

# The Relationship between Mercury Exposure and Psychological Health Status of Dentists

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## Abstract

**Background/Objective:** This study was undertaken to address psychological health effects of dentists' exposure to low ambient levels of mercury.

**Methods:** One hundred and six dentists and 94 general practitioners were randomly selected from clinics in Shiraz city, Iran. Subjects were asked to complete the Persian version of General Health Questionnaire. The data were analyzed using  $\chi^2$  test, independent sample t-test and Mann-Whitney's U test.

**Results:** Both groups were similar as far as all demographic variables, except age, were concerned. No significant difference was noted between the dentists' mean total score of GHQ-28 (17.9) and that of referent subjects (16.34). These scores were significantly lower than the cut-off point of 23 ( $P < 0.01$ ). The mean scores for somatic symptoms, anxiety and insomnia, and depression were significantly higher in dentists than in the referent subjects. The results also showed a significant association between GHQ-28 total scores and length of exposure to mercury ( $P = 0.034$ ); with increase in the job tenure, GHQ-28 total score also increased, indicating a decrement in psychological health status.

**Conclusion:** The current findings revealed that, in general, the dentists' psychological health status was poorer than the referent subjects. Additionally, in all GHQ subscales, the dentists' scores were significantly different from those of their counterparts. Given the fact that exposure to mercury is the most important differentiating variable between both groups, and that neuropsychological disorders are the most common toxic effect of mercury, the difference between psychological health status of the two groups is likely to be related to exposure to mercury.

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## Introduction

Surveillance of physical, psychological and social well-being of people in different communities ensures a dynamic and healthy life. According to the World Health Organization (WHO), psychological health is one of the most important health issues throughout the world.<sup>1</sup> Evidence suggests that depression is a common psychological problem in the modern life. Estimates show that over 20% of the

general population suffers from emotional grief and depression.<sup>2</sup> Scientific findings show that long-term exposure to stress may lead to hypertension and mental disorders.<sup>3</sup> The health care costs for workers exposed to job stress are 50% more than those of health problems in the United States. European Union has estimated that in 15 countries of this region, at least 40 million workers are encountered with job stressors and the annual cost of this is estimated to be 20 billion Euros.<sup>3</sup>

Calna et al. conducted a study on workplace stress and found that the stress level in physicians was higher than that of the general population.<sup>3</sup> In contrast, McManus et al. reported that the stress level in physicians and general population was similar.<sup>3</sup> However, changes in stress levels could be justified according to the characteristics of the job.<sup>3</sup>

There are several indicators to assess psychological health status. For example, some researchers have recommended sleep quality index for this purpose.<sup>4</sup> In general community, most people do not show symptoms of psychopathology; therefore, clinical diagnostic interviews are not an appropriate means for assessing psychological health in epidemiological studies, because they are often expensive and time consuming. In such circumstances, the use of a scale can be useful for screening purposes.<sup>5</sup>

The General Health Questionnaire (GHQ) was developed by Goldberg as a screening instrument to identify psychological disorders in primary health care settings.<sup>3,4,6-9</sup> This questionnaire has been translated into several languages; having a notable impact on the improvement of the researches in behavioral sciences and psychiatry.<sup>10,11</sup> This tool can detect acute psychological disorders (less than 2 weeks) and is sensitive to transient disorders.<sup>11</sup> The main purpose of GHQ is not to diagnose specific psychological illnesses; rather, it is used to differentiate between psychological disorders and health status. This questionnaire has been widely used for measurement of mild psychological disorders in different situations.<sup>1</sup> It was originally designed as a 60-item instrument but several shortened versions are currently available, including the GHQ-30, the GHQ-28, the GHQ-20 and the GHQ-12.<sup>7,10,12,13</sup> Validation studies in different countries on GHQ-12, GHQ-28 and GHQ-60 indicate that the questionnaire has high reliability and validity.<sup>10</sup> In a study in Iran, Ebadi et al. investigated the reliability of the Persian version of GHQ-12. Cronbach's alpha coefficient of the questionnaire was found to be 0.87.<sup>14</sup> Since this brief questionnaire is simple and easy to complete, its application as a screening tool in various research fields is well proven,<sup>7</sup> and has obtained a large acceptability.<sup>15</sup>

In Iran, Persian version of GHQ-28 has been validated,<sup>6,10,14</sup> and used in different studies.<sup>3,4,16</sup> By using this questionnaire, the prevalence of psychological disorders has been reported to be from 11.7% to 43.2% in an Iranian population.<sup>16</sup>

Dentists are occupationally exposed to relatively low concentrations of mercury vapors while working with amalgam and concerns exist over the health effects of this exposure. Dental amalgam consists of mercury (50%),

silver (34.5%), tin (9%), copper (6%), and zinc (0.5%) which has been used over the last few decades in dentistry.<sup>17</sup> Exposure to mercury is associated with multi-organ injury, particularly neuropsychiatric disorders.<sup>18-20</sup> For instance, incidence of neuropsychiatric symptoms such as memory problems, sleep disturbances, impaired concentration and fatigue among dentists have been reported in some studies.<sup>21,22</sup> Similarly, some other studies have shown that chronic exposure to mercury may lead to symptoms such as insomnia, irritability and depression.<sup>23-26</sup> Recently, the authors have shown that the prevalence of neuropsychiatric disorders such as depression in dentists exposed to mercury vapor at sub-TLV level is significantly higher than that of a non-exposed referent population.<sup>27</sup>

Although mercury intoxication is widely studied, but there are some concerns about exposure to low concentrations of mercury vapor and its side effects in dentists.<sup>28,29</sup> Given the above and in view of the fact that no sufficient information exists about dentists' psychological health status at a national scale, the present study was undertaken to address this issue.

## Methods

In this historical cohort study, data were gathered from a group of dentists (exposed group) and general practitioners (GPs) as referent individuals. One hundred and six dentists were selected by simple random sampling technique from 400 dentists working in private and public clinics of Shiraz city, Iran. Additionally, 94 GPs were selected from private and public clinics in a similar manner. All individuals voluntarily participated in the study and signed an informed consent before the commencement of the study. The study was reviewed and approved by Shiraz University of Medical Sciences ethics committee. The subjects were requested to complete a two-part anonymous questionnaire. The first part consisted of demographic characteristics such as age, height, weight, job tenure, gender, marital status as well as the type of clinic (i.e. private or public). The Persian version of General Health Questionnaire with 28 items (GHQ-28) formed the second part. This questionnaire had four subscales, including somatic symptoms (items 1 to 7), anxiety and insomnia (items 8 to 14), social dysfunction (items 15 to 21), and severe depression (items 22 to 28).<sup>3</sup> Each item was scored based on four-point scales (i.e. always to never). Responses to items were scored according to Likert method (from 0 to 3). The scores were summed to calculate the total score of a questionnaire. A cut-off point of 23 was selected for the total score in this study. This means that a total score equal or greater than 23 indicates

poor health status of the subject.<sup>4,7</sup> In another word, higher scores showed a lower psychological health. For each subscale, a cut-off point of 6 was applied. This means that an individual obtaining a score of  $\geq 6$  in each subscale is designated as a possible case of psychological disorder.

#### Statistical Analysis

Statistical analysis of the data was performed using SPSS software, version 16. Demographic and occupational variables in both groups were compared using independent t-test (for quantitative variables) and  $\chi^2$  test (for qualitative variables). Total score and those of the four subscales in both groups were compared using Mann-Whitney U test.

To examine the relationship between GHQ total score and number of the teeth the dentists filled with amalgam daily, as well as age and job tenure, Kendal and Spearman correlation coefficient were applied. Additionally, the total score of GHQ was compared with the cut-off point of 23, using one sample t-test.

## Results

Demographic characteristics of both groups are shown in Table 1. As seen, there were no significant differences in demographic variables between the two groups, except for the age. Table 2 depicts the results of psychological health assessment in four subscales as well as total score of GHQ-28 for the study subjects. The mean values of GHQ-28 total score for the dentists and general practitioners were 17.9 and 16.34, respectively, and their difference was not statistically significant. The GHQ-28 total scores of both groups were significantly lower than the cut-off point value of 23 ( $P < 0.001$ ). Interestingly, when GHQ-28 scores in the four subscales were compared, it yielded different results. Significant differences between the scores of somatic symptoms, anxiety and insomnia, social dysfunction and depression subscales were noted ( $P = 0.045$ ,  $P = 0.008$  and  $P = 0.02$ , respectively).

The correlation between dentist's GHQ-28 total score and age, sex, job tenure and number of amalgam replacement per day is displayed

**Table 1:** Demographic characteristics of the study subjects (Mean $\pm$ SD or n (%))

Variable	Dentists (n=106)	GPs (n=94)	P value
Age (yr)	38 ( $\pm 8$ )	40.8 ( $\pm 7.7$ )	0.01 <sup>‡</sup>
Weight (kg)	69.3 ( $\pm 11.1$ )	70.2 ( $\pm 10.1$ )	0.5 <sup>*</sup>
Height (cm)	169 ( $\pm 8.1$ )	169.5 ( $\pm 8.5$ )	0.6 <sup>*</sup>
BMI	24.2 ( $\pm 3.1$ )	24.3 ( $\pm 2.5$ )	0.7 <sup>*</sup>
Length of exposure or employment (yrs)	11.7 ( $\pm 7.3$ )	11 ( $\pm 5.9$ )	0.4 <sup>*</sup>
No. of amalgam filling or replacements per day	2 ( $\pm 1.5$ )	-	-
Sex			
Male	63 (59.4%)	57 (60.6%)	0.8 <sup>†</sup>
Female	43 (40.6%)	37 (39.4%)	
Marital status			
Single	18 (17%)	10 (10.6%)	0.2 <sup>†</sup>
Married	88 (83%)	84 (89.4%)	
Type of clinic			
Private	35 (33%)	39 (41.5%)	0.2 <sup>†</sup>
Public	71 (67%)	55 (58.5%)	

<sup>\*</sup>Independent t-test; <sup>†</sup> $\chi^2$  test; <sup>‡</sup>Significantly different from its corresponding value for the referent group

**Table 2:** Mean scores of dentists and GPs in GHQ-28 and its four subscales (Mean $\pm$ SD)

Subscales (number of items)	Dentists (n=106)	GPs (n=94)	P value <sup>*</sup>
Somatic symptoms (n=7)	4.44 $\pm$ 3.26	3.68 $\pm$ 3.04	0.045
Anxiety and insomnia (n=7)	4.2 $\pm$ 3.41	3.39 $\pm$ 3.12	0.041
Social dysfunction (n=7)	7.49 $\pm$ 2.59	8.48 $\pm$ 3.12	0.008
Depression (n=7)	1.53 $\pm$ 3.3	0.78 $\pm$ 2.09	0.02
Total score (n=28)	17.9 $\pm$ 8.64	16.34 $\pm$ 7.51	0.086

<sup>\*</sup>Mann-Whitney U test

in Table 3. There was a significant association between the dentists' job tenure and their GHQ-28 total score ( $P=0.094$ ). This means that with increase in the job tenure, GHQ-28 total score increased. No significant association was found between age and GHQ-28 total score in both groups ( $P>0.56$ ).

The mean values of GHQ-28 total score for male and female subjects were 15.45 and 19.48, respectively, and the difference was statistically significant ( $P<0.001$ ) (Table 3).

Statistical analysis revealed a significant association between the number of amalgam replacement per day and dentists' GHQ-28 total score ( $P=0.007$ ) (Table 3).

Table 4 illustrates urinary mercury concentrations in the exposed and non-exposed groups as well as mercury levels in dental clinics ambient air. It is to be noted that the results of biological monitoring of the subjects of this study and toxicological studies have previously been published elsewhere.<sup>27</sup> Table 4 has been taken from this publication. As shown, a significant difference exists between the median of urinary mercury levels ( $P=0.02$ ) in both groups. Similarly, median of creatinine corrected urinary mercury levels was significantly higher in dentists than in GPs ( $P=0.049$ ).

GHQ total scores of both groups were compared using  $\chi^2$  test. The results showed that a higher percentage of dentists acquired total score of greater than 23 as compared to that of GPs (84.9% vs. 80.6%). This difference, however, did not reach statistical significance ( $P>0.05$ ).

## Discussion

This study was conducted to determine the dentists' psychological health status in comparison with a group of general practitioners in Shiraz. Apart from age, both groups had similar demographic

characteristics. Thus, the observed differences in the scores of GHQ-28 subscales could be probably attributed to their working conditions and occupational exposure. Despite a significant difference between the mean ages of both groups, GPs on average were only 2 years older than dentists. It is, therefore, unlikely that this difference has affected the outcome of the study, particularly by considering the fact that there was no significant relationship between age and total GHQ-28 scores. This implies that the observed difference between the two groups' psychological health status is not affected by age factor.

Comparison of GHQ-28 total score in the exposed and non-exposed groups showed that there was no significant difference between them ( $P>0.05$ ). Similarly, with regard to the cut-off point of 23, the means of their acquired GHQ-28 total scores were significantly lower than this value. By contrast, comparison of the mean scores of the four subscales in the two groups revealed that the dentists' scores in somatic symptoms, anxiety and insomnia, and depression subscales were higher than those of the GPs. These findings provided the circumstantial evidence to indicate that psychological health of the dentists in these subscales was lower than that of the referent group. As shown, total score of the GHQ-28 in the two groups was significantly lower than the cut-off point value. This could be explained by the fact that both groups were highly educated. Several studies have shown that with increase in the education level, the GHQ mean score decreases.<sup>30</sup>

An inverse relationship has been reported between age and GHQ total score by some investigators.<sup>8</sup> In previous studies, it was confirmed that the level of stress in young doctors was higher than that of the experienced physicians and, therefore, they had lower psychological health status.<sup>8</sup> In this study, there was no association between age and GHQ-28 total score, while there

**Table 3:** Correlation between GHQ-28 total score and some studied variables in dentists based on regression analysis (n=106)

Variables	B	P value
Age (yr)	-0.106	0.56
Job tenure (yr)	0.332	0.034
Sex	-6.45	<0.001
No. of amalgam filling or replacements per day	0.539	0.007

**Table 4:** Atmospheric and urinary concentrations of mercury in dental clinics and study population, [Median (range)]\*

Variable	Dentists (n=106)	GPs (n=94)	P value <sup>†</sup>
Urine Hg conc. ( $\mu\text{g/l}$ )	2.86 (0.01-18.1)	2.26 (0.21-5.6)	0.02
Urine Hg conc. ( $\mu\text{g/g}$ creatinine)	3.16 (0.01-30)	2.18 (0.33-5.08)	0.049
Mercury levels in ambient air ( $\mu\text{g/m}^3$ )	3.35 (0.4-7.7) <sup>‡</sup>	N/D <sup>**</sup>	---

\*Taken from reference no. 27; <sup>†</sup>Mann-Whitney U test; <sup>‡</sup>Based on 90 measurements; <sup>\*\*</sup>Not detectable

was a significant association between job tenure and GHQ-28 total score, i.e. with increase in the dentists' work experience, GHQ-28 total score increased. This finding was consistent with the results of other studies.<sup>28</sup>

Comparison of GHQ-28 total scores in males and females indicated that the total score in women was significantly higher than men. This finding indicates that under similar conditions, the psychological health status in women is lower than that of men. This finding is consistent with that of a recent study by Lotfi et al.<sup>16</sup>

Since both groups were similar as far as their demographic variables and socio-economic statuses were concerned, significantly higher GHQ score in the somatic symptoms, anxiety and insomnia, and depression subscales in dentists is likely to be attributed to their exposure to mercury. This conclusion is in line with the findings of Moen et al.'s study in which they reported that moodiness and depression were significantly more prevalent among dental assistants than non-exposed subjects, assistant nurses.<sup>22</sup>

The Threshold Limit Value (TLV) for mercury has been set at 25 µg/m<sup>3</sup> by ACGIH (American Conference of Governmental Industrial Hygienists). However, in the current study occupational exposure to airborne concentration of mercury in the dental clinics was below this value. Interestingly, Langworth et al. have reported a significant increase in the prevalence of neuropsychiatric symptoms among a group of dentists who were exposed to airborne concentration of mercury of about 1.8 µg/m<sup>3</sup> (below the present study concentration).<sup>31</sup> Similarly, the results of a recent study have indicated that dentists and dental assistants experienced a decline in neurobehavioral performance at urinary mercury levels equal to those of the current study (<4 µg/l).<sup>32</sup> Therefore, it seems that the current TLV does not provide sufficient protection against the occurrence of neuropsychiatric disorders. This interpretation is also consistent with the findings of Richardson's study,<sup>33</sup> in which the relationship between mercury exposure and neuro-psychological outcomes in the development of Occupational Exposure Limit (OEL) for mercury is generally neglected.<sup>27</sup>

## Conclusion

In general, the level of psychological health in dentists was poorer than their referent subjects. Additionally, in subscales of somatic symptoms, anxiety and insomnia, and psychological depression, the differences were statistically significant. Furthermore, in this study the psychological health status in females was significantly lower than that of

males. In both genders, with increase in the job tenure, psychological health declined. In view of the fact that dentists are different from their counterparts as far as occupational exposure to mercury is concerned, the lower level of psychological health status in dentists may be attributed to their occupational exposure to mercury. This conclusion is further supported by the observation that no significant association was found between GHQ-28 total score and age, while a significant correlation existed for the dentists' job tenure and the GHQ-28 total score.

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