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Association of Blood Lead Level with Thyroid Hormones and Blood Factors in Iranian Traffic Officers

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ABSTRACT

Lead has many applications in the industry, but does not play a vital physiological role in the human body. On the other hand, lead has shown undesirable effects on the nervous, gastrointestinal, and endocrine systems, and people who are highly exposed to this element, due to their occupations or residencies, are affected by its harmful effects. Therefore, we designed a cross-sectional study on traffic officers with high exposure level to lead in Tehran, Iran, to specify the effect of lead on their levels of thyroid hormones and blood cells. The blood lead concentration was measured using Lead Analyzer and Flame Atomic Absorption spectrometry. The levels of thyroid hormones and blood cells were measured using KX-21N and ADVIA Centaur XPT (Immunoassay system) instruments, respectively. The obtained results demonstrated that there was no significant association between blood lead levels and levels of thyroid hormones, number of blood cells, and related blood cells parameters. However, there was a weak association between blood lead levels and the age of participants (r = 0.25). Further studies with higher sample size could confirm these results.

Keywords: Blood lead level, Thyroid hormones, Red blood cells, White blood cells, Blood factors

INTRODUCTION

Lead (Pb) is one of the most important toxic elements in the environment, therefore exposure to lead is considered as one of the global human health concerns. Lead applications are various by playing special roles in the industries, including smelting, battery manufacturing, and mining [1-3] as well as in agricultural fertilizers and pesticide [1,3]. On the other hand, industrialization discharging into rivers has led to polluting water bodies [1]. Moreover, lead pollution of soils as a result of contaminated water bodies and exhaust product of leaded gasoline used in urban areas have had serious environmental effects [4-6].

The lead entrance into the bloodstream is less commonly through the skin and mucosa [7]. However, the main lead absorption occurs via gastrointestinal and respiratory tracts. The latter route absorbs the most amount of lead (30-70%), while this amount is four times higher in adults. Overall, iron deficiency, low dietary calcium, and fasting promote lead absorption [8]. After absorption, lead gets bound to various soft and hard tissues, such as hair dense, bone, and teeth (hard tissues) as well as brain, spleen, kidney, bone marrow, lungs (soft tissues) and the rest is excreted with urine, feces and sweating [7]. About 99% of the circulating lead is bound to red blood cells for about 30-35 days and it then spreads out into the soft tissues over the next 4-6 weeks. The remaining 1% of the absorbed lead is found in serum and plasma. Lead is stored in the bones (95%) which is the primary lead pool [9].

The hypothalamus-pituitary thyroid (HPT) axis controls thyroid function through thyrotropin-releasing hormone (TRH), thyroid stimulating hormone (TSH), and the thyroid hormones (TH), such as thyroxine (T4) and triiodothyronine (T3). Most of the time, T4 and T3 are bound to thyroxine-binding globulin, transthyretin, and albumin, and only less than 1% of circulating T4 and T3 are unbound and active in peripheral tissues [10]. Environmental chemicals, such as lead, might change TH levels *via* several mechanisms, including disruption of iodine transport, and by binding to

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TH-binding proteins, thyroid peroxidase, deiodinases, and related receptor [11,12]. Lead is an environmental chemical that affects the hypothalamic-pituitary axis resulting in diminished TSH, follicle-stimulating hormone (FSH)/ luteinizing hormone (LH), growth hormone (GH) responses, and TRH stimulation while affecting thyroid hormone kinetics [13].

Lead, as a divalent cation, can interfere with enzymes and structural proteins and more importantly with heme production resulting in the reduction of the heme body pool [14]. Ferrochelatase, which catalyzes terminal step in the biosynthesis of hem also gets impaired by lead [15]. In addition, lead can affect glucose-6-phosphate dehydrogenase resulting in decreased red blood cell counts and eventually anemia [16]. Also, it has been shown that blood hemoglobin levels change as a result of exposure to 2.42 μM of lead in adults [15]. Observation of basophilic stippling and premature erythrocyte hemolysis in the blood smear are the hematologic signs of lead poisoning [15].

Nowadays, it is well accepted that lead has many toxic influences on humans' health. Several studies have been conducted on occupational exposure and biological evaluation of lead in various countries [17,18], but there has not been any studies that show the effect of lead on thyroid hormones level in Iranian population. Therefore, in the present study, the effect of high lead level on both thyroid hormones and blood lead level parameters was investigated in a cross-sectional study on patients with high exposure level to lead in Tehran, Iran.

MATERIAL and METHODS

Subjects and Specimen Collection

In the present cross-sectional study, 37 traffic officers highly exposed to lead from all over Tehran were admitted to the laboratory. Lead exposure and no history of any thyroid and blood diseases were the main criteria for the participants to be examined. For the laboratory tests, 10 ml of fasting blood was collected from each person. Blood samples were divided into two tubes: 5-mm, red-capped tubes with no gel for biochemical parameters analysis, and in 5-mm tubes containing ethylene diamine tetra acetic acid for complete blood cell count and blood lead analysis. In preparation for serum analyses, specimens were centrifuged at 3000 g for 5 min after at least 30 min of incubation. The laboratory tests included blood cell counts of red blood cells (RBC), white blood cells (WBC), platelets (PLT) and red blood cell related indexes, including hemoglobin level (HGB), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) as well as conventional biochemical tests detecting serum thyroid hormones, including T3, T4 and TSH.

The examined parameters characterizing the occupational exposure to metals, including blood lead concentration (Pb-B), were measured by SR-P-100 Lead Analyzer (Lead View Plus kit) and Flame Atomic Absorption spectrometry (Shimadzu AA-680). Cells count were measured by KX-21N automatic cell counters (zist kimia Co, lyze and diluent solution) and thyroid hormones were measured by the ADVIA Centaur XPT SIEMENS (Siemens kit)

Ethical Approval

A written consent form was obtained from all participants before participating in the study. The study was approved by the Medical Ethics Committee of the Science and Research Branch of Islamic Azad University.

Blood Lead Determination

The basis of SR-P-100 Lead Analyzer is a potentiometric strip that can measure the level of lead in a complete blood sample and a fresh non-frozen urine, and in samples that have been stored up to 48 h at 4-8 ℃. Blood lead level, which was measured by SRP-100 Lead Analyzer, was further confirmed by Flame Atomic Absorption Shimadzu AA-680 through which the lower, middle and upper range data were measured.

Statistical Analysis

The normality of variable distribution was checked by Kolmogorov-Smirnov test. The continuous variables with normal distribution were expressed as mean and 95% CI, and categorical variables were expressed as percentages. Partial correlation was done to analyze the correlation of Pb level and thyroid hormone with age-adjusted. All data analyses were performed using MedCalc 14.8.1 software.

Table 1. Mean, Maximum, Minimum and Standard Deviation Levels of Lead, Age and Thyroid Panel of the Whole Blood Samples in the Study

Parameters	N	Min.	Max.	Mean	Std. Dev.	Normal range
Lead (μM)	37	0.72	1.69	0.95	0.24	Adult: ≤0.48
Age (year)	37	24	36	29.3	3.47	
T4 (nM)	37	59	135	95.12	22.97	58.1-140.6
T3 (nM)	37	1	3	1.88	0.48	0.92-2.79
TSH (mIU l^{-1})	37	1	4	2.41	1.31	0.55-4.78
Valid N	37					

Table 2. Mean, Maximum, Minimum and Standard Deviation Levels of CBC in Blood Samples

Parameters	N	Min.	Max.	Mean	Std. Dev.	Normal range
Lead (μM)	37	0.72	1.69	0.95	0.24	Adult: ≤0.48
W.B.C (× 10^9/l)	37	5.17	10.04	7.29	1.63	4.30-10.80
R.B.C (× 10^{12}/l)	37	5	6	5.21	0.39	4.5-6.3
Plt (× 10^9/l)	37	178	413	297.72	72.38	150-450
Hb (g l^{-1})	37	160	180	165	7.30	140-175
Hct (proportion of 1.0)	37	0.42	0.50	0.45	0.02	0.41-0.50
M.C.V (fL)	37	80	97	89.24	5.27	77-97
M.C.H (pg/cell)	37	29	31	30.11	0.87	28-32
Valid N	37					

RESULTS

The collected levels of lead and thyroid panels in the whole blood samples of the participants are shown in Table 1. The mean blood lead level in the studied population was 0.95 μM which was higher than the normal value according to the kit insert suggestion (Adult: ≤0.48 μM). The mean TSH level of the samples was 2.41 ± 1.31 mIU/L (0.55-4.78 mIU/L) whereas the highest TSH level was 4 mIU/L for which both values were in the normal range. Also, the mean T3 level was 1.88 ± 0.88 nM(0.92-2.79 nM), with the highest T3 level being 3 nM. Furthermore, the mean T4 hormone was 95.11 ± 22.97 nM (58.1-140.6 nM) and its highest level was 135 nM (Table 1). No significant correlations were observed between Pb and TSH, T3 and T4 levels. There were no significant correlations observed between blood lead level and complete blood count cells. Mean, maximum, minimum and standard deviation levels of complete blood count (CBC) are shown in Table 2.

Correlations between Blood Lead Level and Age

The average age of all the subjects were about 29.32 ± 3.47 years old. The oldest person was 37 whereas the youngest was 24 years old (Table 1). The mean blood lead level in this population was 0.95 μM. There was a weak positive correlation between blood lead level and age (r = 0.25) (Fig. 1). Blood lead level which was measured by SRP-100 Lead Analyzer was further confirmed by Flame Atomic Absorption. The regression analysis and Pearson correlation tests, performed by MedCalc Ver. 14.8.1, indicated that there was a strong correlation between the measured values of the potentiometric device and the atomic absorption device (r = 0.99).

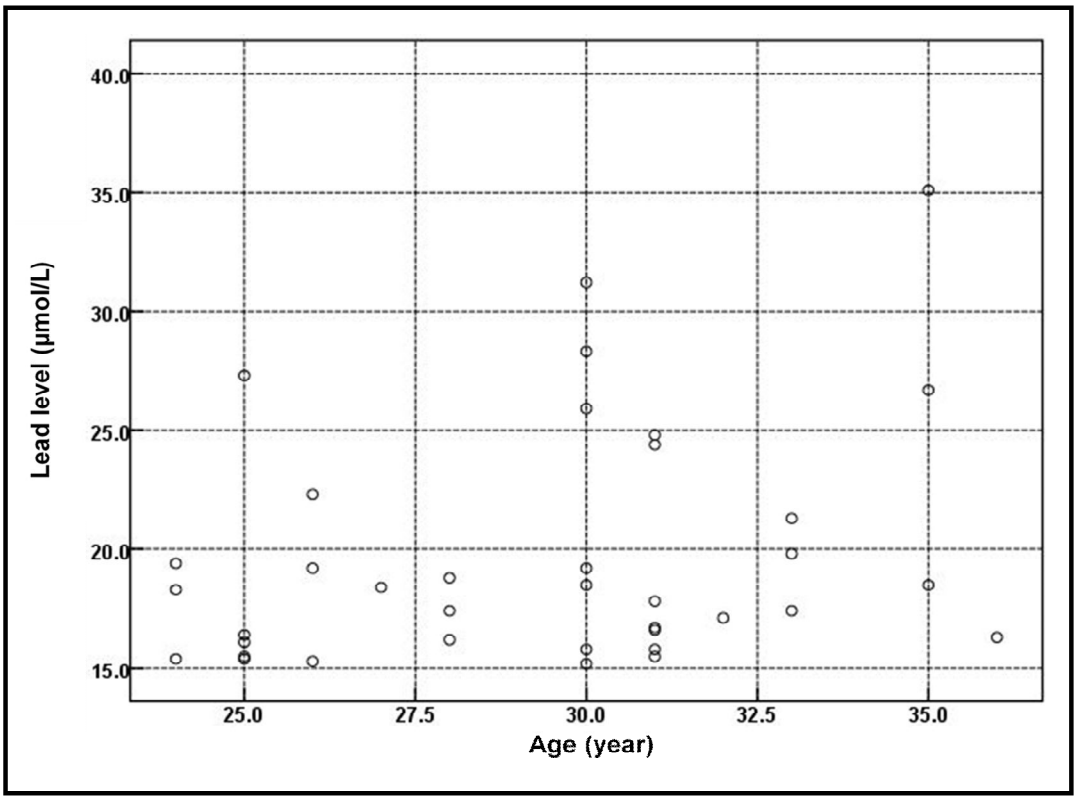

Fig. 1. Correlation between blood lead level and age among participants.

DISCUSSIONS

The results of this study showed that there was no significant relationship between blood lead levels and thyroid hormones (T3, T4, TSH) levels in the cross-section study performed within traffic officers. Previous studies on adolescents (12-19 years old) and adults from the U.S. National Health and Nutrition Examination Survey (NHANES) (2007-2008) demonstrated same result with no consistent pattern of lead and thyroid hormone associations. They declared that their research needed to quantify the associations at higher levels of exposure [10]. Also, another study on auto mechanics, who faced a low dosage of lead for a long time, showed no significant relationship between blood lead levels and T3 and TSH [18]. On the other hand, another study demonstrated that blood lead concentrations were inversely associated with total thyroxine in the general population, but did not correlate with thyroid stimulating hormone, total or free triiodothyronine, nor with free thyroxine. It was therefore assumed that blood lead might have no effect on the thyroid function; however, it could be associated with decreased concentrations of thyroid-binding proteins [17]. Another study on 190 patients diagnosed with occupational disease related to lead intoxication in Ankara Occupational Diseases Hospital found that the levels of the thyroid function test (TFTs) panel and free triiodothyronine (fT3) were significantly higher in the patients with lead exposure, whereas TSH levels were lower ($p < 0.001$). With respect to this study, serum level of lead was also correlated negatively with TSH [19] .

In the present study, a weak positive correlation was observed between age and blood lead level of the participants. The same result was observed in a descriptive cross-sectional study on lead and zinc mine of Kushk Iranian workers [20]. Also, body burden of lead among Swedish adults showed that there was an association between blood level and age and the lead level increased with increasing age while the duration of exposure to lead

seems to affect the blood lead levels [21].

We found no relationships between lead level and blood and white cells, platelet counts, and red blood cells parameters (MCV, MCH, MCHC, Hct and Hb). Similar to the cross-sectional study conducted on lead-poisoned workers in Mashhad, Iran, there was no significant relationship between blood lead level and ferritin and Hb [22]. However, based on a cross-sectional descriptive study performed on 32 welders of the automobile factory, a decrease on blood hemoglobin concentration was observed [23]. Also, according to 190 cases, diagnosed with occupational disease due to exposure to lead studied in Ankara Occupational Diseases Hospital, Hb and MCV values were found significantly lower in the patients with lead exposure than in the controls. In the correlation analysis, serum level of the serum lead was correlated negatively with Hb, MCV [19].

Another descriptive study was carried out in 70 male car painters working in Lahore in which the participants were divided on the basis of lead exposure into two groups: one group with less than and the other group with more than 10 years of exposure. This study showed that serum lead levels were below the safety limits in all the subjects and the duration of exposure had no effects on the hematological indices except hematocrit [24].

CONCLUSIONS

There was no significant association between blood lead levels and levels of thyroid hormones, number of blood cells, and related blood cells parameters (Hct, Hgb, MCV, MCH and MCHC) in the present study performed on traffic officers in Tehran, Iran. However, there was a weak link between blood lead levels and age ($r = 0.25$). Therefore, it seems that lead levels do not affect the level of the thyroid hormones, the number of blood cells and the levels of the red blood cells parameters.

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