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# ANALYSIS OF CHROMIUM, MERCURY, SILVER AND ZINC IN HAIR SAMPLES FROM DENTISTS PRACTICING IN BENGHAZI, LIBYA

## (Analisis Kromium, Raksa, Perak dan Zink Dalam Sampel Rambut Doktor Gigi di Benghazi, Libya)

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**Abstract**

The measurements of mercury, zinc, chromium and silver in hair samples of dentists and control group were carried out by neutron activation analysis. Our results showed that, the level of mercury (mean ± standard deviation) in hair samples of dentists were 5.99 ± 2.64 mg/kg (range of 3.44 – 776 mg/kg) and for control group were 2.45 ± 0.62 mg/kg (range of 1.70 – 3.48 mg/kg) and the difference between the two groups was significant. A high level of zinc in hair samples of dentist and control group was also observed. The level of zinc in dentist was 1081.14 ± 495.36 mg/kg (range of 315 – 1770 mg/kg) while the mean level of zinc was 1862±1581.76mg/kg for the control group (ranged from 688 to 5256 mg/kg) which was found to be significantly higher than those for dentists. The mean levels of chromium and silver show no significant difference between dentists and control group. The hair mercury level of dentists was correlated to the number of weekly working hours, experience in years and age while gender, fish consumption and the number of dental amalgam in mouth of dentists were found to be uncorrelated to the level of mercury.

**Keywords**: dental amalgam, mercury, hair, dentist

**Abstrak**

Pengukuran kandungan raksa,zink, kromium dan perak dalam sampel rambut doktor gigi dan kumpulan kawalan dilakukan dengan kaedah analisis pengaktifan neutron. Hasil yang diperolehi menunjukkan kandungan raksa (min ± sisihan piawai) sampel rambut doktor gigi ialah 5.99 ± 2.64 mg/kg (julat 3.44 – 776 mg/kg) dan bagi kumpulan kawalan ialah 2.45 ± 0.62 mg/kg (julat 1.70 – 3.48 mg/kg) yang menunjukkan perbezaan bererti di antara dua kumpulan tersebut. Kandungan zink yang tinggi bagi kedua-dua kumpulan juga diperhati, kandungan zink dalam sampel rambut doktor gigi ialah 1081.14 ± 495.36 mg/kg (julat 315 – 1770 mg/kg) manakala bagi kumpulan kawalan ialah 1862±1581.76mg/kg (julat 688 - 5256 mg/kg). Terdapat perbezaan bererti dalam kandungan zink bagi kumpulan kawalan berbanding dengan kumpulan doktor gigi. Kandungan kromium dan perak tidak menunjukkan perbezaan bererti bagi kedua-dua kumpulan tersebut. Kandungan raksa doktor gigi mempunyai korelasi dengan jumlah jam berkerja seminggu, bilangan tahun pengalaman dan usia walau bagaimanapun tiada korelasi dengan kekerapan pengambilan ikan dan bilangan amalgam gigi.

**Kata kunci**: amalgam gigi, raksa, rambut, doktor gigi

## Introduction

Hair analysis have been used as a bio-monitor for many elements, both toxic and essential, for assessing environmental exposures and body nutritional status, as well as diagnosis of diseases. Dental amalgam is well known as a major source of mercury exposure in dentistry. An amalgam is a restorative material generally contains 50% mercury (Hg) in complex mixture of other metals. Dentist and dental personnel who work with amalgam are chronically exposed to mercury which is readily absorbed into the body through the skin during handling and by inhalation. Mercury has been demonstrated to have damaging effects on the kidney, central nervous system and

cardiovascular system. The effect of the mercury is to block or inhibit most essential enzymatic processes at very low levels of exposure. Possible adverse effects of mercury exposure in dentistry have been discussed in several studies. To our knowledge, no studies have examined the mercury levels in hair samples of Libyan dentists. The purpose of this study was to assess the levels of exposure to mercury in dentists in Benghazi, Libya to show if the level of mercury in the hair of the dentists exceeded the level of mercury set by WHO [1].

## Materials and Methods

### Sample collection

Thirty two dentists were included in this study. There were randomly selected from 4 dental clinics (2 private, 2 public) in Benghazi, Libya. Each dentist was asked to complete a questionnaire detailing age, gender, number of working hours per week, number of years in experience as a dentist, number of dental amalgam in dentist mouth and frequency of fish consumption per week.

A group of 25 respondents representing the students and the lectures in the faculty of science, Benghazi University was assigned as the control group. The control group members were also asked to complete a questionnaire similar to that of dentists but excluding questions specifically relating to dentists work.

### Preparation of hair samples

Hair samples were collected from donors by single cutting from the occipital region with a pair of clean stainless steel scissors in accordance with the IAEA protocols. The hair samples were cut to lengths of about 2-5 mm. The hair samples were then washed according to the standard procedure recommended by the IAEA: wash hair in acetone, thrice in water and once more in acetone. The samples were then dried overnight in an oven at 60˚C.

Table 1. Description of the study population

| | Male N = 16 | | Female N = 16 | | All Dentists N = 32 | | Control Group N = 25 | |
|---|---|---|---|---|---|---|---|---|
| | Mean ± stdv | Range | Mean ± stdv | Range | Mean ± stdv | Range | Mean ± stdv | Range |
| Age (years) | 32.06 ±4.06 | 25 – 38 | 28.14 ±2.21 | 24 - 32 | 30.20 ±3.85 | 24 -38 | 27.83±9.20 | 19 - 40 |
| Number of dental amalgam | 3.5 ±1.90 | 0 – 8 | 1.86 ±1.51 | 0 - 5 | 2.27 ± 1.73 | 0 -8 | 1.5 ± 1.05 | 0 - 3 |
| Fish Consumption (Meal/week) | 2 | 1 – 3 | 1 | 0 - 2 | 1 | 0 -3 | 1 | 0 - 3 |
| Working Hours/week | 38 ± 13.95 | 18 – 60 | 26.21 ± 10.11 | 18 - 50 | 32.50 ± 13.50 | 18 - 60 | - | - |
| Experience (years) | 6.60 ± 3.70 | 1 – 12 | 3.42 ± 1.51 | 1 – 6.5 | 5 ± 3.3 | 1 - 12 | - | - |

### Hair analysis

Samples were analysed by neutron activation analysis with the kayzero standardization methods. About 0.1 gram of each hair sample and Al-Au wire and Zr monitors were irradiated in a neutron flux of 2.1 x $10^6$ n $cm^{-2}s^{-1}$ in the

PUSPATI TRIGA MKII Reactor for about 6 hours. After a decay period of three days activated samples were analysed by a gamma spectroscopy system consisting of a HPGe detector and the associated electronics. Detail of the analysis has been reported earlier [2-5].

## Results and Discussion

### General description of the study population

The total sample was made up of 32 dentists and 25 controls live in the same general geographical area. For dentists, the results of the survey revealed that 50% of the participating dentists within the two types of gender had ages of 24 – 38 years old. The mean age (± standard deviation) was 30.20± 3.85 years. The number of fish meal consumed weekly by this group varied from 0 to 3 times with an average of 1 time/week. The average number of dental amalgam was 2 in the range of 0 – 8.

For the control group, the population consisted of 11 male (44%) and 14 female (56%). Their mean age was 27.83± 9.20 years in the range of 19 – 40 years. Details description of the population studied are summarized in Table 1.

### Hg, Zn, Cr and Ag level in hair of dentists and control group

The mean (±standard deviation) of total mercury levels in hair samples for whole participating dentists was 5.99±2.64 mg/kg in the range of 3.44 – 776 mg/kg. For male, the mean (±standard deviation) of the total mercury in their hair samples was 6.22±1.32mg/kg in the range of 3.82 – 12.40 mg/kg. For female, the mean level was 6.60 ±4.46 mg/kg in the range of 3.44 – 776 mg/kg. The frequency distribution of mercury concentration for the participating dentists is shown in Figure 1.

For control group, the mean (± standard deviation) of total mercury level in their hair samples was 2.45± 0.6 mg/kg in the range of 1.70 – 3.48 mg/kg. For male, the mean of mercury level (±standard deviation) was 2.19±0.42 mg/kg in the range 1.70 – 2.48 mg/kg. for female, the mean of mercury level (± standard deviation) was 2.70±0.77 ranged from 1.95 – 3.48 mg/kg.

High levels of zinc were found in hair samples of dentists and control. The mean level (±standard deviation) of zinc in hair samples of dentists was 1081.4 ± 495.36 mg/kg in the range of 315–1770 mg/kg. For control group, the mean zinc level was 1862.18 ± 1581.76 mg/kg in the range of 688 – 5256 mg/kg.

The mean level of chromium and silver (±standard deviation) in the participating dentists were 2.60±1.87mg/kg (ranged from 1.25 –13.7mg/kg) and 3.54±1.17 mg/kg (ranged from 0.51 – 4.53mg/kg), respectively. For control group, the mean level of chromium and silver (±standard deviation) were 2.83±1.94 mg/kg (ranged from 0.13 – 12.2mg/kg) and 3.13 ±2.55mg/kg (ranged from 1.78 – 13.3 mg/kg), respectively. No significant difference was found in the level of chromium and silver between dentist and control group. The level of total mercury, zinc, chromium and silver in hair samples of participating dentists and control group were summarized in Table 2.

Our results indicated that, there was a significant difference between hair mercury concentration of dentists and controls. The mean concentration of hair mercury for dentists was about two times that for the control group. In this study, 65% of the participating dentists had level of mercury in their hair exceeded the level of mercury of 5mg/kg which sets by the WHO [1].

Although zinc is an essential element that is found in almost every cell and low level will cause health problem especially for children growth, a high level of zinc can produce acute and chronic effects of toxicity. In this study a very high level of zinc were found in hair of dentists and control group. In contrast to mercury, the mean level in control group hair was found to be significantly higher than that for dentists. However, the source of zinc in both the samples is not known. Further investigation of the blood levels in order to assess internal contamination must be carried out. No significant difference was found between the level of Cr and Ag in hair of dentists and those for control group.

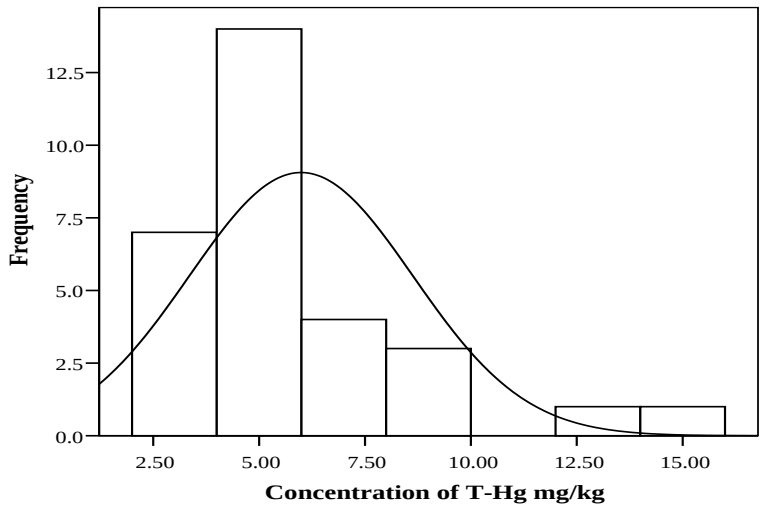


Figure 1. Frequency distribution of total mercury concentration for the participating dentists

The relation between the number of weekly worked hours by dentists and hair mercury concentrations was examined by Pearson correlation. The results showed a significant correlation between the number of weekly worked hours and hair mercury level ($r = 0.561$, $p = 0.001$). Similar correlation was reported by Scarlett et al. [6] but not with Harakeh et al. [7] who found no correlation between hair mercury levels and working hours. While in other study, a significant correlation between urinary mercury and the number of worked hours but no correlation between that and concentrations of mercury in head hair. In this study, Zn, Cr and Ag in dentist's hair were not correlated to weekly worked hours.

Table 2. The level of Hg, Zn, Cr and Ag in hair samples of participating dentists and the control group (mg/kg)

| Group | Hg | | Zn | | Cr | | Ag | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| Dentists | 5.99±2.64 | 3.44-776 | 1081 ±495 | 315-1770 | 2.60±1.87 | 1.25 –13.7 | 3.54±1.17 | 0.51 – 4.53 |
| Control Group | 2.45±0.62 | 1.70-3.48 | 1862 ±1581 | 688-5256 | 2.83±1.94 | 0.13 -12.2 | 3.13 ±2.55 | 1.78 – 13.3 |

Our results showed a significant positive correlation between the hair mercury levels in dentists and the number of years of their experience at 0.05% level (r=0.447, p=0.013). This is in agreement with Scarlet et al. [6] but contradicts with what was reported by Harakeh et al. [7]. Duncan et al. [8] found that, staff working in dental practices for more than five years had small but discernible increases in head hair mercury concentration.

Age was found to be correlated to hair mercury level of dentists at 0.01 level (r=0.531, p=0.001). This finding contrast to that of Ott et al. [9] who found no correlation between mercury level in hair samples of dentists and their age. Tabatabaei et al. [10] found a positive relation between urine mercury and age (p=0.008). For control group, age correlated only with the concentration of zinc in their hair.

The mean mercury level in hair samples of male dentists was higher than that for female. However, the difference was not significant. In control group, gender had effect on the level of mercury and zinc. The level of mercury and zinc in hair of females were significantly higher than those for male. In this study, two samples one male dentists and one female dentists were found to have high level of mercury in their hair (12.40 and 15.80 mg/kg, respectively). This may due to contaminated environment in their work place, where both work in the same clinic. Another two female dentists have a very high level of hair mercury (423 and 776 mg/kg). However, the reason of these high levels wasn't known. In those cases blood test would have confirmed the internal exposure to mercury.

Our results revealed no significant correlation between mercury level in hair of dentists and the number of dental amalgam in their mouth. This comparable to what was reported elsewhere [7] and similar finding was found for Zn, Cr and Ag.

Although fish consumption is a major source mercury exposure, in this study fish consumption had no effect on the level of mercury in dentists or control group hair and this finding accords with Harakeh [7]. A significant correlation between hair mercury level and fish consumption have been reported in our previous study in other nation [2]. The absence of correlation between hair mercury level and fish consumption may be due to low frequency of fish consumption in Libya.

## Conclusion

This study showed that the occupational exposure to mercury in dentists poses a potential risk of increasing systematic mercury level. There is a need for further investigation including environment monitoring of Hg, evaluation and test for neuro-behavior to detect early effects of mercury poisoning. It is important to enforce personnel safety measures to control the exposure. Apart from mercury, our results showed a high level zinc contamination in the hair of dentist and control group. Detail studies need to be carried out to asses the level of zinc in the population of Benghazi and in other cities in general and to investigate the source of contamination.

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