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by Skare I, Bergstrom T, Engqvist A, Weiner JA

Affiliation: Unit of Gases and Vapors, National Institute of Occupational Health, Solna, Sweden.

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Mercury exposure of different origins among dentists and dental nurses

by Ingvar Skare, LEng,[1] Torgil Bergström,[1] Anita Engqvist, BSc,[1] Jan A Weiner, MSc[2]

SKARE I, BERGSTRÖM T, ENGQVIST A, WEINER JA. Mercury exposure of different origins among dentists and dental nurses. *Scand J Work Environ Health* 1990;16:340—7. Mercury exposure was studied among dental personnel with the use of urinary mercury excretion rates and questionnaires. The study covered 314 dentists and dental nurses employed in public clinics and private practices in Stockholm. The obtained urinary mercury excretion rates were analyzed by stepwise regression for assigning them to different origins, such as environmental factors, number of amalgam surfaces, chewing of gum, kind of employment and profession, age, sex, amalgam handling time, and use of amalgam capsules. On the average the occupational contribution to the total urinary mercury excretion rate was small and of the same order as the contribution from their own amalgam fillings (approximately 2 µg of mercury/24 h). There were, however, individuals showing excretion rates close to the levels at which effects on the central nervous system and the kidneys have been reported.

Key terms: amalgam, biological monitoring, capsules, chewing, urinary mercury.

Mercury (Hg) has been of great interest for many years as an excessively harmful environmental and occupational risk factor. The actual reasons for this continued interest have, however, changed over time. Earlier, most attention was paid to problems connected with organic mercury compounds in, for example, seeds and lake fish. In the 1980s the leakage of elemental mercury from dental amalgam was repeatedly verified, and it became obvious that dental amalgam is not as inert as it should be and was earlier considered to be. Amalgam has today been questioned both as a potential health risk factor for all individuals with amalgam restorations and as an occupational risk for dental personnel.

The awareness of environmental hazards from various chemicals is usually demonstrated in modern dental clinics in a high standard of hygiene during the storing of mercury, the mixing of amalgam, the removal and insertion of amalgam restorations, and the handling of spillage. Furthermore, an improved standard of ventilation has contributed to the low mercury exposure levels now normally measured in dentistry. For example, in a recent extensive study of dental clinics by Nilsson & Nilsson in the north of Sweden (1, 2), it was stated that the average occupational mercury exposure was low in comparison with both the present hygienic air standard and the proposed biological monitoring criteria. The highest single urinary mercury concentrations reported by Nilsson & Nilsson (2) should, however, not be considered negligible from a hygienic point of view. Many other studies performed in dentistry have also concluded that, if proper mercury hygiene is not maintained, high levels of mercury are easily reached (3—16).

The objective of the present study was to evaluate the actual mercury exposure of dentists and dental nurses and relate it to different origins, including background mercury exposures.

[1] Unit of Gases and Vapors, National Institute of Occupational Health, Solna, Sweden.
[2] National Board of Occupational Safety and Health, Solna, Sweden.

Reprint requests to: Professor I Skare, Unit of Gases and Vapors, National Institute of Occupational Health, S-171 84 Solna, Sweden.

Subjects and methods

Subjects

With the aid of the Stockholm Dentist Association 265 dentists from a population of about 2000 were selected by random sampling. Both public clinics and private practices were covered. The dentists chosen were given an offer to participate in this study together with their assisting nurses. They were asked to fill out a questionnaire about the number and location of their amalgam surfaces, the frequency with which they chewed gum, age, average amalgam handling time a week, and use of amalgam capsules.

After one reminder 314 subjects (154 dentists and 160 nurses) were obtained, including 72 % of the dentists initially selected from public clinics and 51 % of the dentists selected from private practices. As is apparent from table 1, the dental group consisted of as many dentists as dental nurses, and the subgroup of dentists contained as many men as women. All the nurses were women.

Urine sampling and analysis

All the subjects were given a sampling vessel (5-l polyethylene bottle) containing 1 g of sulfamic acid as a preservative, which allows a urine sample to be stored at room temperature for more than one week without any detectable loss of mercury. The subjects were instructed to collect all voided urine during exactly 24 h. The total mercury content of a 24-h urine sample was used for calculating the current excretion rate, which has been shown to be a stable biological index of mercury exposure (17, 18).

The mercury content of the urine samples was analyzed by a method earlier developed by Lindstedt (19) and Skare (20). The method is based upon a wet digestion technique with acid permanganate solution followed by a two-stage reduction of released bivalent mercury ions to elemental mercury with hydroxylammonium chloride and bivalent tin ions. Liberated mercury vapor was purged into a reading instrument based on the cold atomic absorption principle (Milton Roy, Hg lamp 254 nm, gas cell 30 cm). Standard curves were obtained from urine samples low in mercury and spiked with freshly diluted portions of an acidified mercury nitrate solution (mercury standard 1.00 g Hg/l by BDH Chemicals Ltd, England).

The limit of the quantitative analysis was set at 0.2 µg Hg/l of urine (ie, a level low enough to permit accurate analysis of the urinary concentration of mercury for most occupationally unexposed individuals). At commonly occurring concentrations around 2 µg Hg/l the analytical within-day coefficient of variation was found to be equal to or less than 5 %.

The reliability of the method was tested in two ways. First, on ten different days, duplicates of a dried standard sample of urinary mercury (Seronorm standard, batch 108 from Nycomed AS, Oslo, Norway) was diluted in water to an appropriate mercury level, and an overall mean recovery of 93 % was established. According to the supplier the recommended nominal value of this standard is based on weighed results from six different laboratories showing a range of 87—116 %. Second, on two different days, four real urine samples containing a urinary mercury concentration of 2—10 µg Hg/l were analyzed as triplicates. The overall means were compared with the mean values of duplicates from the same samples given by another laboratory (Analytica AB, Stockholm, Sweden). The achieved results (in pairs) were 2.45/2.5, 3.20/3.2, 4.05/4.1 and 10.3/10.6 µg Hg/l, our values being mentioned first.

Statistics

The effect of the different variables on the mercury excretion rate was investigated by stepwise or multiple regression analysis (21). All the calculations were performed with the programs StatView 512+ and StatWork for Macintosh.

Results

In order to assess basic factors influencing the excretion of mercury in urine, we used the results of a reference group of 35 volunteers from Stockholm from an earlier investigation (22). This previous study (22) — reviewed in table 2 — treated the relationship between the number of amalgam surfaces and the rate of mercury excretion in urine.

The results of a stepwise regression analysis of the data on mercury excretion rate from the reference group are presented in table 3. Since only a few of the referents chewed gum frequently, the variable "high frequency of chewing gum use" was excluded. Only the variable "number of amalgam surfaces" was significant enough to enter the model. The estimated mean for this parameter was 0.07 µg Hg · 24 h^{-1} · amalgam $surface^{-1}$. Exchanging the variable "number of amalgam surfaces" with "number of occlusal amalgam surfaces" did not increase the coefficient of determination.

As can be seen from table 1, there were surprisingly many subjects in the dental group who reported a high frequency of chewing gum use. Furthermore, in nearly all of the public dental clinics, capsules were

Table 1. Dental group characteristics extracted from the questionnaire.

Category of subjects	Number of subjects	Age (years)		Number of amalgam surfaces		Used chewing gum frequently (%)	Used amalgam capsules (%)
		Mean	Range	Mean	Range		
Dentists							
Men	76	43	27—63	21	0—63	29	36
Women	78	42	28—64	24	0—63	49	65
Private practice	90	42	28—63	20	0—63	37	17
Public clinic	64	43	27—64	27	0—63	42	98
All	154	42	27—64	23	0—63	39	51
Nurses[a]							
Private practice	86	37	18—62	25	0—67	43	14
Public clinic	74	38	21—60	28	0—69	43	97
All	160	38	18—62	26	0—69	43	52
Total sample	314	40	18—64	25	0—69	41	51

[a] All the nurses were women.

Table 2. Reference group characteristics reviewed (22).

	Number of subjects[a]	Age (years)		Number of amalgam surfaces		Excretion rate of mercury in urine (μg/24 h)		Mercury concentration in urine[b] (μg/l)	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range
Reference group[a]	35	43	30—58	37	6—84	3.1	0.5—8	2.5	0.25—8

[a] Occupationally unexposed volunteers from Stockholm (13 men and 22 women). For two of them "high frequency of chewing gum use" was stated, which makes 6 % of the entire group.
[b] Uncorrected urinary mercury concentration of integrated 24-h samples.

Table 3. Stepwise regression analysis — model parameters estimated from data of the reference group (13 men and 22 women) (22). (Hg = mercury)

Independent variable	Parameter estimates[a]			Multiple correlation coefficient
	Mean	95 % confidence interval	P-value	
Intercept (μg Hg/24 h)	$\hat{\alpha}=0.6$	0—1.6	0.251	·
Number of amalgam surfaces	$\hat{\beta}_1=0.068$	0.044—0.092	<0.001	r = 0.69
Sex (male = 1, female = 0)	$\hat{\beta}_2$	·	Nonsignificant	·
Age (years)	$\hat{\beta}_3$	·	Nonsignificant	·

[a] Model: mean excretion rate of mercury in urine (μg Hg/24 h) $= \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots$ For entering a variable a cut-off value of F = 2.7 (P = 0.10) was chosen. The standard deviation of the residuals s = 1.56.

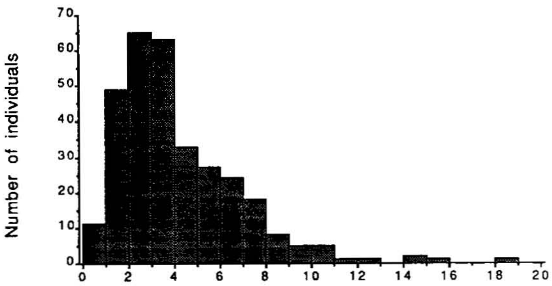

Figure 1. Distribution of the rates of urinary mercury (HgU) excretion from the entire dental group (N = 314).

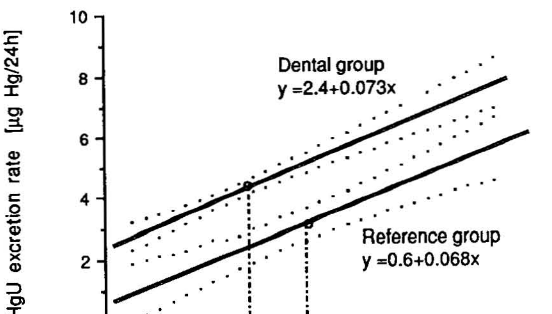

Figure 2. Simple regression of the rates of urinary mercury (HgU) excretion versus the number of amalgam surfaces for the dental and reference groups. (Population means are indicated; the dotted lines show the 95 % confidence intervals for the predicted means)

used during the preparation of the amalgam mixture, whereas in most private practices (approximately 85 %) this technique had not been adopted.

The distribution of the mercury excretion rates of the entire dental group is presented in figure 1. From this distribution, but more explicitly from table 4, it can be concluded that the range of all the excretion rates measured was 0.4—18 μg Hg/24 h with a grand mean of 4.2 μg Hg/24 h. A direct estimation of the effect of occupational exposure through comparison of the overall means in tables 2 and 4 is, however, not feasible as, for example, the dental group averaged fewer amalgam surfaces than the reference group, and this difference would significantly affect the mercury excretion rate.

A simple regression analysis of the data of the entire dental group was performed for the "mercury excretion rates" versus the "number of amalgam surfaces" (figure 2).

The data on the excretion of mercury in the urine of the dental group was further examined with a stepwise regression analysis. The following variables were tested in a linear model: "number of amalgam surfaces," 'high frequency of chewing gum use" (yes versus no), "kind of employment" (private practice versus public clinic), "kind of profession" (dentist versus nurse), "sex," 'age," and "amalgam handling time a week." The same P-value of 0.10 (F = 2.7) as for the reference group was preset for a variable to enter the regression model. As is apparent from table 1, the variable "use of amalgam capsules" correlated highly with 'kind of employment." Only in the private practices was there a substantial intermixing of users and nonusers of amalgam capsules. Therefore, this variable was excluded in the initial analysis of the data from the dental group (table 5).

From table 5 it can be seen that the first variable to enter the equation was, again, "number of amalgam surfaces." For the variable "kind of employment" a mean difference of 1.6 µg Hg/24 h was estimated (ie, subjects from private practices showed a higher mean mercury excretion rate than those from public clinics). The last variable to enter the regression model was "high frequency of chewing gum use," but its presence increased the coefficient of determination only slightly.

None of the variables sex, age, kind of profession, or amalgam handling time entered the regression model at the P-level chosen.

The data from the subset "private practice" were analyzed in a multiple regression analysis including "number of amalgam surfaces," "high frequency of chewing gum use," and "use of amalgam capsules." The estimated mean of the capsule parameter was 0.9 µg Hg/24 h with a 95 % confidence interval of (−0.2)—2.0.

Discussion

Mercury exposure of a reference population occupationally unexposed to mercury

Environmental background levels of mercury are normally very low if the exposure from the consumption of lake fish is excluded. Atmospheric mercury,

Table 4. Mercury analysis of the integrated 24-h urine samples from the dental group.

Category of subjects	Number of subjects	Excretion rate of mercury via urine (µg/24 h)		Mercury concentration in urine[a] (µg/l)	
		Mean	Range	Mean	Range
Dentists					
Men	76	4.5	0.8—18	3.6	0.7—16
Women	78	3.7	0.4—14	2.8	0.3—11
Private practice	90	4.8	0.8—18	3.8	0.6—16
Public clinic	64	3.1	0.4—9	2.3	0.3—6
All	154	4.1	0.4—18	3.2	0.3—16
Nurses[b]					
Private practice	86	4.6	0.6—13	4.1	0.3—15
Public clinic	74	3.9	1.0—15	3.0	0.7—12
All	160	4.3	0.6—15	3.6	0.3—15
Total sample[c]	314	4.2	0.4—18	3.4	0.3—16

[a] Uncorrected urinary concentrations of mercury in the integrated 24-h samples.
[b] All the nurses were women.
[c] The predicted means of the urinary mercury values for individuals occupationally unexposed to mercury (Hg) but bearing 25 amalgam surfaces are 2.3 µg Hg/24 h and 1.7 µg Hg/l, respectively (calculated from reference group data).

Table 5. Stepwise regression analysis — model parameters estimated from the dental group (314 subjects) data. (Hg = mercury)

Independent variable	Parameter estimates[a]			Multiple correlation coefficient
	Mean	95 % confidence interval	P-value	
Intercept (µg Hg/24 h)	$\hat{\alpha} = 1.1$	0.5—1.7	<0.001	·
Number of amalgam surfaces	$\hat{\beta}_1 = 0.081$	0.064—0.097	<0.001	r = 0.431
Kind of employment (Private practice = 1, public clinic = 0)	$\hat{\beta} = 1.6$	1.1—2.1	<0.001	r = 0.521
High frequency of chewing gum use (yes = 1, no = 0)	$\hat{\beta}_3 = 0.5$	0.0—1.0	0.063	r = 0.529
Sex (males = 1, females = 0)	$\hat{\beta}_4$	·	Nonsignificant	·
Age (years)	$\hat{\beta}_5$	·	Nonsignificant	·
Kind of profession (dentist = 1, nurse = 0)	$\hat{\beta}_6$	·	Nonsignificant	·
Average time of amalgam work (hours/week)	$\hat{\beta}_7$	·	Nonsignificant	·

[a] Model: mean excretion rate of mercury in urine (µg Hg/24 h) = $\alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots$ For entering a variable, a cut-off value of F = 2.7 (P = 0.10) was chosen. The standard deviation of residuals s = 2.27.

mostly represented by elemental mercury vapor, appears in unpolluted areas at concentration levels of 1—3 ng/m^3, and the level is normally not higher than 10 ng/m^3 in urban areas. Subsequently, breathing ambient air should, on an individual basis, be connected with a mercury excretion rate of not more than a few tenth's of a microgram of mercury in urine per day. Drinking water contains mercury mainly in oxidized bivalent forms but in negligible amounts. In food, alkyl compounds of mercury dominate, and, with an increasing consumption of lake fish, the intake of mercury may reach hazardous levels. A Swedish mean intake of methylmercury from fish consumption has been estimated to be 4—11 μg/24 h, and roughly one-tenth of this intake is supposed to be excreted in the urine (23, 24). This estimation implies a further addition of some tenth's of a microgram of mercury per day to the total urinary excretion of mercury. The intercept of the regression line for the reference group in figure 2, although subject to high variability, is not inconsistent with these assumptions.

A Swedish Expert Group stated in 1987 (24) that amalgam restorations are probably the source of most of man's exposure to inorganic mercury. Consequently, the concentration of mercury in urine is significantly influenced by the actual status of amalgam, which must be taken into account in studies of low-dose mercury exposure.

In a study by Langworth et al (24—26), concerning 76 men occupationally unexposed to mercury, the fact that the basic analytical method used was not suitable for the range of concentration under study was not mentioned. About 40 % of the values reported for urinary mercury were close to or even lower than the detection limit ($\approx$2 μg Hg/l). For this reason the mean value given for the urinary mercury concentration should be of low significance. A median morning value of 3.0 μg Hg/l for the urinary mercury concentration corresponding to a mean of 27 amalgam surfaces can, however, be estimated from these data.

In the study by Nilsson & Nilsson (2) the median mercury concentrations in the morning urine samples of a reference group of 41 unexposed men and women were 2.2 and 3.3 μg Hg/l, respectively. Values lower than 1 μg Hg/l were not quantified. The mean number of amalgam surfaces was 25.

Von Kröncke et al (27) did not report any significant relationship between the urinary mercury values and the number of amalgam surfaces. Nevertheless, a mean mercury concentration of 1.5 μg Hg/l was given for the morning urine samples of 19 amalgam-free individuals. The detection limit of the method used was said to be 0.5 μg Hg/l.

In a study by Olstad et al (28) morning urine samples showed a mean value of 1.2 μg Hg/l for 73 children. For 14 children free from amalgam a mean value of 0.4 (range 0.1—0.6) μg Hg/l was reported for the urinary mercury concentration. The detection limit was estimated to be "below" 0.2 μg Hg/l.

The only study found using the urinary excretion rate of mercury for estimating mercury exposure was that of Aitio et al (17). For a reference group of 10 individuals a mean excretion rate of 2.4 μg Hg/24 h was reported. This value is in close agreement with our result if it is assumed that the subjects had the same mean number of amalgam surfaces. The reliability of the analytical method used was, however, discussed only for a higher range of concentrations.

With respect to the relationship between urinary mercury excretion rates and the number of amalgam surfaces, it can be seen from tables 3 and 5 that the β_1 estimate of the reference group was supported by that of the dental group. On the basis of the Olstad data (28), the corresponding slope of the regression line could be estimated to be approximately 0.1 $\mu g\ Hg \cdot l^{-1} \cdot$ amalgam $surface^{-1}$. Jokstad presented a large study comprising 650 Norwegian dentists who took part in a national dental congress in 1986 (29). Results from questionnaires and analyses of mercury in morning urine samples were examined. The number of amalgam surfaces averaged 30. With the use of modified data from the Jokstad report, a slope of approximately 0.07 $\mu g\ Hg \cdot l^{-1} \cdot$ amalgam $surface^{-1}$ ($\approx$0.085 $\mu g\ Hg \cdot 24\ h^{-1} \cdot$ amalgam $surface^{-1}$) can be estimated. Thus both these recent Norwegian studies (28, 29) support the relationship found between urinary mercury rates and the number of amalgam surfaces in our present study.

Mercury exposure of dentists and dental nurses

Several studies of airborne and urinary mercury levels have been performed in dentistry during the last two decades. Most of them have reported levels of airborne mercury below or close to the commonly used air standard of 50 μg Hg/m^3 for mercury vapor and the proposed biological standard of 50 μg Hg/l for urine, but some studies reported mercury levels much higher than that (3, 4, 6, 9, 14). In a study by Naleway et al (13) it was remarked that the urinary mercury levels of dentists in the United States had not significantly decreased during 1975—1983. Some other recent studies by Jokstad (29), Nilsson & Nilsson (1, 2), and Roydhouse et al (15) showed, however, that the background levels of mercury vapor in modern dental clinics are normally lower than 10 μg Hg/m^3 and that the urinary mercury levels, on the average, are lower than 10 μg Hg/l. Nevertheless, as seen from the data of Nilsson & Nilsson (2), there are still individuals with urinary mercury concentrations close to 50 μg Hg/g creatinine ($\approx$50 μg Hg/l), the biological limit proposed in 1980 by the World Health Organization (30).

Our study of workers from private practices and public dental clinics in Stockholm supports the opinion that the occupational mercury contribution from dental work of today is generally low. There were, however, individuals in our dental group who showed urinary mercury concentrations close to a level of

15 µg Hg/l ($\approx$20 µg Hg/24 h). This upper limit was obviously lower than that reported by Nilsson & Nilsson (2). A possible explanation is that our dental group could have been somewhat biased towards individuals more concerned about the mercury problem. In support of this possibility we can add that the mean amalgam handling time of the workers in private dental practices in our study was considerably less than the corresponding time spent by the workers in private dental practices in Nilsson & Nilsson's study (2) (8 versus 14 h/week).

On the group level slight effects on the central nervous system and the kidneys have been reported at mercury exposures equivalent to urinary mercury values corresponding to 20—50 µg Hg/l (31—37). Although the clinical significance of these findings has not yet been established, it is apparent that some individuals in our study showed urinary mercury excretions close to this range. Furthermore, the duration of exposure has been demonstrated to be of importance (32, 33, 35). At least dentists, but possibly even dental nurses, can be assumed to have a long duration of mercury exposure.

As even harmful levels of mercury exposure are not instantaneously experienced by man, dental workers suspecting high levels of mercury in their practices or clinics should find it appropriate to have their urinary mercury excretion monitored.

Mercury exposure of the dentists and dental nurses of the present study

Use of chewing gum. The dental personnel of our study were asked whether they frequently used chewing gum or not. As is apparent from table 1, they actually did. Chewing has been pointed out by many authors as a factor strongly increasing the amount of mercury vapor emitted from restorations. The emission of mercury vapor after some minutes of intense chewing is normally increased three- to fivefold, and sometimes by more than that, according to Abraham et al (38), Svare et al (39), Vimy & Lorscheider (40, 41), and our unpublished results. In reference to these experiences the present result indicating only a weak influence from "chewing" was a surprise. It may be that, under experimental conditions, the increase in mercury emission from amalgam was measured from rather "dry" teeth after chewing was terminated. The real appreciable increase in salivation among chewers under normal conditions might cause most of the released mercury vapor to be dissolved in the saliva and swallowed, partly in oxidized form. The gastrointestinal uptake of oxidized mercury is regarded to be comparably low (24).

Kind of employment. The study of Nilsson & Nilsson (1, 2) comprised 267 dentists and nurses in public dental clinics and 150 dentists and nurses in private dental practices. The reported mean of the mercury concentration in the morning urine samples of the dentists (N = 176) was 5.5 µg Hg/l for private practices versus 3.6 µg Hg/l for public clinics, and the corresponding concentration of the dental nurses (N = 241) was 7.5 µg Hg/l for public practices versus 4.7 µg Hg/l for public clinics. In our study the excretion rates for urinary mercury was, on the average, 1.6 g Hg/l higher in the private practices than in the public clinics. Nilsson & Nilsson (1) offered several explanations for the differences in the two kinds of employment. For example, the private dental practices were older, generally smaller, and with a poorer standard of ventilation. In addition, if the private practices handled a larger amount of amalgam per year, it would have been of significance.

As the use of amalgam capsules is connected, at least in private practices, with a higher rate of mercury excretion in the urine (see the following discussion), the mean difference between the two kinds of employment should increase if the amalgam capsule technique was adopted to a greater extent by workers in private dental practices.

Use of amalgam capsules. The use of preloaded amalgam capsules is a technique that has been developed for conveniently preparing the amalgam mixture used by dentists, and it is often regarded as also having a positive effect from a hygienic point of view. The public dental clinics of our study used only this method, while nearly the opposite was true for the private practices. The estimated mean difference in urinary mercury excretion between the amalgam capsule users and nonusers in the private dental practices was 0.9 µg Hg/24 h.

The use of amalgam capsules seems to be coupled with a higher level of exposure to mercury. This finding has also been pointed out by many other authors studying mercury exposure in relation to different amalgam-mixing techniques. The higher level of exposure might be explained by the emission of mercury from the mixing equipment, since the emission is especially high once the equipment has warmed up. Various qualities of capsules, the cleaning and location of shakers, and the type of flooring are significant factors in association with mercury exposure (5, 15, 16, 42—46). In the present study there were too few public clinics working without capsules for us to make any statement of the relevance of the effect of the use of capsules in public clinics.

Sex and kind of profession. It has earlier been proposed by Nilsson & Nilsson (2), Lie et al (47), and Roels et al (35) that higher levels of urinary mercury excretion should be expected from women than from men. The numerical relationships between different urinary mercury values can, however, also be dependent on the unit chosen. For instance, if the determined values are related to creatinine excretion, the difference between the sexes must be considered also in that respect. With our approach of presenting all the values in terms of excretion rates, no such significant difference was found. Neither was a significant mean difference found between the mercury excretion rates of the dentists and the nurses.

Amalgam handling time. Surprisingly, the variable "amalgam handling time" did not show any significant contribution to the explanation of the overall excretion of mercury in urine. The means reported for the amalgam handling time were 8 and 12 h/week for the workers in private dental practices and those in public dental clinics, respectively. The time reported for the public dental clinics was about the same as that reported by Nilsson & Nilsson (2). The difference between the mean of all the urinary mercury excretion rates and the mean for those persons who stated an average amalgam handling time equal to or less than 2 h/week was calculated to be only a few tenth's of a microgram of mercury per 24 h. This finding might indicate that a contaminated background is more significant for mercury exposure than the time currently being spent handling amalgam.

Concluding remarks

An amalgam-free population from Stockholm occupationally unexposed to mercury was estimated to have an average urinary mercury excretion rate of about 0.6 μg Hg/24 h (≈0.5 μg Hg/l) as long as there was no high consumption of lake fish. The bearing of amalgam, together with environmental background exposure to mercury, should result in a mean rate of urinary mercury excretion of about 2.5 μg Hg/24 h (≈2 μg Hg/l). The contribution from each amalgam surface to the entire urinary mercury excretion rate could be estimated to be 0.07 μg Hg/24 h (≈0.06 μg Hg/l).

The dentists and dental nurses of our study in Stockholm had a low average exposure to mercury, as reflected by their mean urinary mercury excretion rate of about 4 μg Hg/24 h (≈3.5 μg Hg/l). Approximately one-half of the measured rate originated from mercury emitted by their own amalgam fillings. The persons employed in private dental practices had a higher level of exposure to mercury than those in the public clinics. The use of amalgam capsules seemed to increase the mercury exposure, at least among the personnel in private dental practices.

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