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Toxic Effect of Some Heavy Metals (Cadmium and Lead) on Thyroid Function

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ABSTRACT

Aim of the work: this study aimed at exploring the effects of lead and cadmium on the thyroid function of workers of welding operation are exposed to welding fumes containing various toxic metals. **Subjects and Methods:** the level of blood lead and cadmium was measured by atomic absorption spectro-photometry. Thyroid stimulating hormone, free thyroxin, free triiodothyronine in serum were estimated by enzyme immunoassay.

Results: the workers with higher level of blood lead level (BLL) (30–60) ug/dl showed high thyroid-stimulating hormone level (0.50-9)uIU/ml andno changes in free thyroxine and free triiodothyronine. No changes in free thyroxine, free triiodothyronine and Thyroid-stimulating hormone level in relation to increase in cadmium level. **Conclusion:** we concluded that higher level of blood lead may cause certain damage to thyroid function leading to subclinical hypothyroidism.

We concluded no relation between cadmium level and thyroid hormones. The smokers have higher cadmium level (0.59-9.6)ug/L.

INTRODUCTION

Lead is one of the most commonly used heavy metals and it has wide applications since ancient times. However, it is also one of the most detrimental pollutants in the industrial environment in many countries. Occupational and environmental exposures to lead continues to be among the most significant public health problems [(1)]. Lead can have adverse effects on many organ systems, and various effects of lead on thyroid functions have been reported in the past 50 years [(2)].

Cadmium (Cd2+) is a heavy metal that is produced due to pollution from several sources. Occupational exposure can result from the amounts released into the environment and from the end-products related to mining, smelting, and electroplating. Also, exposure results from the profound use of consumer products such as nickel/ Cd2+ batteries, pigments, and plastics. Cadmium toxicity is associated with elevated incidences of chronic kidney disease, hypertension, osteoporosis, and leukemia, as well as cancers of the lung, kidney, urinary bladder, pancreas, breast, and prostate[(3)].Some studies recorded the effect of cadmium on thyroid gland[(4)].

However, findings have been inconsistent and sometimes contradictory, and no consensus has been reached regarding the effect of lead and cadmium on thyroid physiology. The purpose of this study was to investigate the potential effects of lead and cadmium on thyroid function by comparing thyroid parameters in lead and cadmium occupational workers to those in healthy controls.

SUBJECTS AND METHODS

The present study included one hundred adult male between 18-49 years old,eighty of them were occupationally exposed to lead and cadmium during welding operation in kafr El-Sheikh governorateand twenty person as control group. Age of the study subjects was in the range of 18-49 years old. The study subjects were classified according to the blood level of lead and cadmium into 3 groups:

Lead groups

Group1: it consisted of 20 normal healthy men with blood lead level range from (0 – 12.5) ug/dL.

Group2: it composed of 40 subjects with blood lead level range from (13–30) ug/dL.

Group3: it included 40 subjects with blood lead level range from (30–60) ug/dL.

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Cadmium groups

Group1: it comprised 20 normal healthy men with blood cadmium level range from (0.01 – 0.50) ug/L.

Group2: it consisted of 40 subjects with blood cadmium level range from (0.54–1.49) ug/L.

Group3: it included 40 persons with blood cadmium level range from (2.1–9.8)ug/L.

Blood lead and cadmium level

Lead and cadmium was measured by AA 6650 Shimad ZU atomic absorption spectrophotometer. For the measurement of lead and cadmium levels in blood, 5 ml of blood was obtained from the antecubital vein and was collected in heparinized lead-free tubes. Collection of samples was done in a lab near the target factory and transported in an ice box to the central lab.

Serum thyroid hormone profile

Venous blood samples were collected aseptically without additives, then centrifuged to obtain the serum specimens. Measurement of serum free triiodothyronine (FT3) and free thyroxine (FT4) by (competitive enzyme immunoassay).Serum TSH by (atow-site immunoenzymometric assay).All measurements were done with TOSOH AIA 21 analyser (TOSOH Corporation, Tokyo, Japan) using the TOSOH reagents[(5)].

The study was done after approval of ethical board of Al-Azhar University and an informed written consent was taken from each participant in the study.

Statistical analysis

- Data were analyzed by Sigma Plot version 12.5.
- Data was summarized as mean ± SD.
- Differences between groups were analyzed by (Kruskal-Wallis test) and (Shapiro-Wilk test) and t-test. Post-hoc testing was performed by the Tukey test to compare the difference among the groups.
- Simple linear correlation (Pearson correlation coefficient test) (r) was also done to test for linear relations between lead and cadmium and other variables.
- P-value is considered significant if < 0.05.

RESULTS

Results of this study were classified into lead and cadmium groups.

Lead group

Demographic data

No significant correlation was found between blood lead level and duration of exposure.

Thyroid function tests

The mean value of FT3 in group 1 was 3.0 ± 0.53 Pg/ml, in group 2 it was 2.8 ± 0.37 Pg/ml. while mean in group 3 was 2.9 ± 0.55 Pg/ml. There was no significant difference between FT3 values within the three groups.

The mean value of FT4 in group 1 was 1.1 ± 0.30 ng/ml, in group 2 it was 1.2 ± 0.28 ng/ml. while mean in group 3 was 1.2± 0.34 ng/ml. There was no significant difference between FT4 values within three groups.

The mean value of TSH in group 1 was 2.3 ± 0.9mIU/ml, in group 2 it was 1.7 ± 0.36 mIU/ml. While mean in group 3 was4.0± 1.0mIU/ml. There was significant difference in TSH values between the three groups.

Table 1: Comparison between the 3 studied group according to serum FT3, FT4 and TSH.

	Group 1 (n= 20)	Group 2 (n= 40)	Group 3 (n= 40)	P value
FT3				
Mean SD	3.0 ± 0.53	2.8 ± 0.37	2.9 ± 0.55	0.77
Median	3.0	3.1	3.1	
FT4				
Mean SD	1.1 ± 0.30	1.2 ± 0.28	1.2 ± 0.34	0.78
Median	1.5	1.2	1.2	
TSH				
Mean SD	2.3 ± 0.9	1.7 ± 0.36	4.0 ± 1.0	0.007***
Median	1.9	1.6	4.8	

Cadmium group

Demographic data

The mean age for group 1 was 29.5 ± 10.7 yr, for group 2 was 33.5± 10.5yrs. While for group 3 it was 32.8 ± 11.8.6yrs. It seems that there was no significant difference between the 3 groups regarding the age.

No significant correlation was found between blood cadmium level and duration of exposure.

Thyroid function tests

The mean value of FT3 in group 1 was 2.9± 0.56 Pg/ml, in group 2 was 2.9 ± 0.54 Pg/ml. while mean in group 3 was 2.9 ± 0.38 Pg/ml. There was no significant difference between the three values in the three groups. (Table 2, Figure 11)

The mean value of FT4 in group 1 was 1.1 ± 0.30 ng/ml in group 2 it was 1.2 ± 0.34 ng/ml. while mean in group 3 was 1.2± 0.28 ng/ml. There was no significant difference between the values of the three groups. (Table 2, Figure 12)

The mean value of TSH in group 1 was 2.1 ± 0.1mIU/ml, in group 2 was 2.9±0.5 mIU/ml. while mean in group 3 was 2.7± 0.32 mIU/ml. There was no significant difference between the values of the three groups.

Serum cadmium level in smoker and non-smoker:

The mean value of serum cadmium level in smoker group was 3.0 ± 1.7 ug/dl. And it was 1.4 ±0.3ug/dl in non smokers. There was significant difference between smokers and non-smokers in serum cadmium level.

Table 2: Comparison between the 3 studied group according to serum FT3, FT4 and TSH.

	Group 1 (n= 20)	Group 2 (n= 40)	Group 3 (n= 40)	P value
FT3				
Mean SD	2.9 ± 0.56	2.9 ± 0.54	2.9 ± 0.38	0.93
Median	2.8	2.9	3.0	
FT4				
Mean SD	1.2 ± 0.30	1.2 ± 0.34	1.2 ± 0.28	0.86
Median	1.2	1.2	1.1	
TSH				
Mean SD	2.1 ± 0.1	2.9 ± 0.5	2.7 ± 0.3	0.66
Median	1.4	1.9	2	

Table 4: Comparison between serum cadmium level in smoker and non-smoker

	Non-Smoker	smoker	P value
Mean SD	1.4 ±0.3	3.0± 1.7	
Median	0.90	2.3	0.02***

DISCUSSION

The results of our study revealed that there was significant difference between blood lead level in group 1 and 3 and between group 2 and 3 regarding TSH. No significant difference between the three groups regarding FT3 and FT4.

Several studies have evaluated the effects of lead on thyroid hormones levels in occupationally exposed workers.

It was found that no significant alteration was observed in the mean T3 and T4 levels of exposed workers. On the other hand, there was a rise in TSH associated with increasing levels of blood lead. The similarities between our study and this study may be attributed to the near ranges of BLL of both study subjects [(6)].

It was retrospectively examined the records of 65 men who had been exposed to lead while working as automotive mechanics or in battery factories, classified the lead-exposed workers into three groups according to their blood lead levels, as follows: 40 - 59 μg/dl, 60 - 79 μg/dl, or 80 μg/dl and above. TSH levels were high in all three groups having different blood lead levels despite normal fT3 and fT4 levels. Raised TSH levels in the three groups may be due to the higher levels of BLL in Pekcici's study in comparison to our study [(7)].

Our finding are in accordance with those of other investigator who investigated one hundred subjects occupationally exposed to lead in a factory for bullets and shots in Alexandria aiming to evaluate the potential effect of blood lead levels on thyroid indices (fT3, fT4, and TSH) and thyroid gland ultrasound. The study subjects were classified according to the blood level of lead into 3 groups:

Group I: 10-25 Micrograms/dl

Group II: 26 -40 micrograms/dl

Group III: 41-60 micrograms/dl

This study revealed that there was significant difference between group I and III and between group II and III regarding TSH. No

significant difference between the three groups regarding FT3, FT4or ATPO. Regarding thyroid ultrasound (U/S), all the 3 groups showed many abnormalities regarding size and texture with the presence of multiple or solitary thyroid nodules. Group III had the highest percent of U/S abnormalities and there was significant statistical difference between group I&II, II&III and I&III. These laboratory and radiological changes suggest that lead causes primary sub-clinical hypothyroidism due to direct damage to the thyroid gland **(8).**

The results of our study revealed that there was no significant difference between blood cadmium levels between the three groups regarding TSH. No significant difference between the three groups regarding FT3 and FT4.

Our results was agree with those of other investigator who investigated 1724 participants (517 painters, 344 welders, 431 miners, and 432 smelters) with an occupational exposure more than 10 years and for whom blood cadmium levels for the previous 3-year period were obtained from patient records were included in the study. The age range was 18 to 70 years, with a median age of 38 years. In this study there was no significant difference for serum thyroid stimulating hormone (TSH) and there was a positive correlation between cadmium and serum free T4 and T3 levels. He classified the exposed participants in to six groups in according to blood cadmium level but positive correlation with free T4 and free T3 with normal reference range**(9).**

The present study revealed significant difference in cadmium level between smokers and non-smokers.

It was reported that the mean whole blood Cd content in smokers was 1.9 times higher than in non-smokers (2.67+1.21ug/l and 1.37+0.45ug/l respectively(mean+SD), average age 30 years)**(10).**

It was found that smokers have a 1.7 fold increase of serum Cd content compared to non-smokers (0.92+0.83ug/l and 0.55+ 0.48ug/l, average age 36 years)**(11).**

It was showen that serum Cd values of young smokers were at least 3.1 fold increased in comparisons to young non-smokers (0.61+0.75ug/l and below the lower limit of detection (LOD) 0.2ug/l; average age 16years). These data highlight the dramatic difference in serum cadmium levels between smokers and non-smokers**(12).**

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