

行政院國家科學委員會專題研究計畫成果報告

牙體技術人員的職業暴露與健康狀況及肺功能之流行病學研究

An Epidemiological Study of Occupational Exposures, Health Complaints, and Lung Function among Dental Technicians

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中文摘要

牙體技術人員有多重的職業暴露，其對健康的影響需要更多的研究來釐清，尤其是金屬合金塵粉及甲基丙烯酸甲酯單體 (methyl methacrylate, MMA) 與肺功能或呼吸疾病的關係、及其它多種牙體技工所常用材料的可能健康效應，都有待進一步的探討。再者，台灣地區牙技人員的職業暴露與健康狀況並不被了解。本研究的主要目的是調查牙技人員的疾病盛行率與職業暴露、偵測技工所中的粉塵與單體的濃度、探討牙技的肺功能與其職業暴露之間的關係。研究分三部份，首先是郵寄的問卷調查，對象是台中市的牙技人員，收集的資料有健康狀況、職業史、與重要的干擾因子。第二部份是偵測 5 個不同型態的技工所中的單體及可吸入性塵粉粒子 (PM_{2.5}) 之濃度，一天 8 小時、一週五天；並且以 X-ray fluorescence (XRF) 分析塵粉中之金屬元素，包括鎳、鉻、鈉、鈷等。第三部份是配合空氣偵測，同時測試五家技工所員與其他願意參加本研究之牙技人員的肺功能，一週三天，分別在早上與下午下班前測試。本研究運用 SAS 軟體作資料分析，包括敘述性統計、雙因子分析、multiple linear regression、repeated measurements analysis。本研究結果如下：首先，在問卷調查部份，以掛號信件郵寄相同問卷兩次給 204 家技工所後，有 76 家的信件因無人收信而被退回，實際回覆的

問卷數為 102 份，校正後之回收率約為 29%。此 102 位牙體技術人員平均(標準差)年齡為 30.6(10.6)歲，平均工作年數為 8.4 (7.7)年。其中 65%從事固定義齒的製作，70%覺得有因工作而引起的眼睛乾澀與疲勞，58%覺得工作場所有「刺激鼻子的味道」。其次，空氣偵測的結果顯示五家技工所的 MMA 單體濃度都低於 0.05 µg/ml；但是 PM_{2.5} 濃度有顯著差異，五家技工所的最底與最高之 8 小時平均濃度分別為 43 µg/m³ 與 685 µg/m³，而且同一技工所中不同工作區域的 PM_{2.5} 濃度變異很大；XRF 分析顯示個別金屬元素的濃度都很低。最後，五家技工所 45 位員工的肺功能與技工所空氣中的 MMA 或是 PM_{2.5} 之濃度之關係未達統計上的意義 (p>0.05)。總結而言，參加本研究之牙體技術人員過半數有覺得因工作而引起的眼睛乾澀與疲勞等問題；不同型態的技工所空氣中的 MMA 濃度很低，但是 PM_{2.5} 之 8 小時平均濃度因技工所不同而有顯著差異，在 XRF 分析中個別金屬元素的濃度都很低；牙技人員的肺功能與其技工所空氣中的 MMA 或是 PM_{2.5} 濃度之關係未達統計上的意義。受限於低參加率，本研究結果應謹慎解釋。其他牙體技術人員的職業暴露與健康狀況仍需更多的流行病學研究與探討。

關鍵詞：牙體技術人員、粉塵、甲基丙烯酸甲酯、肺功能測試、問卷調查、流行病學

Abstract

Dental technicians have multiple occupational exposures, which may have adverse effects on their health. Studies are needed to examine the metal alloy dust-lung function association, the methyl methacrylate (MMA)-respiratory health relations, and potential health effects of other materials frequently used in the laboratories. Furthermore, the occupational exposures and related health problems among Taiwanese dental technicians have not been well understood. The purposes of the proposed study were to: (1) survey the prevalence of health problems and exposures among dental technicians; (2) monitor and assess air concentrations of dusts and MMA in dental laboratories; and (3) investigate the associations between occupational exposures and lung function among subjects with self-reported respiratory symptoms. This study had three main parts. The first part was a mailed questionnaire survey of health problems and occupational exposure history of dental technicians in Taichung city. The second part comprised monitoring concentrations of MMA monomer and particulate matter with aerodynamic diameter less than $2.5 \mu\text{m}$ ($\text{PM}_{2.5}$) in five different laboratories, 8 hours a day, five days a week for one week. Furthermore, metals, including nickel, chromium, and cobalt, in the particles were analyzed by X-ray fluorescence (XRF). The third part consisted of spirometric tests for all voluntary workers and those working in the five laboratories. Lung function was measured on six occasions, before and after work-shift on three days in one week. The data analysis included descriptive statistics, bivariate analysis, multiple linear regression analysis, and repeated measurement analysis, using SAS software. The results were described as followed. Firstly, after sending the questionnaire by registered mails twice to all 204 dental laboratories, the mails to 76 laboratories were returned for unknown addresses or other reasons. In total, 102 dental technicians answered the questionnaire,

with an adjusted response rate of 29%. The means (SD) of age and duration of employment were 30.6 (10.6) and 8.4 (7.7) years, respectively. Sixty-five percents of the participants fabricated crowns and bridges. Seventy percent of them reported job-related eye problems, and 56% complained irritating smell in the laboratory. Secondly, results of air sampling and analyses showed that all five laboratories had MMA levels less than $0.05 \mu\text{g}/\text{ml}$. However, concentrations of $\text{PM}_{2.5}$ ranged from $43 \mu\text{g}/\text{m}^3$ to $685 \mu\text{g}/\text{m}^3$ and were significantly different among laboratories ($p < 0.05$). Within a laboratory, $\text{PM}_{2.5}$ levels also varied from location to location. The XRF analysis showed low concentrations of metals in the particles. Finally, forty-five technicians agreed to have spirometric testing and there was no statistically significant association between their lung function and MMA or $\text{PM}_{2.5}$ concentrations, respectively, in the dental laboratories. In conclusion, more than half of the participating workers complained work-related eye problems. MMA levels were low in these five different types of dental laboratories, but $\text{PM}_{2.5}$ concentrations were significantly different among laboratories. Lung function was not significantly associated with air concentrations of MMA or $\text{PM}_{2.5}$ in the laboratories. This study was limited by low response rate and interpretation of the study results should be cautious. Further epidemiological studies are needed to investigate the occupational exposures and health of dental technicians in Taiwan.

Keywords: dental technician; dust; methyl methacrylate; spirometric test; survey; epidemiological study

Background and Specific Aims

Dental laboratories technicians have multiple occupational exposures, which may have adverse effects on their health. The potential occupational risk factors include chemical, physical, psychological, ergonomic,

and other job-related factors [1,2,3]. Several studies have been conducted to investigate the potential health effects of a variety of occupational exposures among dental technicians. Major concerns were the potential adverse effects from inhalation of methyl methacrylate (MMA) monomer [4] and dusts from grinding and polishing of metal alloys, resins, ceramics, plaster, and the abrasives used for polishing. The others included reactions from dermal contact with resin-based materials, noises and vibration of handpieces, and long working hours. The dust-lung function and the MMA-respiratory health relations among dental technicians merit clarification. Note that none of these studies was carried out in Taiwan. There are more than 2000 dental laboratories and 8000 dental technicians in Taiwan. The occupational exposures and related health problems among these workers are not well understood. The purpose of this epidemiological study was to investigate the occupational exposures and health status of dental technicians. The specific aims were to: (1) survey the health problems and occupational exposures of dental technicians; (2) assess dental technicians' exposures to respirable dust and MMA monomer, respectively; and (3) investigate the associations between occupational exposures and lung function among dental technicians.

Methods

The proposed epidemiological study had three main parts. The first part was a cross-sectional survey of health conditions, occupational history, life-style risk factors, and demographics of dental technicians in Taichung. Self-administered questionnaires were sent to all 204 dental laboratories by registered mails, followed by a reminding postcard in one week, and by another mailing of same questionnaires.

The second part comprised exposure assessment for the indoor and breathing zone concentrations of MMA monomer and particulate matter with aerodynamic diameter

less than 2.5 μm ($\text{PM}_{2.5}$) in five different dental laboratories. Based on the questionnaire survey, we selected five dental laboratories representing specific types of laboratories respectively (small; making fixed and removable prostheses; producing fixed prostheses only; making orthodontic appliances and removable dentures only) and agreeing to participate in the study. For each dental laboratory, sampling was conducted for five days in one week. Sampling pumps were placed on the working table and samplers were set near worker's breathing zone. XAD-2 absorbent tubes (SKC226-27) were used to capture MMA vapor with 50mL/min flow rate and analyzed following US NIOSH Method 2537. Cyclone samples were used to collect $\text{PM}_{2.5}$ in the air. Major elements (such as Si, Ni, Mo, and Cr) produced during manufacturing dental prostheses were quantified by X-Ray Fluorescence (XRF) (EX-6600AF, Jordan Valley). At least two vapor and five particle samples were taken at each sampling day; the actual sampling number depended on the operation condition of that factory.

The third part consisted of spirometric tests for subjects agreeing to participate in the study and those working in the five selected laboratories. Lung function were measured on six occasions: one just before workshift and one after shift on Monday, Tuesday, and Friday in the week with air sampling. The spirometric testing procedures, calibration, and quality control of the data complied with the recommendations of the American Thoracic Society (1987; 1994). Dry rolling sealed spirometers (SensorMedics Corporation, CA, USA) were used to test lung function. Percent-predicted value of lung function parameters were calculated using the equations from the Veterans General Hospital in Taipei.

Data analysis included descriptive statistics, bivariate analysis, multiple logistic and linear regression analysis, and repeated measurement analysis. The SAS version 8.0 software (SAS Institute Inc., NC) were applied for the analyses.

Results

After sending the questionnaire by registered mails twice to all 204 dental laboratories, the mails to 76 laboratories were returned for unknown addresses or other reasons. In total, 102 dental technicians answered the questionnaire, with an adjusted response rate of 29%. The means (SD) of age and duration of employment were 30.6 (10.6) and 8.4 (7.7) years, respectively. Sixty-five percents of the participants fabricated crowns and bridges. Seventy percent of them reported job-related eye problems, and 56% complained irritating smell in the laboratory.

Results of air sampling and analyses showed that all five laboratories had MMA levels less than 0.05 $\mu\text{g}/\text{ml}$. However, concentrations of $\text{PM}_{2.5}$ ranged from 43 $\mu\text{g}/\text{m}^3$ to 685 $\mu\text{g}/\text{m}^3$ and were significantly different among laboratories ($p < 0.05$). Within a laboratory, $\text{PM}_{2.5}$ levels also varied from location to location. The XRF analysis showed low concentrations of metals in the particles.

Forty-five technicians agreed to have spirometric testing. Among them, one worker had clinically abnormal lung function. The percent-predicted values of were calculated for four spirometric parameters, including forced vital capacity (FVC), forced expiratory flow in one second (FEV_1), FEV_1/FVC , and forced expiratory flow at 25% to 75% ($\text{FEF}_{25-75\%}$). Means of percent-predicted FVC, FEV_1 , FEV_1/FVC , and $\text{FEF}_{25-75\%}$, respectively, were not significantly different among the five laboratories with different air concentrations of $\text{PM}_{2.5}$. Furthermore, there was no statistically significant association between the percent-predicted FVC and FEV_1 , respectively, and concentrations of MMA or $\text{PM}_{2.5}$, adjustment for confounding factors.

Discussion

More than half of the participating dental technicians complained work-related eye problems. MMA levels were low in the five participating dental laboratories, but $\text{PM}_{2.5}$ concentrations were significantly

different among laboratories. Lung function was not significantly associated with air concentrations of MMA or $\text{PM}_{2.5}$ in the laboratories. Interpretation of the study results should be cautious. This study had low response rate and selection bias could not be ruled out. Further studies are needed to investigate the occupational exposures and health of dental technicians in Taiwan.

Self Evaluation of Study Results

This study has two major strengths. First, several methods, including occupational history, types of dental prostheses made, and air monitoring of MMA and $\text{PM}_{2.5}$ concentrations, were used to assess workers' occupational exposures in the dental laboratories. Second, many important factors related to lung function were evaluated in the multivariable analysis to reduce potential confounding effect in the $\text{PM}_{2.5}$ -lung function association. This study was limited by low response rate, although tremendous efforts were made to increase participation. In addition, the small sample sizes also made the estimation of association imprecise.

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