

An Epidemiological Study of Dental Caries among 11175 Petrochemical Industry Employees in East China

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Abstract

Aim: To investigate some special or potential factors or incidence rate of dental caries in employees of Zhenhai Refining & Chemical Company (ZRCC) in Ningbo China.

Materials and Methods: A total of 11,175 employees were surveyed during October 2010 to September 2011. Each employee took a self-administered questionnaire and underwent a clinical oral examination, during which the standard examination procedures and diagnostic criteria of WHO were employed. Data in the questionnaires included smoking, body mass index (BMI), alcohol drinking and environment factors (i.e. exposure to Hydrogen Sulfide).

Results: Besides such basic information as that, the prevalence of dental caries in this petrochemical enterprise was 70.7% ± 0.8%. The decayed, missing, filled teeth (DMFT) index was 3.59 ± 4.175; the DMFT index in the group aged 35~44 and aged 65~74 were 3.26 ± 3.65 and 5.38 ± 6.11 respectively, which was lower than the average level in East China (4.79 ± 4.14 and 14.96 ± 9.59), and the filled rate was 24.3%, of which the female filled rate in ZRCC was significantly higher (p<0.05), our multiple linear regression analysis extraordinarily showed that DMFT index was correlated with BMI (p<0.015), alcohol drinking (p<0.000) and environment factor (i.e. exposure to Hydrogen Sulfide) (p<0.000). **Conclusions:** The DMFT index in the groups aged 35~44 and aged 65~74 in employees of ZRCC was lower than average in East China, The BMI smoking favorite and environment factor Hydrogen Sulfide are calling our attention. Further study about economic or social medical factors, chemical or pharmacological mechanisms and effect on dental caries are to be conducted.

Keywords: Dental caries, Epidemiological study, Petrochemical industry employees

Introduction

Dental caries is one of the most prevalent chronic diseases throughout people's lifetime. It affects most adults with tooth loss as its main outcome [1]. According to the third national survey of oral health status in 2005 in China, the prevalence of dental caries, which is one of the most two common dental diseases, is still high. However, the prevalence of dental caries among different areas is of difference [2].

Zhenhai Refining & Chemical Company (ZRCC) is the largest base for crude oil processing in China, with capacity of 23 million terephthalic acid (tpa). It produces petroleum products through three units: refining, fertilizer, and chemical products. There are more than 10 thousand employees in ZRCC (including retired employees). Oral diseases have considerable impact on overall well-being of an individual, but there are few reports related the current dental caries and influential factors to the chemical industry employees [3,4]. In this study, we want to conduct an analysis to identify the current dental caries and the factors, such as body mass index (BMI), smoking habit, drinking alcohol habit, environment factor (i.e. exposure to Hydrogen Sulfide), that associate with the prevalence of dental caries among petrochemical industry employees in ZRCC as a basis for formulating strategies for oral health prevention.

Material and Methods

Selection of the subjects

A total of 11,175 petrochemical industry employees in ZRCC were included in this study. They all received annual oral examination as a part of the annual checkup. Some data were collected through a self-administered questionnaire. All the 11,175 employees joined this study are volunteers. This study was conducted from October 2010 to September 2011, and it has been approved by the Ethical Committee of Zhenhai Lianhua Hospital.

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Questionnaire

A self-administered questionnaire was distributed among employees. All of them were informed to submit the questionnaire before the clinical examinations. It can be divided into 4 parts: 1) personal data (i.e. age, gender, etc.). 2) Lifestyle behavior (i.e. smoking, drinking alcohol habits). 3) Working and medical history. 4) self-assessed oral health status (see Appendix). This method is frequently used in epidemiologic studies, and showed itself a valid and useful summary indicator of overall oral health status [5].

Dental Clinical Examination

Clinical examinations were conducted according to the WHO recommendations that refer to planning, indexes, diagnostic criteria and methodology [6].

Three dentists carried out these examinations in the Zhenhai LianHua Hospital. They were trained by the same epidemiologist. The intra-examiner agreement was good and all kappa values were above 0.85. In the clinical examination, the employees were divided into three groups. Each group had one dentist and one nurse. The dentists performed the examination and the nurse recorded the findings. The decayed, missing, filled teeth (DMFT) was recorded on the oral health survey form in the computer using a plain mirror and a ballpoint probe under standardized conditions with an optimal artificial lighting and a drying tooth device [7].

Meanwhile, petrochemical employees in some departments are exposed to Hydrogen Sulfide (HS). HS fumes are continuously discharged from open containers and leaked from pipes. The HS concentration is detected at a level under 0.5 mg/m³. Although the working processes involve a dilution of the concentrated air.

Smoking habit was coded following the WHO definition [8].

Tobacco users were divided into several categories: non-smoker, light smoker (<10 cigarettes·day per day and <3 years),

and heavy smoker (>10 cigarettes day per day or >3 years).

Drinking alcohol habit definition: from the time point from the previous year, regardless of the type of alcoholic drink, as long as both defined as drinking alcohol [9].

The BMI was calculated as the ratio of the body weight (kg) to the square of height (meters). Based on the WHO criteria [10], four categories are defined: underweight (BMI<18.5 kg·m⁻²), normal weight (18.5 kg·m⁻²≤BMI<24.9 kg·m⁻²), overweight (25 kg·m⁻²≤BMI<29.9 kg·m⁻²), and obese (BMI ≥ 30 kg·m⁻²).

Statistical Analysis

Data from the paper questionnaires and clinical examinations were entered into Excel software and then statistical analyses were conducted using SPSS software (16.0 Version). Quantitative data were presented as mean ± S.D. Descriptive summary statistics were obtained for all demographic and outcome variables. Chi-square tests were used to compare outcomes between different groups by different variables (i.e. age, gender, BMI, etc.). Multiple linear regression analysis was conducted to determine the independent variable of DMFT index's adjusted by different related factors. Taking into account the hypothesis of the study, non-smoker, no exposure to HS, no drinking alcohol habit and BMI ≤ 24.9 kg·m⁻² were considered the reference group. Differences were considered statistically significant at p<0.05.

Results

11,175 petrochemical industry employees participated in the examinations and answered the questionnaires. 7,466 (66.8%) were males and 3,709 (33.2%) are female. The mean age was 44.39 ± 12.74 years, 43.01 ± 12.85 years for male and 47.16 ± 12.06 years for female. The age frequency distribution among groups of ≤24, 25~34, 35~44, 45~54, 55~64, 65~74, and ≥75 years were 384 (3.4%), 2475(22.1%), 3271(29.3%), 2619(23.4%), 1487(13.3%), 855(7.7%), 84(0.8%). Table 1

			≤24	25~34	35~44	45~54	55~64	65~74	≥75	Total
Gender	Male	N	341	1908	2189	1619	832	519	58	7466
		P(%)	4.57	25.56	29.32	21.68	11.14	6.95	0.78	
	Female		43	567	1082	1000	655	336	26	3709
			1.16	15.29	29.17	26.96	17.66	9.06	0.70	
Exposure to HS	yes		247	1067	1073	518	61	0	0	2966
			8.33	35.97	36.18	17.46	2.06	0	0	
	no		137	1408	2198	2101	1426	855	84	8209
			1.67	17.15	26.78	25.59	17.37	10.42	1.02	
Drinking alcohol	yes		28	323	670	539	209	103	7	1879
			1.49	17.19	35.66	28.69	11.12	5.48	0.37	
	no		356	2152	2601	2080	1278	752	77	9296
			3.83	23.15	27.98	22.38	13.75	8.09	0.83	
Smoking habit	yes		35	655	1028	718	261	101	7	2805
			1.25	23.35	36.65	25.60	9.30	3.60	0.25	
	no		349	1820	2243	1901	1226	754	77	8370
			4.17	21.74	26.80	22.71	14.65	9.01	0.92	
BMI	abnormal		71	512	754	774	521	305	32	2969
			2.39	17.24	25.40	26.07	17.55	10.27	1.08	
	normal		312	1962	2515	1842	958	544	32	8165
			3.82	24.03	30.80	22.56	11.73	6.66	0.39	

N=numbers, P=percentages

Table 1. Distribution of components and percentages (%) of gender, working environment, drinking, smoking and BMI among age group.

summarized the distributions of gender, exposure to HS, drinking alcohol habit, smoking habit and BMI among age groups.

Table 2 showed the decayed, missing, filled teeth (DMFT) index was 3.59 ± 4.18 ; untreated decay was 1.59 ± 2.00 ; missing teeth due to caries level was 1.37 ± 2.52 ; and number of filled teeth was 0.7 ± 1.35 . The DMFT index increased with age. For the decayed teeth, the tooth decayed rate is 70.7%; the number of mean decayed teeth was 1.59 ± 2.00 in all the subjects. In ZRCC, the tooth decayed rate and the number of mean decayed teeth in female were significantly higher than those in male (76.9% and 1.86 ± 2.13 ; 67.7% and 1.34 ± 1.91 , respectively) ($p < 0.001$).

For the filling teeth, the tooth filling rate was 24.3%, the mean filling teeth was 0.70 ± 1.35 in all the subjects, The tooth filling rate and mean filling teeth in women were statistically higher than those in men (31.4% and 1.08 ± 1.628 , 18.4% and 0.52 ± 1.133 , respectively) ($p < 0.001$). The highest filling rate occurred in the 25~34 age group, and then the tooth filling rate gradually declined with an increasing age. Except for the age group 18~24 and age group over 75, women in the other groups had significantly higher tooth filling rate than men.

For the missing teeth, the tooth missing rate was 41.8%, the mean missing teeth was 1.37 ± 2.52 , The tooth missing rate and mean missing teeth in women were significantly higher than those in male (46.5% and 1.56 ± 2.63 , 39.4% and 1.27 ± 2.45 , respectively) ($p < 0.001$). In the age groups of 25~34, 35~44, 45~54, 55~64, the DMFT indexes of male and female were significantly different.

The overall caries prevalence rate in petrochemical industry employees was $70.7\% \pm 0.8\%$. Among them, 5,052 men had cavities, the caries prevalence rate was 67.7%; 2,852 women had caries, the rate was 76.9%. In the age-groups of 35~44 and 65~74, the caries prevalence rate were 63.8% and 68.0%. The caries prevalence rate increased with age gradually before the age of 55; after that, it declined with age. The caries prevalence rate between male and female was significant different ($p < 0.001$) (among groups).

The third national oral health epidemiological survey which chosen 35~44 and 65~74 as representative samples was conducted in China in 2005, so we also selected these two-age-groups in order to make the data comparable. Table 3 showed that the comparison of DMFT index between petrochemical industry employees in ZRCC and the average level of East China. The DMFT index of ZRCC employees in the age group 35~44 and 65~74 were 3.26 ± 3.65 and 5.38 ± 6.11 teeth, all lower than the average level of East China (4.79 ± 4.14 and 14.96 ± 9.59 teeth). The petrochemical industry employees in the age groups 35~44 and 65~74 had mean decayed teeth (1.56 ± 1.96 , 1.84 ± 2.52), and compared with average level of East China (1.49 ± 2.20 , 3.07 ± 3.83). The mean decayed teeth of age groups 35~44 was higher than average level of East China, while the mean decayed teeth of age groups 65~74 was lower than average level of East China. The mean missing teeth (0.96 ± 1.67 , 2.88 ± 4.22) were significantly lower than that of average level in East China (2.74 ± 2.81 , 11.52 ± 9.46). The mean filling teeth (0.74 ± 1.39 , 0.66 ± 1.34) were higher than that of average level in East China (0.55 ± 1.32 , 0.36 ± 1.06).

Age Group	gender	n	D	M	F	DMF	p value
24≤	Female	43	1.07 ± 1.61	0.79 ± 1.34	0.58 ± 1.47	2.44 ± 3.29	0.152
	Male	341	0.86 ± 1.54	0.40 ± 1.00	0.51 ± 1.22	1.77 ± 2.85	
	Total	384	0.88 ± 1.55	0.44 ± 1.04	0.52 ± 1.25	1.84 ± 2.90	
25~34	Female	567	1.93 ± 2.21	0.7 ± 1.31	1.27 ± 1.85	3.9 ± 4.16	1.174*10 ⁻¹⁷
	Male	1908	1.29 ± 1.83	0.59 ± 1.23	0.6 ± 1.21	2.49 ± 3.19	
	Total	2475	1.44 ± 1.94	1.05 ± 1.66	0.76 ± 1.41	2.81 ± 3.49	
35~44	Female	1082	1.94 ± 2.15	1.05 ± 1.66	1.18 ± 1.726	4.18 ± 4.18	4.463*10 ⁻²⁴
	Male	2189	1.38 ± 1.84	0.91 ± 1.67	0.52 ± 1.13	2.81 ± 3.27	
	Total	3271	1.56 ± 1.96	0.96 ± 1.67	0.74 ± 1.391	3.26 ± 3.65	
45~54	Female	1000	1.94 ± 2.08	1.53 ± 2.23	1.11 ± 1.592	4.59 ± 4.25	1.511*10 ⁻¹⁶
	Male	1619	1.43 ± 1.84	1.49 ± 2.41	0.5 ± 1.113	3.43 ± 3.61	
	Total	2619	1.62 ± 1.95	1.51 ± 2.34	0.73 ± 1.343	3.85 ± 3.90	
55~64	Female	655	1.97 ± 2.17	2.39 ± 3.10	1.05 ± 1.514	5.4 ± 4.75	3.317*10 ⁻⁴
	Male	832	1.5 ± 1.97	2.54 ± 2.64	0.48 ± 1.054	4.52 ± 4.64	
	Total	1487	1.71 ± 2.07	2.47 ± 3.41	0.73 ± 1.308	4.91 ± 4.70	
65~74	Female	336	1.84 ± 2.32	2.95 ± 4.39	0.88 ± 1.472	5.67 ± 6.19	0.278
	Male	519	1.85 ± 2.65	2.84 ± 4.12	0.52 ± 1.22	5.2 ± 6.05	
	Total	855	1.84 ± 2.53	2.88 ± 4.22	0.66 ± 1.336	5.38 ± 6.11	
≥75	Female	26	1.58 ± 2.02	5.04 ± 8.00	0.62 ± 1.329	7.23 ± 9.25	0.188
	Male	58	1.79 ± 2.63	2.64 ± 4.72	0.41 ± 1.093	4.84 ± 6.76	
	Total	84	1.73 ± 2.45	3.38 ± 6.02	0.48 ± 1.1167	5.58 ± 7.64	
Total	Female	3709	1.86 ± 2.13	1.56 ± 2.63	1.08 ± 1.628	4.5 ± 4.458	3.609*10 ⁻⁶¹
	Male	7466	1.34 ± 1.91	1.27 ± 2.45	0.52 ± 1.133	3.13 ± 3.88	
	Total	11175	1.59 ± 2.00	1.37 ± 2.52	0.7 ± 1.345	3.59 ± 4.18	

D: Decayed teeth, M: Missed teeth, F: Filled teeth, DMF: the decayed, missing, filled teeth

Table 2. The decayed, missing, filled teeth (DMFT) index of ZRCC in East China among age groups.

	35~44				65~74			
	DMFT index (mean ±SD)	Decayed teeth (mean ±SD)	Missed teeth (mean ±SD)	Filled teeth (mean ±SD)	DMFT index (mean ±SD)	Decayed teeth (mean ±SD)	Missed teeth (mean ±SD)	Filled teeth (mean ±SD)
ZRCC	3.26 ± 3.65	1.56 ± 1.96	0.96 ± 1.668	0.74 ± 1.391	5.38 ± 6.107	1.84 ± 2.52	2.88 ± 4.22	0.66 ± 1.336
average level of East China	4.79 ± 4.14	1.49 ± 2.20	2.74 ± 2.81	0.55 ± 1.32	14.96 ± 9.59	3.07 ± 3.83	11.52 ± 9.46	0.36 ± 1.06

Table 3. comparison of DMFT index between petrochemical industry employees in ZRCC and the average level of East China in age group of 35~44 and 65~74

variable	B	SE	Beta	t	Sig.
age	.069	.003	.210	21.194	.000
Gender	-.876	.038	-.099	-9.939	.000
Exposure to HS	.259	.106	.023	2.439	.015
Drinking alcohol	-.667	.107	-.060	-6.209	.000
Smoking habit			-.001	-.129	0.898
BMI	-.066	.013	-.048	-5.067	.000

Table 4. Regression models for the response variable DMFT index and its components, with age, gender, exposure to HS, smoking, drinking alcohol as predictor variables

The results of multiple linear regressions of independent variables on the DMFT index adjusted by gender and age, exposure to HS, smoking habit, drinking alcohol habit, the BMI could be seen from Table 4. The final model identified that age, gender, drinking alcohol habit, exposure to HS and the BMI were significantly related to the DMFT index. While smoking habit wasn't significantly related to the DMFT index.

Discussion

In this study, we used an epidemiological method to analyze the prevalence of dental caries among petrochemical industry employees in ZRCC, NingBo, China. Although some epidemiological studies on dental caries in adult have been carried out in China, most of these studies only included urban residents or rural residents [11,12]. There were very limited studies that paid close attentions to petrochemical industry employees.

World Health Assembly (1982) and WHO (1982) defined the acceptable dental health level in terms of average DMFT index for adults in different age groups: 6 DMFT index for age 35~44 and 12 DMFT index for age over 65 [13]. In this study, the DMFT index was estimated as 2.88 ± 3.44 for all the employees, 3.26 ± 3.65 for the age group of 35~44, and 5.38 ± 6.11 for the age group of 65~74. Compared with them, the DMFT index in this study were in low levels. The low DMFT index in ZRCC may be attributed to the good dental care for every petrochemical industry employee. Each one was offered a medical checkup every year, which includes an oral examination. If there were some dental problems in one's teeth, he (or she) would get some suggestions and free treatments of basic dental caries, such as filling and extractions. Another reason which has been supported [14] is that the employees in ZRCC has a good socio-economic status (average income in ZRCC is about 4 times average national income (80000/17175 yuan). However, more studies are required to further evaluate the effects of these factors.

According to cariological data, the most important comparable age groups are those of 35~44 and 65~74. In this study, the caries prevalence rate in the age-groups of 35~44 and 65~74 were 63.8% and 68.0%, which were lower than that reported in the WHO Oral Health Country Profile (94%). The results were close to those in the study conducted by Zhang et al in northeast of China in the age group of 65~74 (67.5%) [15]; but were lower than those in the study conducted by Zhu et al in Zhejiang (81.8%) [16].

In this study, we also found that women work in this petrochemical enterprise had significantly higher DMFT index than men, which was in agreement with the results from many other surveys in both industrialized and developing countries [17,18]. A proposed explanation for this tendency maybe that the females

are more prone to dental caries than the males [19]. The reason of tendency maybe the fear of going to dentists and dietary habit between males and females are of difference [20], while further study would be necessary to confirm the above guesses.

Epidemiological methods have been applied to identify the factors that related to dental caries immunity and susceptibility. In our research, we choose gender and age, exposure to HS, smoking habit, drinking alcohol habit and the BMI as predictor variables to evaluate DMFT index. Smoking habit, drinking alcohol habit were chosen as they are the most widely used factors to reflect health-related behaviours [21]. As a surrogate measure for obesity, BMI is widely used as it corrects for an individual's height in relation to weight, and is commonly used as an nutritional status indicator [22] it can help to measure diet-related health outcome together with dental caries. we chosen BMI index may help to verify the relationship between dental caries and obesity [23] and may contribute to further study. Previous studies, Cda Mata, et al. showed that general health, xerostomia, diet, fluoride exposure, past dental history need to be taken into account when evaluating the risk of dental caries [24] Wala, et al. revealed that acid workers had significantly higher erosion, debris, calculus, and gingivitis index. It seems that the loss of tooth surface by erosion and accumulation of plaque renders these areas susceptible to caries and stain [25]. Werckmeister and Ruppe also found that workers in the chemical company had higher prevalence of damages in the periodontium [26]. Merylyn Hooley *et al* undertook an updated systematic review of the relationship between body mass index and dental caries in children and adolescents from 2004 to 2011, drawing that Dental caries was associated with both high and low body mass index [27]. In our study, we analyzed 7,901 of subjects with dental caries. They were of different genders and age, exposure to HS, and having different smoking habit, drinking alcohol habit and the BMI, the relationship between dental caries with these factors were illustrated in Table 4. It has been noticed that the genders, age, drinking habit and the body mass index were significantly associated with dental caries. The further studies about the mechanism would be necessary to be done.

Conclusions

In this study, low level of the prevalence of dental caries in employees of ZRCC in East China was observed. The reasons maybe that they have good oral preventive management. The results of multiple linear regressions were that the DMFT index was directly correlated with BMI and smoking habit. The precise mechanism would be necessary to do further study.

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