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Original Article

The Lead Exposure among Lead Workers: An Epidemiological Study from West Turkey

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Abstract

Background: This study has been conducted on workers from several workplaces where materials containing lead are used during December 2006-April 2007 in Eskişehir, a city of the Middle Anatolian Region of Turkey.

Methods: The study and control groups were occured with 403, and 97 men, respectively. After each interview with the individuals, their blood pressures (BP) and complete blood counts (CBC) were measured. The blood lead level (BLL) of 10 µg/dL was accepted as cut off level for high BLL. In statistical analyses, Chi-square test (x^2), Fisher's exact test, Student *t*-test, Kolmogorov-Smirnov Z test, and Logistic regression analysis were applied.

Results: The mean age was 35.55±9.00 yr (min=18, max= 54) in study group. The prevalence of high BLL was 10.2% (n= 41) in study group. The working on smeltery, and the working on polyvynil chloride product, and history of lead poisoning are important risk factors for high BLL (for each one $P< 0.05$).

Conclusion: This study indicated several precautions and steps to be taken for better protection from lead poisoning: considering workplace medicine more seriously and particularly planning special health programs in order to raise awareness among workers for using protective gear/wear and applying routine hygienic habits, and improving the preventive measures for workplaces, and providing technical equipment for routine MAC measurements in workplaces, and increasing the legal liability and sanctions.

Keywords: *Lead, Occupational exposure, Blood lead level*

Introduction

Lead is a soft, malleable, heavy metal usually occurring in nature in small amounts and used in more than 150 industrial sectors due to its highly malleable character. Occupational exposure to lead is most commonly seen during lead mining and processing, preparation of lead alloys, production of lead containing paint, rubber, or plastic materials, soldering and welding, and accumulator manufacturing and repair. Lead dust and vapors produced and dispersed during those works result in lead exposure. Although lead has been frequently used in printing procedures previously, today, the sector which uses lead most is known to be accumulator manufacturing and repair. In Turkey, lead poisoning cases mostly occur in accumulator industry and workplaces which have small space and no adequate ventilation (1-5).

Lead poisoning, which had been first described by Hippocrates, causes negative effects particularly on nervous system and hematopoietic system (1, 6). Currently, prevalence of lead poisoning has been considerably reduced in developed countries due to enactment of comprehensive and effective legislations regarding health at work and environmental health (7-9). However in Turkey, lead poisoning (17.0% of all occupational diseases) is still the most commonly encountered occupational disease following silicosis-silicotuberculosis (66.0% of all occupational diseases) (10). In Turkey, lead poisoning cases mostly occur in accumulator industry and workplaces which have small space and no adequate ventilation (1, 5).

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While subjective complaints, physical examination results, and psychological tests are important for diagnosis, in order to reach a definitive diagnosis, laboratory results are required. BLL is the most reliable test in the diagnosis of lead poisoning (1, 11). In United States Adult Blood Lead Epidemiology and Surveillance (US-ABLES) reported that a national public health objective for 2010 (objective 20-7) is to reduce the prevalence of BLLs >25 μg/dL among employed adults to zero in 2004 (12). BLLs ≤10 µg/dL was defined that nontoxic level by US-Centers for Disease Control and Prevention (CDC) (13). Occupational Safety and Health Administration of US (OSHA) has declared BLLs ≥ 40 µg/dL in people working in environments where lead containing materials are used as lead poisoning (14).

In the present study, we aimed to determine lead exposure rates of workers in Eskisehir working in environments where materials containing lead are used, investigate risk factors believed to be associated with lead poisoning, and evaluate workplace conditions in terms of health at work.

Material and Methods

The present cross-sectional study has been conducted on workers from several workplaces where materials containing lead are used between from December 2006 to April 2007 in Eskisehir that is a city of the Middle Anatolian Region of Turkey.

The approval of the Ethics Committee of Eskisehir Osmangazi University Medical Faculty has been obtained for the study (28.04.2006, No.11). Following the approvals of the owners or people in charge of the workplaces, written informed consents of the workers were obtained, as well.

We determined 15 large business (which has more than 50 workers) and 160 small business (which has less than 50 workers, 132 of those had 2-3 workers) which use materials containing lead from the records of Eskisehir Trade and Industry Directorate and Eskisehir Lathers and Auto Repairmen Chamber, belonging to year 2006. Then we talked with the representatives of those business enterprises by phone or in person. In total, 10 enterprises belonging to plastic, ceramic, polyvinyl chloride, chemistry, metal, and auto painting sectors, agreed to involve in the study. Except auto painting, all of them were large scale enterprises. 403 male laborers having lead exposure and working in the included enterprises, constituted the study group of the study. There was no female laborer who was exposed to lead in those workplaces.

Nine hundred and seven healthy men working as orderly in Eskisehir Osmangazi University and Anatolian University, living in Eskisehir Provincial center, and having no history of previous lead exposure, were included in the study as the control group. Mean ages of study group and control group were similar (t= 0.526, *P*= 0.600) (no shown data in table).

In order to evaluate the lead exposure and influence of lead over their health conditions, a questionnaire consistent with the literature (1-19) was prepared. Moreover, possible symptoms of lead poisoning such as abdominal pain, constipation, indigestion, lack of appetite, weakness, weight loss, muscle pain, headache, nervously, and hand tremor, were questioned as well. Among these symptoms, those which have been experienced in the last 3 months were accepted.

The questionnaire was applied by in person interviews that face to face method and eventually physical examination of workers was realized. During the physical examination, symptoms which are considered as pathognomonic are investigated: Burton line, Gubler stain, silver color, lead colic, hand drop, and foot drop.

After each interview with the individuals of study and control groups, their BPs was measured. Systolic and diastolic BPs were measured by an ERKA sphygmomanometer from their upper right arm in sitting position while holding their right arms at heart level. Measurements were applied after a 5 min. rest and 2 times with at least 2 min intervals. Both for systolic and diastolic BPs, average value of the measured two values were used. Individuals with systolic BP ≥140 mmHg and/or diastolic BP ≥90 mmHg and/or people, who receive antihypertensive treatment, were described as hypertensive (20). Further, by using Me-

dical Research Council (MRC) Scale, muscle strength was evaluated (21).

By the help of a disposable injector, 4 cc venous bloods were drawn from each worker. The obtained venous blood samples were transferred into 2 vacuum blood tubes (Vacutest kima) containing Ethylene Diamine Tetra acetic Acid (EDTA). One of those tubes containing venous blood sample was sent to the Eskisehir Osmangazi University Medical School Blood Bank in the same day for CBC and preparation of a peripheral smear. The remaining tube was used for determining the BLL.

Complete blood count was performed with *"COULTER® LH 750 Hematology Analyzer"* device. As recommended by World Health Organisation, Haemoglobin (Hb) concentration below 13 g/dL was evaluated as anemia (22). Erythrocytes with basophilic granulation were investigated on the peripheral smear. Presence of more than 500 erythrocytes with basophilic granulation in 1 million erythrocytes was accepted as a positive result (23).

BLL was determined by *"LeadCare® Blood Lead Test System"*. This test is considered to be appropriate for field studies due to its cost-effective, easy-to-apply, portable features. Pineau et al. (24) reported this test as a reliable method. While individuals with BLL ≥10 μg/dL were accepted as people with high BLL, and results ≥40 μg/dL were categorized as cases of lead poisoning (13, 14).

The preventive measures for workplaces and their current applicability were evaluated with another survey.

All the procedures performed on the study group were also applied to the control group under the same conditions.

The obtained data were evaluated by the help of a Statistical Program of Social Scientific (SPSS) version 13.0 statistical program package. Chi-square test (x^2), Fisher's exact test, Student t test, Kolmogorov-Smirnov Z test, and logistic regression analysis were applied. For certain values, 95% confidence interval (CI) was calculated. Level that $P< 0.05$ was deemed as statistically significant.

Results

The age of 403 men constituting the study group, was varying from 18 to 54 and the mean age was 35.55±9.00. Distribution of workers with and without high BLL in terms of various features was presented in Table 1.

The mean BLL of workers was 3.74±5.29 μg/dL, and while lowest value was 0.1 μg/dL, the highest value was 36.6 μg/dL. Mean BLL of control group consisted of 97 people was 1.29±1.13 μg/dL compared to that of study group (t= 8.539, $P< 0.001$).

While no lead poisoning case was found in the study group, there were 41(10.2%) workers who showed high BLL (≥10 μg/dL). The people with high BLL were not detected in the control group.

Several protective habits for workers with and without high BLL are outlined in Table 2.

Mean duration of work per day was 8.88±1.52 hours, varying between range of 7.5 and 12 hours. One hundred and eighty and one (44.9%) of the workers were working more than 8 hours a day. All the workplaces had adequate ventilation system, work wear, masks, and gloves. Except the auto painting enterprise, again all the workplaces had a separated cafeteria, and WC-shower, dressing rooms. Wet work method, one of the protective measures, was seen only in 2 workplaces in the metal processing field, and only in those workplaces MAC measurements were being applied routinely. Initial (before admitted to job) and periodical examinations were being applied in all the workplaces except auto painting enterprise.

The high BLL is mostly (%86.7) seen in workers who work in smeltery. Distribution of workers with and without high BLL regarding their work branches is presented in Table 3.

By results of logistic model, The working on smeltery, and the working on polyvynil chloride product, and history of lead poisoning are important risk factors for high BLL (for each one

P< 0.05). Effects of some variables to BLL in logistic model are presented in Table 4.

No Gubler stain, silver color, lead colic, hand drop, or loss of muscle strength (<5/5) were found as a result of the physical examinations on study and control group. Peripheral smear analysis revealed no erythrocytes with basophilic granulation. The prevalence of symptoms in study and control groups is presented in Table 5.

The prevalence of symptoms in workers with and without high BLL is presented in Table 6.

While presence of hypertension and anemia in study group workers with and without high BLL is shown in Table 7, the correlation between BLL and blood pressures and hematological parameters is given in Table 8, and mean RBC, Hb, Htc, MCV, MCH ve MCHC values of workers in study and control group are outlined in Table 9.

Table 1: Distribution of workers with and without high BLL in terms of various features

Features	High blood lead level (≥10 µg/dL)		Statistical analyses
	No n (%)	Yes n (%)	x^2; p
Age group (yr)			
<30	105 (86.8)	16 (13.2)	
30-39	116 (94.3)	7 (5.7)	
≥40	141 (88.7)	18 (11.3)	4.165; >0.05
Educational level			
Middle school and less (=<8 years)	107 (81.1)	25 (18.9)	
Lycee and above (>8 years)	255 (94.1)	16 (5.9)	16.504; <0.001
Marital status			
Single	74 (11.4)	7 (8.6)	
Married	288 (89.4)	34 (10.6)	0.260; >0.05
Smoking			
No[a]	130 (89.8)	16 (10.2)	
Yes	232 (90.3)	25 (9.7)	0.154; >0.05
Alcohol			
No[a]	272 (90.4)	29 (9.6)	
Yes	90 (88.2)	12 (11.8)	0.378; >0.05
Duration of work (yr)			
<1	38 (71.7)	15 (28.3)	
1-9	169 (91.4)	16 (8.6)	
≥10	155 (93.9)	10 (6.1)	22.584; <0.001
History of lead poisoning			
No	356 (90.6)	37 (9.4)	
Yes	6 (60.0)	4 (40.0)	Fisher p=0.012
Total	362 (89.8)	41 (10.2)	

[a] No smoking/alcohol= Any+cessation.

Table 2: Several protective habits for workers with and without high blood lead level

Habits	High blood lead level (≥10 µg/dL)		Statistical analyses
	No n (%)	Yes n (%)	x^2; p
Habit of hand washing / taking a shower at the end of the work hours			
No	54 (75.0)	18 (25.0)	21.086; <0.001
Yes	308 (93.1)	23 (6.9)	
Washing their work wear period			
=<2 weeks	345 (90.1)	38 (9.9)	Fisher *P*= 0.443
>2 weeks	17 (85.0)	3 (15.0)	
Wearing mask habit			
No	178 (89.9)	20 (10.1)	0.002; >0.05
Yes	184 (89.8)	21 (10.2)	
Wearing gloves habit			
No	120 (91.6)	11 (8.4)	0.670; >0.05
Yes	242 (89.0)	30 (11.0)	
Total	362 (89.8)	41 (10.2)	

Table 3: Distribution of workers with and without high BLL regarding their work branches

Work branches	High blood lead level (≥10 µg/dL BLLs)			Statistical analyses
	No n (%)[b]	Yes n (%)[b]	Total n (%)[c]	x^2; p
Plastic	74 (100.0)	0 (0.0)	74 (18.4)	
Ceramic	73 (98.6)	1 (1.4)	74 (18.4)	
Chemistry	28 (90.3)	3 (9.7)	31 (7.7)	
Metal[a]	142 (94.7)	8 (5.3)	150 (37.2)	136.976; <0.001
Auto painting	9 (90.0)	1 (10.0)	10 (2.5)	
Polyvinyl chloride	34 (69.4)	15 (30.6)	49 (12.2)	
Smelting	2 (13.3)	13 (86.7)	15 (3.6)	
TOPLAM	459 (82.8)	41 (8.2)	403 (100.0)	

[a] There are 4 work places in metal process branche, [b] Per in raw, [c] Per in column.

Table 4: Effects of some variables to blood lead level in logistic model

Variables	B	Standart error	Wald	df	*p*	Odd's Ratio	Confidence interval 95%
Educational status (Referance: Lycee and above)							
Middle school and less	0.726	0.428	2.880	1	0.090	2.066	0.894-4.777
Duration of work (year) (Referance: ≥10 years)							
≥10			2.180	2	0.336		
1-9	0.935	0.634	2.171	1	0.141	0.393	0.113-1.361
<1	0.852	0.787	1.171	1	0.279	0.427	0.091-1.996
Habit of hand washing / taking a shower at the end of the work hours (Referance: Yes)							
No	0.941	0.636	2.190	1	0.139	2.561	0.737-4.777
History of lead poisoning (Referance: No)							
Yes	2.568	0.821	9.790	1	0.002	13.045	2.610-65.192
Smelting worker (Referance: No)							
Yes	4.790	1.051	20.766	1	0.000	120.341	15.333-944.506
Polyvinyl chloride worker (Referance: No)							
Yes	3.322	0.666	24.906	1	0.000	27.720	7.519-102.195
Constant	3.591	0.462	60.442	1	0.000	0.028	

Table 5: The prevalence of symptoms in study and control groups

Symptoms	Study group (n=403)	Control group (n=97)	Statistical analyses
	n (%)	n (%)	Z; p
Abdomen pain	8 (2.0)	2 (2.1)	0.007; >0.05
Constipation	20 (5.0)	1 (1.0)	0.348; >0.05
Anorexia	10 (2.5)	2 (2.1)	0.037; >0.05
Dyspepsia	4 (1.0)	2 (2.1)	0.095; >0.05
Weakening	4 (1.0)	1 (1.0)	0.003; >0.05
Halsizlik	31 (7.7)	4 (4.1)	0.316; >0.05
Head pain	48 (11.9)	5 (5.2)	0.597; >0.05
Nervousness	53 (13.2)	5 (5.2)	0.707; >0.05
Tremor in hands	14 (3.5)	0 (0.0)	0.307; >0.05
Muscle pain	50 (12.4)	10 (10.3)	0.185; >0.05

Table 6: The prevalence of symptoms in workers with and without high Blood lead level

Symptoms	High blood lead level (≥10 µg/dL BLLs)		Statistical analyses
	No (n=362) n (%)	Yes (n=41) n (%)	Z; p
Abdomen pain	7 (1.9)	1 (2.4)	0.031; >0.05
Constipation	17 (4.7)	3 (7.3)	0.159; >0.05
Anorexia	9 (2.5)	1 (2.4)	0.003; >0.05
Dyspepsia	3 (0.8)	1 (2.4)	0.098; >0.05
Weakening	4 (1.1)	0 (0.0)	0.067; >0.05
Halsizlik	29 (8.0)	2 (4.9)	0.190; >0.05
Head pain	43 (11.9)	5 (12.2)	0.019; >0.05
Nervousness	48 (13.3)	5 (12.2)	0.065; >0.05
Tremor in hands	14 (3.9)	0 (0.0)	0.235; >0.05
Muscle pain	42 (11.6)	8 (19.5)	0.480; >0.05

Table 7: Presence of hypertension and anemia in study group workers with and without high blood lead level

	High blood lead level (≥10 µg/dL BLLs)		Statistical analyses x^2; p
	No (n=362)	Yes (n=41)	
	n (%)	n (%)	
Hypertension			
No	261 (90.0)	29 (10.0)	
Yes	101 (89.4)	12 (10.6)	0.034; >0.05
Anemia			
No	357 (89.7)	41 (10.3)	
Yes	5 (100.0)	0 (0.0)	Fisher p=0.583

Table 8: Correlation between blood lead level and blood pressures and hematological parameters

Pearson correlation	Blood lead level (µg/dl) n=403
Blood pressures	
Systolic blood pressure (mmHg)	r=0.014 *P*=0.779
Diastolic blood pressure (mmHg)	r=0.082 *P*=0.101
Hematological parameters	
RBC (10^6/µl)	r=0.022 *P*=0.660
Hb (g/dl)	r=0.034 p=0.498
Hct (%)	r=0.026 *P*=0.605
MCV (fl)	r=0.021 *P*=0.677
MCH (pg)	r=0.030 *P*=0.552
MCHC (g/dl)	r=0.027 *P*=0.594

*RBC: Red Blood Cell count, Hb: Hemoglobin, Hct: Hematocrit, MCV: Mean Corpuscular Volume, MCH: Mean Corpuscular Hemoglobin, MCHC: Mean Corpuscular Hemoglobin Concentration.

Table 9: Mean RBC, Hb, Htc, MCV, MCH ve MCHC values of workers in study and control group

Hematological parameters	Study group n=403	Control group n=97	Statistical analyses t; p
RBC (10^6/µl)	5.10±0.40	5.07±0.46	0.709; >0.05
Hb (g/dl)	15.40±1.13	15.10±1.50	1.840; >0.05
Hct (%)	45.05±19.79	44.05±4.00	0.938; >0.05
MCV (fl)	88.51±40.09	87.01±5.22	0.727; >0.05
MCH (pg)	30.12±2.11	29.84±2.13	1.197; >0.05
MCHC (g/dl)	35.39±15.15	34.27±0.87	1.474; >0.05

*RBC: Red Blood Cell count, Hb: Hemoglobin, Hct: Hematocrit, MCV: Mean Corpuscular Volume, MCH: Mean Corpuscular Hemoglobin, MCHC: Mean Corpuscular Hemoglobin Concentration.

Discussion

In the present study, mean BLL of workers was found to be significantly higher than that of control group ($P< 0.001$). Moreover, various studies from Turkey (25, 26), and from the other countries (27) showed higher BLLs in laborers working in workplaces in which materials containing lead are used, than that of workers that are not expos0ed to lead.

Lead poisoning has not been found among the workers constituting the study group (≥40 µg/dL). Low lead exposure rates and efficient institutional and/or personal protective measures may be the reason behind this result.

We determined have high BLL in 41 (%10.2) of the workers. In 2003, Kim et al. (15) reported prevalence of high BLL among male laborers working in workplaces where lead-containing materials are used, as 37.7%. Reynolds et al. (16) reported the prevalence of high BLL (≥10 µg/dL) in laborers working in workplaces where lead-containing materials are used in Iowa between from 2003 to 2006, as 12.6%. Yassin et al. (4) reported the prevalence of BLL level in laborers working in workplaces where lead-containing materials are used in US between from 1988 to 1994, as 2.5%.

There may be an indirect correlation between advanced age and lead poisoning because as the age advances, a person's duration of work within an environment containing lead, increases. No correlation was found between prevalence of high BLL and age groups in the study group ($P> 0.05$). The study conducted by Bakirci & Bakirci (28) in 2007 on laborers working in workplaces including lead-containing materials in Istanbul revealed a similar result as well. The study performed by Saito et al. (17) between from 1990 to 2000 on laborers working in places where lead-containing materials are used, showed an increase of lead poisoning risk with the advancing age.

The prevalence of high BLL was higher in individuals with lycee or above degree of education compared to that of workers with an educational background of middle school level or less ($P< 0.05$). This result may indicate that individuals with an educational level of lycee or above abide by the work conditions and protective measures better. But to be lycee or above degree of education was not found an important risk factor for high BLL ($P> 0.05$).

If we consider that single workers would have a more irregular life compared to married ones, they may be expected to behave more careless in adapting the protective rules which would lead to higher BLLs in them. However, we determined no result indicating a correlation between marital status and lead poisoning. In the present study, there was no significant difference regarding the preva-

lence of high BLL between single and married workers ($P > 0.05$).

Smoking in workplaces where materials containing lead are used, causes workers to frequently contact their lead-contaminated hands with their mouth. Thus, lead intake is realized via digestive route. Moreover, the lead in the smoke of a cigarette is taken by respiration. Smoking, which casues lead intake by one of those 2 routes, is a risk factor for lead poisoning (6, 29). The some studies were reported that high prevalence of lead poisoning in lead workers (2, 30, 31). In the present study, no difference was determined between smokers and non-smokers in terms of high BLL ($P>0.05$). This result may be explained by the fact that smoking was prohibited in workplaces and people were applying the personal hygiene rules.

Long-term and high dose alcohol consumption presents a risk for lead poisoning (6). Adeniyi & Anetor (32) reported a higher prevalence of lead poisoning among alcohol consuming lead worker. But, in the present study no difference prevalence of BLL was found between workers consuming and not consuming alcohol ($P > 0.05$). Low alcohol consumption at long intervals can be the underlying reason.

In our study, prevalence of high BLL was determined to be higher in workers who worked less than 1 yr ($P< 0.05$). The inexperience of the workers who worked less than 1 yr might be the underlying cause of this result. However, working less than 1 yr was not found an important risk factors in logistic model ($P> 0.05$). Some studies (15, 17) were reported similar results.

Individuals with a lead poisoning history constitute an important risk group. Prevalence of high BLL was found to be significantly higher in workers with a history of lead poisoning compared to workers with no such history ($P<0.05$). And addition, lead poisoning history was important risk factors in logistic model ($P< 0.05$). These results may be explained by the ongoing risk factors which had caused the previous lead poisoning. A study conducted by Bakirci & Bakirci (28) reported similar results.

Prevalence of high BLL in workers who had the habit of hand-face washing and/or shower taking after the end of the work, was lower compared to workers who did not have those habits ($P< 0.05$). This result is important because they indicate the importance of the habit of hand-face washing and/or shower taking after the end of the work, for lowering lead poisoning risk. But, the habit of hand-face washing and/or shower taking after the end of the work was not found an important risk factor in logistic model ($P< 0.05$). Studies conducted by ISGUM in Turkey (2) and studies conducted abroad (33-35), showed lower lead poisoning rates in workers with habits associated with good personal hygiene.

Using workwear of smooth and slippery characteristics without any pockets is also important for lowering the risk of contact with lead (29). Our study showed that all the workers had the habit of using workwear. This result may be due to awareness on protective properties of workwear and its mandatory use.

No correlation was determined between work wear washing frequency and high BLL ($P> 0.05$). The fact that workers who are exposed to lead less, soil their wear less, may be the underlying reason of washing with long intervals.

Among Turkish workers, mask is generally an unwanted personal protective gear because it makes breathing difficult and forms moisture within the mask space. However, mask usage is important due to its protective properties for respiratory system against dust, poison gas, and vapours. Another personal protective gear is glove which protects hands from lead contamination via contact, and usually long gloves made of caoutchouk or plastic, are preferred for lead protection (5, 29). The fact that in the present study, approximately half of the workers were using mask and only 1/3 were wearing gloves, indicates inadequate awareness in workplaces on this issue.

No difference of prevalence of high BLL was found between workers who have and have not the habit of using mask/glove (for each of them $P> 0.05$). This result may indicate inadequate and inefficient usage of mask/glove.

For the workplaces included in the study; presence of appropriate ventilation systems, adequate number of protective gear and wear, and cafeteria-WC-shower-dressing room, indicate a good environment in terms of health at work.

Wet mopping and washing the floors frequently, in order to inhibit noxious dusts which had fallen to the floor, dissolve into air is called wet work method. Because this method was not being applied in majority of the workplaces although required to, an unawareness and lack of work conditions enabling the application of this method were evident.

In Turkey, according to the Work Health and Work Safety Regulation, MAC measurements should be carried out periodically for the air of the workplace (36). Absence of periodical MAC measurements in most of the included enterprises may be due to weakness of legal sanctions and lack of technical equipment.

Initial (during admittance to employment) and periodical health examinations aimed for early diagnosis, are legally mandatory (5). In most of the enterprises included in this study initial and periodical exams were carried out indicating accordance with the respective law.

In the present study, prevalence of BLL in smeltery and polyvinyl chloride works, is determined to be higher than those of other work groups ($P< 0.05$). And both works was important risk factors for high BLL by results of logistic model (for each one $P< 0.05$). The reason of higher lead poisoning rates in those 2 work groups may be due to more frequent use of lead-containing materials, lack of wet work method, and high number of inexperienced workers. Kim et al. (15), reported higher prevalence of lead poisoning for accumulator and plastic manufacture workers than those of other work groups. Reynolds et al (16) reported a high prevalence of lead poisoning in works involved with laboratory and paint.

Lack of those pathognomonic symptoms in all of the workers, is an expected result arising due to low BLLs of the workers. A study conducted by Karim et al (37), revealed Burton line in 2% of workers laboring in workplaces involving lead-containing material.

Today, erythrocytes with basophilic granulation, is a rare symptom of lead poisoning (38). In the present study, no erythrocytes with basophilic granulation were determined. A study conducted by Onarlioglu et al. (25), revealed similar results.

No difference was found between the study group and control group in terms of the prevalence of several non-specific symptoms (for each symptom $P> 0.05$). This result may be explained by short-term and non-intense exposure of workers in the study group. A study conducted by Lee et al. (39) showed a higher prevalence of symptoms in study group compared to that of controls. Moreover, a study performed by Matte et al. (33), revealed loss of muscle strength, gastrointestinal system symptoms, and a reduction in attention-memory functions as the presenting symptoms which are more commonly seen in study group than control group. Atlihan et al. (40) in 1989 on laborers working with lead-containing materials in Diyarbakir-Turkey, revealed the most common symptoms of lead poisoning as weakness and nervousness.

No difference was determined in terms of symptom prevalence between workers having and not having lead poisoning (for each symptom $P> 0.05$). A study conducted by Kirby et al. (18) reported a similar result, as well.

Lead is known to increase hypertension risk (6). Kirkby & Gyntelberg (41) reported higher hypertension prevalence in lead workers. But in our study, no difference was found in terms of hypertension presence between workers having and not having high BLL ($P>0.05$). This result may be explained by presence of very few workers who displayed a BLL $\geq$25 μg/dL in the study group.

While a BLL $\leq$30 μg/dL does not cause an increase in systolic and diastolic BPs are expected to elevate by every increase in BLL. In the present study, no correlation was found between BLL and systolic and diastolic BPs (for each of them $P> 0.05$). A study conducted by Wu et al. (42) revealed a similar result as well. Contrary, some

studies (43-45) were reported posirtive correlation between BLL and systolic-diastolic BPs.
Anemia was determined in 5 (%1.2) of the workers in study group and no significant difference was found between workers having and not having high BLL (P>0.05). This result may indicate that BLLs of workers were not high enough to cause anemia. Moreover, one other possible reason of low anemia prevalence may be adequate and balanced nutrition of workers. Aome studies (46, 47) reported similar results.
It is known that decreases in hematological parameters occur due to lead exposure (46). In the present study, no correlation was found between BLLs and hematological parameter values of workers (for each of them P> 0.05). BLLs which are not high enough to induce changes on hematological parameters, may explain those results. A study conducted by Karita et al. (31) revealed decreases in hematological parameters of laborers working with lead-containing materials as a result of increases in their BLLs.
In the present study, no difference was determined between the study and control groups regarding hematological parameters (for each of them P> 0.05). This result may be due to BLLs that are not high enough to induce a change on hematological parameters of both study and control groups. By various studies form Turkey (25), and from the other countries (19, 48), Hb and Htc levels have been found to be lower in people with occupational lead exposure compared to those of control group.
Limitations of this study:
The study group was not a sample of all lead workers in Eskisehir city. Therefore this study is not a prevalence study. High lead exposured workers were absent in their workplaces because of lead poisoning therapy in study period. All these events could be reason to bias. Addition, control group was occured lower size than study group because of reluctant receive to this study of healthy individuals.
The conclusion of this study indicated several precautions and steps to be taken for better protection from lead poisoning: considering workplace medicine more seriously and particularly planning special health programs in order to raise awareness among workers for using protective gear/wear and applying routine hygienic habits, and improving the preventive measures for workplaces, and providing technical equipment for routine MAC measurements in workplaces, and increasing the legal liability and sanctions.

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