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# Some results on Hg content in hair in different populations in Albania

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**Abstract**

The mercury content in hair, for exposed dental workers and unexposed groups of people living in Albania was studied. The influence of factors such as age, sex, body weight, fish consumption in the diet, number of dental amalgam fillings and time exposed to mercury, was determined. The mean value of mercury content in hair for the subjects under study (0.705 μg/g) was found to be lower than the value referred from the World Health Organization (WHO) for people who do not consume fish with a high methylmercury content (1–2 μg/g). A significant positive correlation of Hg content with the number of dental amalgam fillings, time under exposure and frequency of fish consumption in the diet was found. These correlations became stronger when exposed and unexposed groups of people were evaluated separately. © 2000 Elsevier Science B.V. All rights reserved.

*Keywords:* Mercury; Hair; Fish diet; Amalgam

## 1. Introduction

Recently there has been increased interest in the monitoring of heavy metal burdens for exposed groups as well as for normal populations. Since mercury is a potentially toxic metal, many studies have been carried out for its determination in different human tissues.

Hair is a suitable indicator for the monitoring of human exposure to mercury (Yoshinaga et al., 1994). Mercury levels in hair have been shown to reflect mercury levels in internal organs (Clarkson, 1992; Pfeiffer et al., 1993) as well as dietary intake (Clarkson, 1992; Malm et al., 1995). How-

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ever, controversy regarding the usefulness of monitoring the total body burden using hair analysis still exists.

It is widely accepted that scalp hair is a suitable indicator for the monitoring of human exposure to mercury pollution. Scalp hair is considered as the best screening indicator for human contamination from methylmercury. Hair stores methylmercury after its ingestion into the body and scalp hair levels correlate well with the concentration in the blood at the time hair is being formed (Malm et al., 1995). A strong correlation between the content of mercury in hair and mercury content in the blood has been reported in several studies (Clarkson, 1992, Pfeiffer et al., 1993, Akagi et al., 1995). There are also findings (Cernichiari et al., 1995) which demonstrate the significance of using maternal hair levels for biological monitoring in pre-natal studies.

The WHO currently estimates that mercury amalgam fillings have a relative contribution of mercury to the human system much greater than all other sources such as air, water and diet combined (Kennedy, 1999). A fish diet is also considered as a major path through which mercury is accumulated.

Previously, there have not been any comprehensive studies of the mercury content of hair of populations in Albania. Authors have reported mercury pollution in marine sediments and marine biological materials collected along the Albanian Adriatic Coast (Baraj et al., 1994; Babi et al., 1998; Celo et al., 1999). Large amounts of fish are consumed by populations living on the coast as well as by inhabitants living in the interior. As a result, fish consumption has been thought to be an important source of mercury intake in these populations.

One of the major sources of occupational exposures in Albania is thought to be the mishandling of mercury during the preparation of amalgam in dental clinics with poor ventilation systems.

The objectives of the study were twofold:

1. to determine mercury concentration in hair of people exposed to mercury while working in dental clinics as well as of normal, unexposed people (control group);
2. to characterize the influence of factors such as age, sex, exposure to mercury, and fish consumption on the mercury concentration in the hair.

## 2. Materials and methods

### *2.1. Sampling*

A questionnaire was prepared in order to collect data on the age, sex, body weight, occupation, number of dental amalgam fillings, frequency of fish consumption, the time of exposure for the individuals working in dental clinics, as well as notes on each subject's method of hair treatment (washing, dying, etc.)

Hair strands from each participant were collected according to Grandjean et al. (1994) from the root in the occipital region and then placed in plastic bags.

### *2.2. Pre-treatment and digestion of the samples*

The hair samples were placed in 100 ml beakers, washed with warm 0.25% detergent solution (dodecyl sulfate, sodium salt), rinsed more than 10 times with distilled water and finally rinsed twice with acetone. They were air dried until the difference between two sequential weights of dry hair was less then 5%. The results are reported in dry weight.

The digestion procedure was based on several different methods (Kratzer et al., 1994; Akagi et al., 1995; Malm et al., 1995; Barbosa et al., 1997). In our case, 3.5 ml of concentrated $HNO_3$ was added to 0.2–0.3 g of hair sample placed in a half pressured Teflon bomb. After overnight digestion at room temperature, the samples were digested at 80–90°C for 5–6 h. Finally, 0.5 ml of a BrCl oxidizing mixture was added and the mixture was heated again for 1 h at 60–70°C.

Cold vapor atomic absorption spectroscopy was used for mercury determination. All the measurements were performed using a Pye Unicam Model SP9 spectrophotometer. A home built vapor generation system was used for the reduction of

Table 1
General information for the subjects ($n = 61$; 14 males and 47 females) studied

| Age | | No. of amalgam fillings | Age of amalgam fillings | Frequency of fish consumption | Years of exposure to mercury |
|---|---|---|---|---|---|
| Mean | 33 | 5 | 9 | Twice per month | 12.5 |
| Range | 20–56 | 0–12 | 0–20 | 0–8 | 0–30 |

mercury using $SnCl_2$. Nitrogen was used as a carrier gas for the transport of mercury vapor into the cell.

For verification of the accuracy of the analytical data, a Japanese Certified Reference Material (CRM No. 13, Human Hair) was analyzed along with the samples. Efforts were also made to prepare an internal reference material of hair samples (Yoshinaga et al., 1994) After each run, the values of the CRM and internal standard were depicted using quality control charts ($\chi$-charts).

## 3. Results and discussion

Table 1 summarizes the characteristics of the entire population. Table 2 gives some statistical parameters for the pooled mercury concentrations in hair for all the subjects in the study.

The overall mean value of the mercury content in the hair samples (0.705 $\mu g/g$) was within the range (1–2 $\mu g/g$) that the WHO considers as normal for populations that do not consume fish with high methylmercury content. The highest value found (1.955 $\mu g/g$) was less than 20% of the warning limit for pregnant women (10 $\mu g/g$). The values reported from our investigation were comparable with those cited in the literature for normal subjects.

As a first step in the examination the results for possible sources of variation, and the distribution type of the overall grouped values was studied. In our case we had 78.7%, 90.1% and 94.0% of the values lying in the ranges $\mu \pm \sigma$, $\mu \pm 2\sigma$ and $\mu \pm 3\sigma$, respectively. According to Miller and Miller (1993) this situation cannot be attributed to a normal distribution.

The distribution of the logarithms of the values was later investigated. It was found that the calculated $\chi^2$ (10.2) was smaller than the tabular $\chi^2$ (11.3), which means that, for $P \leq 99\%$, the values follow a lognormal distribution.

The correlation coefficients of several factors with the measured mercury content in hair was considered helpful for finding out to what extent these factors influence the accumulation of mercury in the hair of the subjects. The data are presented in the Table 3.

The negative correlation between mercury content and body weight is also cited elsewhere (Drasch, et al., 1997; WHO, 1990). The correlation between mercury content and years of exposure for dental workers was also found to be significant ($P < 0.05$). It means that the influence

Table 2
Pooled results of mercury content in hair for all subjects

| Parameter ($n = 61$) | Hg value ($\mu g/g$) |
|---|---|
| Mean | 0.705 |
| Median | 0.499 |
| Geometric mean | 0.591 |
| Minimum value | 0.195 |
| Maximum value | 1.955 |
| Standard deviation | 0.478 |
| CI with 95% certainty | 0.582–0.827 |

Table 3
Correlation coefficients of Hg content in hair with other factors

| Type of correlation ($n = 61$) | $R$ value |
|---|---|
| Hg content in hair | |
| Body weight | −0.067 |
| Number of dental amalgam fillings | +0.153 |
| Age of dental amalgam fillings | +0.088 |
| Years of exposure | +0.281 ($P = 0.016$) |
| Frequency of fish consumption | +0.189 |
| Age of the cases | +0.012 |

of the exposure to amalgam, mercury vapors and working in poorly ventilated rooms in dental clinics, is evident. No linear correlation was found between mercury hair levels and the age of the subject's dental amalgam fillings or to the age of the subjects. This fact could be explained by the relatively short biological half-life time (Knobeloch et al., 1995; Landis and Yu, 1998) of mercury within the organism compared with the long duration of dental amalgam fillings within the mouth cavity. The correlation between the mercury content and the number of dental amalgam fillings may be considered more relevant in the studies of this type.

The correlation between mercury hair levels and the frequency of fish consumption in the diet was slightly positive, showing the influence of fish consumption on mercury intake. However, the average frequency of fish consumption for the subjects under study, was quite low (once in 2 weeks) so it was expected that any correlations found would be weak.

The distribution of mercury content in the hair between the two sexes was investigated. A summary is given in Table 4.

The mean value of mercury content on the hair of female subjects was found to be higher than that of males. Contradictory findings are cited elsewhere (Akagi et al., 1995; Malm et al., 1995; Lebel et al., 1996). However, in these other studies, no significant difference in mercury content in the hair of the two sexes was found. There is some doubt about the validity of our findings since the number of males in our study group was less than the number of females.

Table 4
Summary of mercury content by sex

| Parameter (μg/g) | Female ($n = 47$) | Male ($n = 14$) |
|---|---|---|
| Mean | 0.75 | 0.52 |
| Median | 0.62 | 0.39 |
| Minimum value | 0.195 | 0.205 |
| Maximum value | 1.955 | 1.579 |
| Standard deviation | 0.495 | 0.39 |
| CI with 95% certainty | 0.61–0.9 | 0.3–0.75 |

### 3.1. Occupational groups

There were two groups of exposed people in this study. One group worked at a dental clinic in Tirana ($n = 23$), the second at Durres ($n = 13$). The remaining subjects were unexposed people. The exposed cases from the dental clinics in Tirana and Durres were considered separately because another important factor, such as fish consumption could influence the results to a different extent in each group. A summary of each population group is shown in Table 5.

The correlation coefficients of mercury content with other factors are summarized in the Table 6.

### 3.2. Dental clinic of Durres

The mean value of the mercury content in analyzed hair samples from individuals working in the dental clinic of Durres was more than twice

Table 5
Summary of mercury content of hair by exposure group

| Statistical parameters (μg/g) | Dental clinic Durres ($n = 13$) | Dental clinic Tirana ($n = 23$) | Unexposed population ($n = 25$) |
|---|---|---|---|
| Mean | 1.136 | 0.726 | 0.405 |
| Median | 1.148 | 0.724 | 0.395 |
| Minimal value | 0.465 | 0.205 | 0.195 |
| Maximal value | 1.955 | 1.844 | 1.698 |
| S.D. | 0.48 | 0.456 | 0.3 |
| CI with 95% certainty | 0.84–1.43 | 0.53–0.91 | 0.322–0.577 |

Table 6
Correlation of Hg content in hair with other factors, by exposure group

| Type of correlation | Dental clinic Durres ($n = 13$) | Dental clinic Tirana ($n = 23$) | Unexposed population ($n = 25$) |
|---|---|---|---|
| Hg content | | | |
| Body weight | −0.023 | −0.09 | +0.09 |
| Number of dental amalgams | +0.55 ($P = 0.052$) | +0.58 | +0.07 |
| Age of dental amalgam | +0.41 | −0.04 | +0.02 |
| Time of exposure | +0.288 | +0.136 | – |
| Frequency of fish consumption | +0.68 ($P = 0.009$) | +0.08 | +0.61 |

as high as the mean value of the control group of our study. This value (1.136 μg/g) is also higher than the mean value found in other investigations (Barbosa, et al., 1996) for cases with the same type of exposure. The same trend was found for the minimum and maximum values.

Within this group, the correlation between mercury content and frequency of fish consumption was relatively high ($r = 0.68$) and was found to be highly significant ($P = 0.009$). People of this group consume much larger amounts of fresh fish since they live in a coastal city where fishing is an important activity. Significant correlations were found between mercury content and the number of dental amalgams ($r = 0.55$ $P = 0.052$) and mercury content and exposure time.

### 3.3. Dental clinic of Tirana

The mean value for the mercury content in the hair of individuals working in the dental clinic of Tirana was approximately one-half the mean value for the dental clinic of Durres and higher than the mean value for the control group. Regarding the correlation, almost the same trend was observed for the effect of the number of dental amalgam fillings to the mercury content. As expected, there was a slight positive correlation between mercury levels vs. years of exposure and mercury levels vs. frequency of fish consumption. Unlike the exposed group in Durres, the frequency of fish consumption was of minor importance for the mercury content in hair.

#### 3.3.1. Group of unexposed people

The mean mercury content on the hair samples collected from this group (0.405 μg/g) was only one-third of the mean value of subjects from Durres. This group of randomly chosen unexposed subjects yielded the lowest mercury content in hair. For the cases surveyed in this group there were found almost the same trends but smaller correlation coefficients than in two other groups. The particular influence of diet could be noticed.

## 4. Conclusions

The mean value of mercury in hair for the combined population is well within the range that the WHO classes as normal. The observation of a positive relationship from the fish consumption in the diet proves its importance in the mercury content in organism and in hair. It is also evident that a positive relationship exists between the number of amalgams in the mouth cavity and mercury content in hair. The mercury exposure of technicians in dental clinics is important for the mercury retention in hair. In most cases this exposure is due to old methods of preparation of amalgam and working in poorly ventilated rooms. Among the factors affecting the mercury content for the individuals within a certain group, the number of amalgams in the mouth cavities and fish consumption are of a certain concern.

In order to have more reliable conclusions a greater number of cases would need to be sam-

pled. The investigation of the methylmercury content would be worthwhile.

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