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Original Article

Occupational stress among workers having exposure to lead

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ARTICLE INFO

Article history:

Received 8 November 2015

Accepted 28 December 2015

Available online 2 May 2016

Keywords:

Lead

Toxicity

Epidemiology

Health status

Occupational exposure

ABSTRACT

Background and aim: Lead has been classified as a probable carcinogen, and ambiguity regarding its toxicity persists due to limited epidemiological evidences. The aim of this study was to investigate the association of occupational lead exposure and symptoms, which indicate malfunctioning in eye, digestive system, upper respiratory tract, chest and skin among men in a case control study.

Methods: Incident cases, which are occupationally exposed to lead ($n = 208$) and general healthy population controls ($n = 64$), were interviewed to fill a validated questionnaire for checking their health status. Body mass index (BMI) was also calculated. The cases consist of workers, who are employed in automobile repairing, tyre and tube maintenance, lead acid battery recycling etc. Comparison was done using t test and Mann Whitney's U test. Odds ratio was also calculated.

Results: The workers were having an increased prevalence of symptoms than normal healthy controls examined throughout this study. BMI was observed to decline continuously among workers with respect to increase in the years of exposure at workplace environment. This decrease in BMI was significant in comparison to healthy controls among group of workers having more than 15 years of exposure to their workplace environment. The symptoms studied throughout this study were also observed to increase in per cent frequency among workers with increase in exposure time.

Conclusion: Increase in the frequency of symptoms was observed among workers with increase in years of occupational exposure. BMI in workers was significantly declining with increase in years of exposure to work environment.

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<http://dx.doi.org/10.1016/j.cegh.2015.12.004>

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1. Introduction

Lead is one of the most toxic heavy metals in the environment nowadays. It is abundant heavy metal, which is globally distributed, causes serious health effects, and is an important environmental toxin.¹ Human occupations related to lead and its compounds expose workers to such heavy metals and their ill effects. The exposure to lead causes mainly due to lead-related occupations like leaded gasoline, industrial process such as smelting of lead and its combustion, lead based painting, lead containing pipes, battery recycling, grids, bearing arm industry, pottery, pipes, boat building, pigments and printing of books, etc. On identifying its effects on health, its widespread use has been discontinued in many countries of the world. In several industries, it is still used vehemently in many sectors namely car repairing, battery manufacturing and recycling, refining and smelting, etc. Long exposure of lead also causes anaemia and an increased blood pressure mainly to old and middle aged people.^{2,3} In pregnant women, an increased exposure can lead to miscarriage.⁴ Severe damage to the tissues of brain and kidneys in both adults and children had been found associated with increased exposure of lead levels, which results in death.⁵ A reduction in fertility results due to chronic lead exposure was reported in males.⁶ Workers exposed to lead were found having an impairment in respiratory functions with elevated blood lead and zinc protoporphyrin concentration.⁷ Lead does not have any physiological role in the body, and there is no threshold value for the level of lead in blood, below which its concentration can be considered as safe. Heavy metals including lead are also found in traditional medicines; hence a number of diseases have been reported due to consuming of traditional medicine.⁸

One of the major sources for lead poisoning in adults is by occupational exposure. An estimate made by the National Institute of Occupational Safety and Health (NIOSH) states that more than 3 million workers in the United States are potentially exposed to lead in the workplace.⁹ Occupational exposure is the major concern and is also the main cause of lead poisoning.¹⁰ Occupational workers such as, lead miners and smelters, plumbers and fitters, auto mechanics, glass manufacturers, construction workers, battery manufacturers and recyclers, firing range instructors, and plastic manufacturers are at risk due to lead exposure. Men involved in occupations such as welding and manufacture of battery recycle workers are also at a risk for lead exposure.¹¹ The children, whose parents are involved in the occupations, which expose them to lead at workplaces generally have dust containing lead with clothes or skin, which increases the chances of exposure in their children.¹² In addition to this, the other common places of occupations, where chances of lead toxicity are always a possibility are places, where works of lead-acid batteries or pipes, and metal recycling and foundries are generally taking place.¹³ The other chance of lead exposure occurs through various ways such as inhalation, ingestion or skin contact. Lead exposure may also increase through direct contacts of lead or lead based compounds through mouth, nose and eyes and through cracks of skin. A total of 35–40% of inhaled lead dust in adults is deposited in lungs, and about 95% of that goes into the bloodstream.¹⁴ The literature available on

lead has studied mostly effects of its toxicity on human and other animal groups in haematological and genotoxic bases. However, no study is available to study the symptoms, but the current study focuses on. The study is designed to undertake survey and interview to examine the general account of health in workers, who are exposed to lead and involved in occupations such as automobile repairing, tire and tube maintenance, and lead acid battery recycling. This study can help making comprehensive diagnosis and adding up more symptomatology in the list of lead exposure-related symptoms. Besides this, the study thoroughly analysed the medical comorbidities in relation to the number of years of exposure. This study may also help to include broad range of symptoms during examination of patients, which generally come from the workplaces, where lead exposure is common.

2. Materials and methods

2.1. Study population

The study population consists of working men related to occupations at car garages, workshops, car repairing centres, lead acid battery recycle workers, tyre and tube repairing workers in the Aligarh region, which is a district of north Indian state of Uttar Pradesh and located at the coordinates of 27.88° N and 78.08° E.

2.2. Ethics statement

The study was approved by the Institutional Ethics Committee of Jawaharlal Nehru Medical College (JNMC), Aligarh Muslim University, India. An informed consent was obtained after discussing the objective of the study with participants.

3. Method

The study was designed to undertake an epidemiological survey regarding the medical comorbidity in workers, who are occupationally exposed to lead. A survey was undertaken among the workers exposed to lead by directly visiting to the car garages, workshops, car repairing centres, lead acid battery recycle workers, tyre and tube repairing workers. A medical report of general health status was taken by using a medical *pro forma*.

A total of 393 lead exposed participants and 75 normal general population controls were initially contacted for examining their general health status. Many confounding factors were taken into consideration including smoking, drug usage, pan and guthka chewing and alcohol usage, which reduce the final eligible participants among the workers to 208 and control participants to 64. Smokers, tobacco chewers or alcohol drinkers were not included in this study so to rule out any external factor, which may lead external induction of the variables included in the study. All participants were divided into five groups (groups 1–5) depending upon the years of exposure to occupational environment. In order to reduce or nullify age-related effects, the comparison (normal and healthy) group was chosen, in a way that it includes men

Table 1 – The age distribution of lead exposed workers and controls.

Groups	Age range (years)	Healthy controls		Workers		
		Number (n)	Portion of the total (%)	Years of exposure	Number examined	Portion of the total (%)
1	18–26	15	23.43	0–5	34	16.34
2	24–32	17	26.56	>5–10	54	25.96
3	28–35	10	15.62	>10–15	47	22.59
4	37–45	12	18.75	>15–20	38	18.26
5	42–53	10	15.62	>20	35	16.82
Total		64			208	

from similar age groups as was in participants occupationally exposed to lead. The participant structure into groups among both healthy controls and workers is given in Table 1. The weight and height of every participant were measured in order to calculate body mass index (BMI). The BMI was calculated as weight in kilograms divided by the square of height in metres. Details of personal and general information along with specific medical examination related to lead toxicity were recorded in the predesigned medical *pro forma*.

The study subjects were all males. Subjects were categorised on the number of years exposed to lead through lead-related occupations. A medical *pro forma* was used to collect the data regarding their exposure history, nature and direction of work, smoking and drinking habits medical history and symptomatology checklist of general symptoms and those associated with skin, upper respiratory tract, dental problems and problems related to digestion.

All the workers were also examined based on the number of years of exposure through lead-related occupations. Frequencies were calculated for all the variables in percentage. The total frequency from all the age groups was also calculated.

3.1. Statistical analysis

The data were evaluated by means of an exploratory and descriptive analysis through Shapiro–Wilk test for checking the distribution and compare the summary statistics among the study group. Depending on the distribution of the variable under study, the comparison was performed by means of t-test and Mann Whitney U test. Odds ratio (OR) was also calculated between the two groups. SPSS version 16 and Sigma plot version 11.0 were used for data analysis throughout this study. The online available statistical package Medcalc was used to calculate the OR for every symptom along with 95% confidence interval (CI) between healthy controls and workers.

4. Results

The examination of the health status of workers and control group participants was conducted in relation to skin, chest, eye, nose, mouth and digestion. In addition, the general symptoms like malaise, tiredness, headache and recurrent infections were examined in healthy controls and workers. Malaise was observed significantly higher in workers than controls ($p < 0.05$). Further results are illustrated in Tables 2

and 3. All the variables were analysed for the distribution by means of an exploratory and descriptive analysis. BMI was observed to be lower in workers comparing to controls in all groups. However the difference was significant only in groups 4 and 5, which indicates the decrease in BMI with increase in years of occupational exposure. The results are depicted in Fig. 1. The distribution pattern for body mass index among five groups (1–5) in healthy controls and workers are shown in Fig. 2. Further it is clear from the figure, which depicts that there are increased number of workers with less BMI in groups 4 and 5 indicating the effect of long exposure at workplace environment. The results are further illustrated in Fig. 2.

4.1. Skin-related symptoms

Three skin-related symptoms were studied: dermatitis (*inflammation of the skin*), urticaria (*itchy red patches on skin*) and hyperkeratosis (*outgrowth and thickening of the outer layer of skin*). The per cent frequency of dermatitis was observed as 5.51 ± 2.79 , which was higher than controls 3.33 ± 4.71 (Mann Whitney $T = 23.00$, $p = 0.421$) with OR along with 95% CI as 1.73 (0.37, 8.02). Urticaria was however higher in frequency than dermatitis and was observed as 8.26 ± 2.74 as against 1.33 ± 2.79 among controls ($T = 17.00$, $p = 0.032$). OR (CI) is 5.60 (0.73, 42.98). A significant difference was observed in the frequency of hyperkeratosis among workers 5.85 ± 2.41 than controls 0.00 ($t = -5.421$, $p < 0.001$) OR (CI) is 8.20 (0.47, 140.55). Moreover the frequency was observed higher among workers who have long exposure than ones who have lesser exposure. No person is observed to suffer from hyperkeratosis among the control group. Further results and OR are illustrated in Tables 2 and 3.

4.2. Chest-related symptoms

The symptoms of cough, sputum (*mucus exuded from respiratory passages*), chest pains, wheezes (*breathe with a rasping sound*), tight chestedness and shortness of breath were all found in increased frequency in workers having occupational exposure to lead in relation to comparison group. The chest symptom among workers were marked and it is observed that workers showing cough symptoms was prevalent among 23.05 ± 8.06 which was significantly higher as against 9.35 ± 1.93 among controls ($t = -3.694$; $p = 0.006$). The workers reported to have problems of sputum was 12.03 ± 6.78 as against 3.66 ± 5.0 against controls ($t = -2.213$, $p = 0.058$). The chest pain reported

Table 2 – The mean per cent prevalence of the symptoms along with the t test and Mann Whitney U test comparisons among the workers occupationally exposed to lead and general population comparisons.

Symptoms	Mean per cent frequency Mean $\pm$ SD		t test (t)	p	Mann Whitney U (T)	p
	Control	Workers				
Malaise	4.14 $\pm$ 3.91	15.65 $\pm$ 6.68	–3.314	0.011		
Tiredness	4.17 $\pm$ 3.91	22.87 $\pm$ 12.48			18.00	0.056
Headache	3.33 $\pm$ 4.71	10.77 $\pm$ 3.29			18.00	0.056
Recurrent Infections	4.84 $\pm$ 4.65	12.34 $\pm$ 7.15	–1.965	0.08		
Dermatitis	3.33 $\pm$ 4.71	5.51 $\pm$ 2.79			23.00	0.421
Urticaria	1.33 $\pm$ 2.97	8.26 $\pm$ 2.74			17.00	0.032
Hyperkeratosis	0.00	5.85 $\pm$ 2.41	–5.421	<0.001		
Cough	9.35 $\pm$ 1.93	23.05 $\pm$ 8.06	–3.694	0.006		
Sputum	3.66 $\pm$ 5.0	12.03 $\pm$ 6.78	–2.213	0.058		
Chest pain	2.00 $\pm$ 4.47	8.63 $\pm$ 5.82	–2.019	0.078		
Wheezes	0.00	4.95 $\pm$ 2.23			15.00	0.008
Tight chestedness	0.00	8.93 $\pm$ 3.74			15.00	0.008
Shortness of breath	0.00	6.05 $\pm$ 3.57	–3.779	0.005	22.50	0.310
Conjunctivitis	0.00	1.66 $\pm$ 2.53			22.50	0.310
Keratitis	0.00	1.66 $\pm$ 2.53			22.50	0.310
Ulceration of Lids	0.00	4.77 $\pm$ 4.98	–2.138	0.065		
Pallor	3.66 $\pm$ 5.05	8.32 $\pm$ 1.80			23.00	0.421
Icterus	3.66 $\pm$ 5.05	7.04 $\pm$ 2.90			23.00	0.421
Nasal irritation	0.00	9.67 $\pm$ 1.30	–16.64	<0.001		
Sore throat	0.00	8.88 $\pm$ 3.55	–5.593	<0.001		
Hoarseness	0.00	4.20 $\pm$ 4.12	–2.276	0.052		
Sinusitis	0.00	2.19 $\pm$ 3.0			22.50	0.310
Rhinitis	0.00	2.76 $\pm$ 3.96			22.50	0.310
Metallic taste	0.00	3.67 $\pm$ 3.68	–2.231	0.056		
Dental erosion	4.50 $\pm$ 4.39	7.76 $\pm$ 2.24	–1.474	0.179		
Dental discolouration	4.50 $\pm$ 4.39	8.31 $\pm$ 2.24	–1.530	0.165		
Halitosis	1.17 $\pm$ 2.62	8.58 $\pm$ 4.71			18.00	0.056
Mouth ulceration	5.33 $\pm$ 8.69	7.19 $\pm$ 2.19			22.00	0.310
Mouth bleeding	0.00	8.46 $\pm$ 2.40	–7.868	<0.001		
Abdominal pain	3.17 $\pm$ 4.58	10.87 $\pm$ 1.78			16.00	0.016
Nausea	2.00 $\pm$ 4.47	7.22 $\pm$ 1.28			20.00	0.151
Vomiting	0.00	8.09 $\pm$ 2.00	–9.025	<0.001		
Diarrhoea	2.00 $\pm$ 4.47	6.05 $\pm$ 1.66			20.00	0.131
Constipation	0.00	5.81 $\pm$ 1.24			15.00	0.008
Poor appetite	0.00	12.34 $\pm$ 3.02			15.00	0.008

among lead exposed workers as 8.63 ± 5.82 and in control as 2.00 ± 4.47 ($t = -2.019$, $p = 0.078$). Moreover the frequency of chest-related symptoms was shown an increase with an increase in years of exposure to lead. Further detailed results including other chest-related symptoms and OR are illustrated in [Tables 2 and 3](#).

4.3. Eye-related symptoms

Symptoms related to the eyes were having little difference between the working group and comparison group. In case of conjunctivitis and keratitis (*inflammation of the Cornea*), there was no significant difference between workers and comparison group as analysed by Mann Whitney and U Statistic tests; both these symptoms were observed to have $T = 22.50$ and $p = 0.310$. There are few individuals, who show the symptoms such as conjunctivitis and keratitis among the workers having long exposure for more than 15 years. In case of ulceration of lids and pallor (*pale condition*), differences were calculated by t test between the two groups. Among workers, it is reported to have 4.77 ± 4.98 , while no individual among control was

reported ($t = -2.138$, $p = 0.065$), and while in case of pallor per cent frequency of 8.32 ± 1.80 against 3.66 ± 5.05 ($T = 23.00$, $p = 0.421$) among controls were reported. It was further observed that frequency of symptoms increases with years of exposure. Further results with OR are illustrated in [Tables 2 and 3](#).

4.4. Nose-related symptoms

Among the symptoms related to nose, the prevalence of nasal irritation reported to be significantly higher as 9.67 ± 1.30 as against 0.00 in controls ($t = -16.640$, $p < 0.001$). In addition, significant differences were also reported for sore throat, whose per cent frequency is 8.88 ± 3.55 as against 0.00 in controls ($t = -5.593$, $p < 0.001$). Metallic taste was reported among 3.67 ± 3.68 workers against 0.00 control individuals ($t = -2.231$, $p = 0.056$). Moreover the nose-related symptoms are more prevalent among workers having long-term exposure to lead than those having early exposure. Further symptoms studied are illustrated in [Tables 2 and 3](#), which indicate the malfunctioning of nasal system and their OR.

Table 3 – The OR along with 95% CI of the symptoms among the workers occupationally exposed to lead and healthy general population comparisons (as controls).

Symptoms	Control versus workers OR with 95% CI		
	OR	95% CI	p
Malaise	2.06	0.87, 4.84	0.097
Tiredness	1.80	0.85, 3.87	0.12
Headache	3.66	0.83, 16.04	0.08
Recurrent infections	2.65	0.77, 9.11	0.12
Dermatitis	1.73	0.37, 8.02	0.48
Urticaria	5.60	0.73, 42.98	0.097
Hyperkeratosis	8.20	0.47, 140.55	0.146
Cough	3.63	1.38, 9.56	0.008
Sputum	4.04	0.92, 17.60	0.06
Chest pain	5.60	0.73, 42.98	0.09
Wheezes	6.82	0.39, 118.07	0.18
Tight chestedness	11.78	0.69, 198.82	0.08
Shortness of breath	8.20	0.47, 140.55	0.14
Conjunctivitis	2.19	0.11, 43.10	0.60
Keratitis	2.19	0.11, 43.10	0.60
Ulceration of lids	6.14	0.35, 107.01	0.213
Pallor	2.75	0.62, 12.27	0.18
Ictiris	2.23	0.49, 10.11	0.29
Nasal irritation	14.02	0.83, 235.28	0.06
Sore throat	12.52	0.74, 210.85	0.07
Hoarseness	5.46	0.31, 96.06	0.24
Sinusitis	2.83	0.15, 53.43	0.48
Rhinitis	3.48	0.19, 63.91	0.40
Metallic taste	6.82	0.39, 118.07	0.18
Dental erosion	1.69	0.47, 6.01	0.41
Dental discolouration	1.92	0.54, 6.76	0.30
Halitosis	5.60	0.73, 42.98	0.09
Mouth ulceration	1.58	0.44, 5.64	0.48
Mouth bleeding	12.52	0.74, 210.85	0.07
Abdominal pain	3.85	0.88, 16.81	0.07
Nausea	4.89	0.63, 37.81	0.12
Vomiting	5.60	0.73, 42.98	0.09
Diarrhoea	3.85	0.49, 30.25	0.19
Constipation	8.20	0.47, 140.55	0.14
Poor appetite	18.73	1.12, 311.83	0.04

4.5. Mouth-related symptoms

Among mouth-related symptoms, dental erosion was observed having per cent frequency of 7.76 ± 2.24 {OR (95% CI) is 1.69 (0.47, 6.01)} as against 4.50 ± 4.39 among control group ($t = -1.474$, $p = 0.179$). Dental discolouration was reported to have a per cent frequency of 8.31 ± 2.24 as against 4.50 ± 4.39 in control group ($t = -1.530$, $p = 0.165$). OR calculated for all mouth-related symptoms is given along with 95% CI in Table 3. Mouth bleeding shows a decreasing pattern from early exposure group to those having a long time exposure. The overall per cent frequency was significantly higher 8.46 ± 2.40 as against 0.00 in control groups ($t = -7.868$, $p < 0.001$). Further results for mouth-related symptoms and OR are illustrated in Tables 2 and 3.

4.6. Digestion-related symptoms

The final types of symptoms studied in this survey are related to digestion. All the symptoms studied in relation to digestion between workers and healthy comparison participants have

Fig. 1 – The mean BMI among healthy controls and workers among five different groups. In all the groups, the workers were having less BMI than controls; however, this difference was significant only in group 4 ($p < 0.05$) and group 5 ($p < 0.01$).

relative difference between them, in which exposed workers have an increased per cent frequency of such symptoms. Abdominal pain was observed as 10.87 ± 1.78 as against 3.17 ± 4.58 among controls ($T = 16.00$, $p = 0.016$). Per cent frequency of nausea is 7.22 ± 1.28 as against 2.00 ± 4.47 in controls with Mann Whitney ($T = 20.00$, $p = 0.151$). Vomiting was observed to be significantly higher among workers 8.09 ± 2.00 in against controls 0.00 ($t = -9.025$, $p < 0.001$). Poor appetite frequency among workers was 12.34 ± 3.02 as against 0.00 in controls with Mann Whitney $T = 15.00$, $p = 0.008$. In addition, the symptoms studied as a malfunction in digestion and their calculated OR are further illustrated in Tables 2 and 3.

5. Discussion

The toxicity of lead has been studied extensively and is evident from the literature. Though such studies are usually performed on animal models, there is a limited number of epidemiological studies on workers at workplaces. The decrease in BMI among workers indicates that there is significant occupational stress among workers having long exposure to lead at their workplace. The BMI of such workers was also below the normal reference range indicating that they must have to take care and prevent further exposure. The present study also deals to examine the medical comorbidities including symptoms/problems concerning the six body parts, such as, skin, chest, eye, upper respiratory tract, oral and digestive tract among workers. For comparison, the healthy controls are also examined for all the symptoms studied in workers. Many symptoms related to these organ systems were observed to have a significant difference among workers exposed to lead and lead-related compounds in relation to the

Fig. 2 – The normal distribution and frequency of BMI range among healthy control and working men from five different groups based on age and years of exposure to workplace environment.

comparison group. Effects of lead on human health may also involve a complex interaction of biological, environmental, familial and socioeconomic factors. Human exposure to lead and lead-related compounds in environment can act as a medium to produce a variety of pathological effects. The general health of the workers occupationally exposed to lead and its related compounds deteriorates because of illnesses due to the exposure of toxic chemicals like lead. In the present study, the workers occupationally exposed to lead and its related compounds are also observed to be highly heterogeneous in exhibiting the symptoms studied throughout this study. The reasons for this is generally unknown, as such findings have also been reported in earlier studies, in which many people are reported to be asymptomatic even with high levels of lead present in the blood.¹⁰ There is a need to understand the principles, on which the heterogeneity relies upon which makes individuals so different in exposure-related toxicity. Though several can be easily traced out like biological, environmental, familial which also include diet factors hygienic and unhygienic foods.

The difference in the onset and prevalence of symptoms between exposed workers and comparison group not necessarily indicate the direct effect of lead exposure. Lead may also decrease the immune activity of exposed workers and may make them prone to several diseases or secondary infections due to other environmental pollutants. Similarly, the exposed workers, because of having occupational lead-related alteration in several normal bodily functions, can be vulnerable to infections or symptoms observed throughout this study. Lead may also have its effect on the immune system. Several studies have reported the decreased immune functions due to lead toxicity.^{15–17} This may in turn result in the onset of certain symptoms studied in this work. Decreased immune activity may also lead to increased chances for recurrent infections. Among the symptoms related to skin problems such as dermatitis, urticaria and hyperkeratosis, a relative difference between the exposed workers and comparative group was observed. The differences were significant for hyperkeratosis as calculated using t test, and significant differences in urticaria were also observed with Mann Whitney U test. Such symptoms can be related to the exposure because of the direct

contact of the skin with the toxic substances from the occupations studied in this work. Lead entering a body by being absorbed through skin pores can cause infections, which may then lead to a number of skin diseases.¹⁸

The chest-related symptoms may be due to primary exposure of lead that may accelerate the infection leading to symptoms such as cough and sputum. A significant difference in cough like symptoms was observed between controls and workers ($p < 0.001$). The other symptoms are related to eyes, which are also examined in this work. These include symptoms such as conjunctivitis, keratitis, ulceration of lids, pallor and icterus. Certain workers involved in welding make them prone to several eye-related symptoms such as conjunctivitis and keratitis. There is a direct association between eyes and central nervous system, and as lead effects the physiological actions of the nervous system will also affect our vision. A reduced sensitivity of rod photoreceptors has been shown due to lead exposure.¹⁹ Other studies show blurred vision and irritated eyes as well as an increased susceptibility to cataract.²⁰ Although there are large number of studies indicating the detrimental effects of lead toxicity, one study¹¹ shows that small amounts of lead can benefit in the good health of eyes. However other study shows that a cumulative lead exposure can lead to increased risk of age-related cataract.²² In cataract studies, lead has been shown to be present in the lens of the eyes. There are several preventive measures, which can be taken care of by (1) avoiding generation of mists, (2) following the strict hygiene rules and (3) implementation of fountains for washing eyes in the immediate work area. Using eye protection such as impact resistant goggles and splash as well as shields to prevent face is also necessary. In contrary to most of the studies, one study shows lead has got beneficial effects also and was used from Egyptian times as a product in cosmetics used to outline eyelids.²¹ The study suggested that “submicromolar concentrations” of lead ions may play a role in boosting the action of immunological defences.²¹ It is also shown that production of nitric oxide (NO), which is an essential messenger in our innate immune system is stimulated by lead ions which communicates with immune cells such as macrophages and enhances the capillary blood flow for increased white blood cells to migrate at the site of infection.²¹

Several symptoms examined, for example, nasal irritation, sore throat, rhinitis (*inflammation of the sinus membrane*) or metallic taste reflects the exposure of toxic chemicals such as lead or its related compounds. Several studies report infections of respiratory tract and the symptoms associated with respiration due to lead exposure.^{22–24}

Symptoms related to mouth and teeth such as dental erosion and discolourisation, halitosis (*bad breathe*), ulceration and mouth bleeding indicate that occupational presence of the workers in polluted environment containing lead dust in the air can make easy passage into body through mouth. This may cause the mouth and its related tissues very prone to infections. Even the passage of lead dust to mouth may cause the epithelial layer of mouth prone to easy damage, which can cause the mouth bleeding frequently. There are no studies, which show the symptoms such as halitosis, ulceration and mouth bleeding in relation to lead. However studies, which show association between dental caries and lead exposure, are

well documented.^{25–28} Finally, the symptoms related to digestive system including abdominal pain, nausea, vomiting, diarrhoea, constipation and poor appetite are perhaps the ones, which show the first appearance in lead poisoned person. Such increased frequency of symptoms related to digestive system may also indicate the direct effect of lead exposure at the contaminated places, which in the present study are workplace environment. These symptoms are also not studied well as the present literature is concerned, though some rare evidences are found in the literature.^{29,30} This can, to some extent, be curtailed by taking steps to reduce exposure to toxic substances which can help improve health of occupationally exposed workers. In addition, modification in diet by including vegetables or foods which have good content of antioxidants may help reduce the toxicity by removing considerable portion of the lead from body. The variation of the per cent frequency of various symptoms among the workers may also reflect variable food habits. Workers, whose daily diets contain good content of antioxidant can safeguard from the toxic effects of lead to a greater extent. The authors of this study are currently engaged in the assessment of the toxic status of occupationally exposed workers in comparison to healthy general population controls including haematological, genotoxic and biochemical parameters.

6. Conclusion

This study presents a number of symptoms and their medical comorbidity, which has usually not or rarely studied among the workers occupationally exposed to lead. Symptoms examined in this study showed a considerable difference between the two groups. The symptom examined was showing noteworthy differences in the frequency of symptoms between healthy controls and workers. It is recommended that the workers related to lead-related occupations must take care and use the measures to prevent from direct contact with either lead or lead-related compounds. It is also recommended that the workers use protective uniforms, which can prevent them from taking lead dust to their home and prevent their families and children from exposure with lead. Meanwhile, a complete washing of the full body parts before leaving their work place is highly recommended, which possibly can help to make the safe environment for work and for family. This study helps in further widening the horizon of lead poisoning in order to guide the health professionals to inquire about the possible lead toxicity at occupational places. Further study in this area is encouraged.

Conflicts of interest

The authors have none to declare.

Acknowledgements

The authors are thankful to the Chairman, Department of Zoology, and the host institution Aligarh Muslim University for

providing facilities for the research. All participants who took part in this study and shared information are deeply acknowledged. Further, we like to extend our sincere thanks to Isaac Nabi (MD) for his kind help during this work. The fellowship to ALW from University Grants Commission, New Delhi is also acknowledged.

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