25 (n = 25).

2.3 Ethical Considerations

The protocols for this research were approved by the Ethics Committee of the Baluchistan University of Engineering, Information Technology and Management Sciences Quetta, Pakistan (Approval Reference No. IORG 0008823 OMB No: 0990-0279, registered in US Department of Health and Human Services HHS). Informed willingness was obtained from the technicians'/ research population for collecting blood samples and administering the questionnaire. Persons who were not willing to participate in this research work were excluded. A certified paramedics collected the blood samples.

3. RESULTS

The results section was divided into three parts- biological sampling, health risk factors and hygiene Conditions of Technicians.

3.1 Results of Biological Sampling

The study found that all the technicians irrespective of their profession have significant lead concentrations in their blood ranging from 6.3 $\mu g\ dL^{-1}$ to 24.90 $\mu g\ dL^{-1}$. The auto-technicians were divided into 3 different age groups: 18–26, 27–36, and greater than 37 years. All participants were males working daily for 8 to 12 hours, with an average of 10 hours working. These automobile technicians had 4 to 24 years of work experience (YWE). The age of the participants lies between 18 to 54 years. The result of the BLL is given in Table 1.

Table 1 Result of Elevated Lead Levels in Auto-technicians

Age Group in Years	Total number of Participants	Minimum Lead Concentration level	Maximum Lead Concentration Level	WHO Standard (source WHO 2011)
18- 26	12	6.3 μg/dL	17.10 μg/dL	5 μg/dL
27- 36	18	6.7 μg/dL	21.60 μg/dL	
Above 37	20	7.7 μg/dL	24.90 μg/dL	

3.1.1 Age and Lead Concentration

The age group 18–26 years has a lead concentration of 6.3 μg/dL to 17.10 μg/dL; the mean concentration found in the group was 10.39 μg/dL. In the age group 27–36 years, the lead concentration lies between 7.9 μg/dL and 17.9 μg/dL; the average lead concentration was found to be 11.59 μg/dL and in the age group greater than 37 years, it lies between 7.7 μg/dL to 24.90 μg/dL. The overall lead concentration in technicians was found to be 14.08 μg/dL. The average mean blood lead trace of the combined groups was 12.56 μg/dL. The results of the study indicate that BLLs were found high in all three categories of technicians. The comparison between the three categories of technicians, the older technicians (more than 37 years old), whose working experience and exposure time are more have higher levels of lead concentration in their blood. The comparison between blood lead levels and the WHO standards indicates that all the technicians have high lead levels. Figure 1 shows the comparison of BLL in technicians.

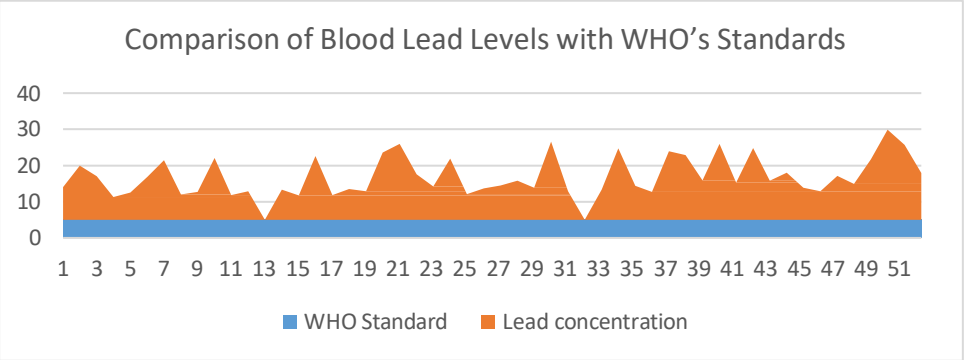

Figure 1: Comparison of Blood Lead Levels in Automobile Technicians with WHO's Standards

3.1.2 Exposure Time at Work and Lead Concentration

The time duration for the work of the technicians was also divided into 2 working groups: those working within 5 to 8 hours, and more than 8 hours. The time range of their work falls between 9.30 a.m. and 10 p.m. The study found that all the technicians work more than 4 hours per day. The results show that 24 % of the technicians were working in the range of 5–8 hours per day, and 76 % of technicians were working more than 8 hours per day. The elevated blood lead level depicted a growth due to increased daily working hours. All the automobile technicians who spent more than 8 hours and operated 5 to 6 days per week had elevated blood lead levels, and most of them had to work as masters. They continued work between 9.30 a.m. and 10 p.m.

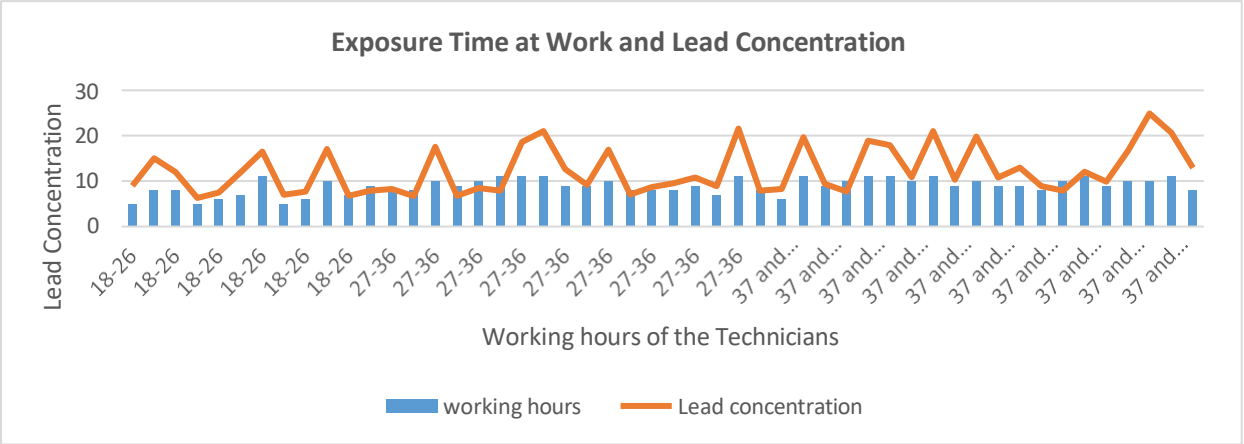

Figure 2: The graph shows the Exposure Time at Work and Lead Concentration

3.1.3 Years of Work Experience and Lead Concentration

The technicians were sub-categorized into 3 clusters of years of work experience (YWE): 0-3, 4-8, and more than eight years. There were 9 participants with work experience of 0–3 years, 16 with work experience of 4–8 years, and 25 with work experience of more than eight years. The study results reveal that as the YWE increases, the BLL of the occupationally exposed automobile technician increases. Hypothetically, it is anticipated that as the YWE and exposure time of the occupationally vulnerable technicians increase, their BLL will also show proportional elevation, considering the multiple factors of exposure. Given this consideration, the lead levels were found to be elevated in the blood of the older technicians (greater than 37), but not very significant as compared with other categories of technicians. The exposure period is a key factor in the calculation of lead toxicity and health effects. Figure 3 shows the relationship between technicians' age and work experience.

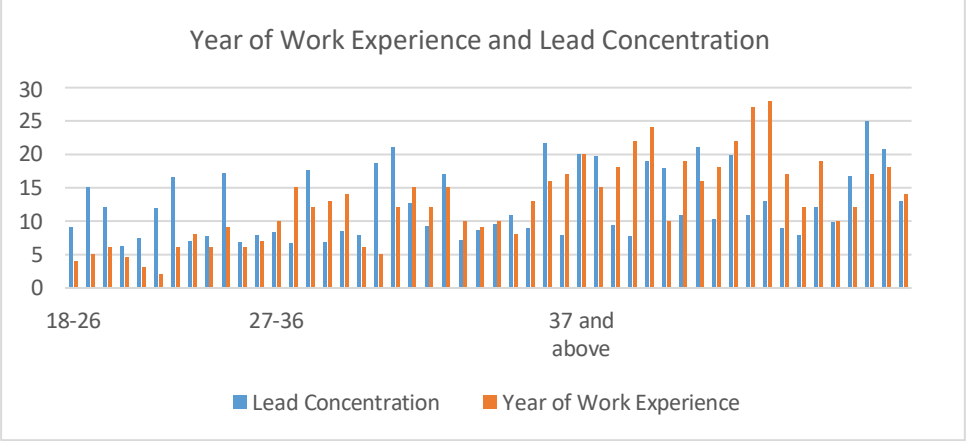

Figure 3 Comparison between years of work experience and Lead concentration

3.1.4 Lead Concentration in the Control Group

The total sample for the unexposed group was 25 (n = 25). The group consists of young, energetic people between the ages of 16 and 25 years. The unexposed group has an education level ranging from metric to a master's degree. They all eat a healthy diet and live in less polluted areas.

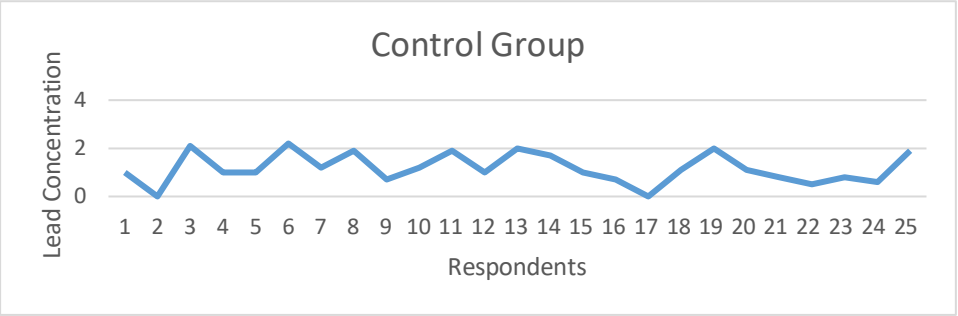

Figure 4: Concentration of Blood Lead Level in the Control Group

3.2 Results of the Survey

In this research study, structured questionnaires were the research tool adopted for the analysis. The major research question and its objectives indicate findings in the following areas: economic status, health and diet, clinical complaints, housing, and social aspects. A total of fifty questionnaires were distributed among different categories of automobile technicians in selected areas of Quetta City. Four indicators of elevated blood lead levels in automobile technicians were converted into 90 measurable questions.

3.2.1 Results of Health Risk Factors in Automobile Technicians

From questionnaires, the health data revealed that the most common health complaint among the occupationally exposed automobile technicians was pain in the muscles, with a magnitude of 60%. Increased exposure to lead in the workplace was reportedly causing higher blood pressure i.e. 48% of technicians had elevated blood pressure (BP > 140/90 mm Hg). The other repeatedly observed health symptom is fatigue and weakness, with a magnitude of 38% and 45%. Another common symptom among technicians is constipation, the ratio is 42 %. Other health complaints in technicians were lack of appetite (22 %), Anemia (12 %), and hypertension (10 %). The least observed health complaint was shivering (in one automobile technician). The ratio of health complaints along with their percentages is given in Table 2

Table 2 Result of health symptoms in technicians

S. No	Health Symptoms	Percentage
1	Muscles Pain	60 %
2	Blood Pressure	48 %
3	Fatigue	38 %
4	Weakness	45 %
5	Lack of Appitide	22 %
6	Constipation	42 %
7	Anemia	12 %
8	Hypertension	10 %
9	Shivering	02 %

3.3 Results of Hygiene Conditions of Technicians

The results of the study show that 80% of the technicians do not have a good appetite. The majority of the technicians (80 %) came from their homes without having breakfast. They eat junk food or take a small quantity of flavored spicy rice (Biryani Rice) from a nearby vendor at 11 a.m. as breakfast. Technicians take meals twice a day, at 11 a.m. and after 9 p.m. 46% of automobile technicians used to eat junk food, and 68% take no citrus food with their meals. As the economic conditions of the technicians are not very good, there are no fruits in their meals. Tea (green or black tea with no milk) is their favorite drink; all the technicians take tea at least six times a day. There is a significant correlation between a good appetite and BLLs in automobile technicians, as poor eating habits play a significant role in elevated blood lead levels. As

the BLL increases, the appetite of the workers becomes low (7, 27).

The exposed workers do not properly wash their hands before taking meals at their workplace. The result exhibited that 90% of the automobile technicians have an eating habit in the garages; 30% of them do not bother to wash their hands before eating; 50% wash their hands with washing detergent or kerosene oil; and only 20% take proper handwashing and care for hygiene. In 99% of the workplaces, the toilet or bathing facilities are not available. The results of the study show that 100% of automobile technicians did not take a bath before going home from work. This indirect action takes lead particles to home. The lead particles may also be carried on tainted shoes, hair, clothes, and nails of automobile technicians, which can be a high health risk factor for their families if appropriate hygiene or cleanliness practices are not practiced.

Frequent hand-to-mouth actions by technicians at auto workshops, for example, chewing gadgets, tools, smoking, etc., were also found to be linked with considerably higher BLL. While working, 78% of automobile technicians suck gasoline into their mouths, 89% use lead gasoline to wash their hands, and 89% put gadgets or tools into their mouths while working. Lead exposure was also occurring due to the chewing habit of lead-containing electrical wiring; the result shows that 90% of the technicians' chew lead-connected wires and non-food items in their mouths.

An ineffective and poorly ventilated system and low-quality air circulation system in garages are also linked to significantly impaired cognitive functioning and are sources of elevated lead levels in technicians. There is an ineffective or poor air ventilation control system in all (99%) of the garages. Further, it was also observed that 80% of the technicians live in congested or roadside areas, which also offer inordinate inhalation of atmospheric lead. Congested housing localities are mainly linked to lower socio-economic positions and higher BLL.

Personal protective equipment (PPEs) is scarcely used by automobile technicians. More than 80% of automobile technicians did not use any PPE such as face masks, hand gloves, safety gadgets, shoes, uniforms, or separate clothes in their working places. 100 % of technicians do not take any occupational health and safety training from any government department or NGO. 97% of exposed occupants (technicians) remained unaware of the toxicity associated with the use of lead.

Another reason for the high magnitude of lead toxicity in technicians is using high lead-containing smuggled gasoline. As technicians perform multiple tasks with leaded gasoline, such as washing and cleaning different automobile parts from gasoline, etc., they use smuggled leaded gasoline due to its cheapness and easy availability.

It is often observed late at night or after work, 90% of the technicians make a bonfire and sit around the circle; especially in winter, the celebration occurs for hours. To make the bonfire, they use cloth assorted with oil or leaded petrol. A black, thick, smoky environment is created around the bonfire, which produces heavily contaminated lead-contained smoke. Inhaling and breathing in such an environment can enhance the lead level in the technician's blood.

There is a significant correlation between illness and lead as 74% do not get proper medical checkups whenever they get ill. 70% of the technicians take home remedies whenever they get ill or take self-medication.

Discussion and Policy Directions

No lead levels in the blood are considered safe, and the health effects are similar regardless of the route of entry (9,28). Inside bodies, lead is accumulated in bones, blood, and tissues. Lead in the body does not stay forever, rather it is stored there as a source of continual internal exposure. As we age, the lead demineralizes our bones and causes non-specific symptoms such as irritability, stomach ache, diarrhea, colic, urinary, kidney, distractibility, weakness, lethargy, brain damage, reproductive systems, etc. (3, 29-32). Lead intoxication is a slowly progressive condition that is difficult to detect but could manifest with non-specific symptoms only. As we see in the case of lead intoxication in Quetta City all of the technicians were suffering from different kinds of illness such as irritability, stomach ache, diarrhea, colic, distractibility, weakness, lethargy, etc. If lead inhalation occurs longer in the body of technicians then its will damage the hematopoietic, nervous, cardiovascular, urinary, anemia, kidney, brain damage, and reproductive systems, etc.

In Pakistan, the health and safety procedures recommended in most laws are not in line with changing times. Many high-risk occupational health and safety (OHS) sectors are not covered by these rules. They contain very few technical standards. Similarly, little is known about the present risk factors for high blood pressure levels. There is also limited information about job exposure in leading Pakistan. Moreover, occupational exposure limits are still missing from Pakistan's laws and do not have proper laws to deal with Lead toxicity. There are also flaws in the health and hygiene laws, especially in the implementation of these laws. Therefore, revising the outdated policies and standards in Pakistan is pivotal for reducing unhealthy exposures in the population as well as achieving health objectives. Therefore, time needs to thoroughly revise and update these laws based on new data to protect vulnerable technicians.

In Quetta City, Pakistan ineffective environmental laws, lack of NEQs, absence of policy on lead human exposure limits, and data monitoring system; Quetta are some of the reasons that make Quetta one of the lead contamination Cities in the world (18). As the lead environmental sources in Quetta city are many, the major source of lead contamination is air. Over-crowdedness in Quetta causes the worst polluted air, traffic overcrowding, and smoke-emitting vehicles, and the use of high lead-containing smuggled gasoline poses serious health hazards to its residents. The use and burning of smuggled

gasoline by the majority of the residents of Quetta is considered the major source of lead pollution in Quetta City. There is a huge difference in prices of Pakistani gasoline and smuggled gasoline. Therefore, the policy initiative that the government should take is to reduce the high prices of gasoline in the country and also implementation of strict environmental laws in the country.

In the research, two awareness sessions were conducted and a follow-up was also done with the technicians. When asked about why they are not using the protective equipment while working. They replied that the equipments are very costly and they cannot afford it. High prices of PPEs are due to they are from imported other countries. Therefore, the government should give the know-how about PPE and supply PPE at a subsidence rate to the technicians and upgrade the local industries by giving incentives in taxes to make PPEs in Pakistan. When asked about the use of smuggled fuel which contains high sulfur and lead in their working. They answered that the local fuel is very costly and they cannot afford it. If the government lowered its gasoline prices and made it equal to the smuggled gasoline, then they would use it. As the price of gasoline is very high in the country, the government should take steps to reduce the price of gasoline in the country and make it affordable to the general public. About the conjunction and low air ventilation system in the garages. They reply that they have shifted into the open air. It was observed that those technicians who worked in the garages moved to the footpath or roadside. All of this creates other social problems due to unawareness, making a disturbance on the road by blocking the traffic flow, creating problems for pedestrians, and frequent traffic jams. This creates frequent fighting and abuse between drivers, policemen, and technicians. Therefore, the government should adopt a strict policy and specify land in open spaces where vehicles can park easily and a systematic design for garages should be developed and it was passed by a concerned government agency.

Awareness is the only solution to combat the ill effects of lead toxicity. It was very hard to convince the technicians but once they were convinced they made a considerable change in their habits. In the research, two awareness sessions were conducted and a follow-up was also done with the technicians. It was observed that the technicians made a significant change in their habits after the sessions. It was noted that the technicians wash their hands before taking their meals with soap, previously majority did not wash their hands, or use washing detergent or petrol for washing but, now they use soap to wash their hands and face. They also added affordable fruit especially citrus fruit to their diet such as lemon, orange, etc. It is also observed that they separate their working clothes. In the morning and after work, the technicians changed their clothes and left the working clothes in the garage before going home. The bone-fire activity was also limited to occasions. Therefore, it was practically noted that awareness creates a considerable change in their attitude. Therefore, by giving awareness to the technicians the problem of lead toxicity may be solved up to 60 percent. In this regard, the government should develop policies regarding awareness. The government should develop a special section in the health department in which the employees are well-versed in awareness programs, these workers will go door to door in the garages and give awareness programs about the toxicity of lead and its ill effects.

4. CONCLUSION

Breathing and working in a contaminated environment causes evaluated blood lead levels in the population of Quetta city. The major reasons for higher lead levels in technicians are that most automobile technicians are illiterate and unaware of lead toxicity effects, further, they do not use personal protective equipment (PPE) at workplaces and do not care about personal hygiene measures. The habit of feeding without washing their hands, chewing lead-containing connective wires and gadgets, and warming themselves by burning leaded gasoline or oil in winter generate high Blood Lead Levels in technicians. Further, working in congested and poorly ventilated environments, using leaded smuggled gasoline, washing hands with leaded gasoline, etc. are some of the occupational exposures to lead. Technicians also lack knowledge about health and safety procedures/ protocols / occupational health and safety training. The study concluded that the majority of the reasons for high blood lead levels in technicians can be solved by giving them awareness about the toxicity effects of lead. Therefore, the government should adopt a single-point agenda by raising awareness among the technicians. Awareness programs should be based on knowledge awareness, knowledge building, and knowledge deployment. In this regard, the government should develop a field force and train staff for the purpose of awareness. These field force visits the garages and give awareness to the technicians. If the government has other priorities than involving health-based NGOs for awareness. Therefore, consistent and ongoing awareness programs are necessary for the success of controlling lead toxicity in Quetta City. Further, other policy initiatives that the government should take are to give incentives to the local industries to make PPE in the country, to reduce the dependency on smuggled gasoline the government should decrease the gasoline price in the country.

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