國立臺灣大學公共衛生學院職業醫學與工業衛生研究所

博士論文

Graduate Institute of Occupational Medicine and
Industrial Hygiene College of Public Health
National Taiwan University

Doctoral Dissertation

臺灣醫師與牙醫師死亡風險之研究

Mortality Rates and their Determinants among Physicians and Dentists in Taiwan

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中華民國 100 年 7 月

July, 2011

國立臺灣大學博士學位論文
口試委員會審定書

臺灣醫師與牙醫師死亡風險之研究
Mortality Rates and their Determinants among Physicians and Dentists in Taiwan

本論文係商東福君（學號 F95841008）在國立臺灣大學職業醫學與工業衛生研究所完成之博士學位論文，於民國 100 年 7 月 18 日承下列考試委員審查通過及口試及格，特此證明

口試委員：＿＿＿＿＿＿＿＿＿＿（簽名）

（指導教授）

National Taiwan University

Thesis Verification Form

We hereby recommend that thesis submitted by *Shang Tung Fu* entitled *Mortality Rates and their Determinants among Physicians and Dentists in Taiwan* be accepted as fulfilling the thesis requirement for the degree of Doctor of Philosophy in the Institute of Occupational Medicine and Industrial Hygiene.

Thesis committee:

Date 07/18/2011 (mm/dd/yyyy)

口試紀錄表

國立臺灣大學研究所博、碩士學位考試試卷(口試紀錄表)

99 學年度第 2 學期　　考試日期：100 年 7 月 18 日

系所組別：職業醫學與工業衛生研究所　　考試地點：公衛大樓 R701

學號：**F95841008**　　記錄：

姓名：商東福

學位考試成績： A （請以等第制評分，成績評量定義詳見下列說明，研究生及格標準為 B-）

論文題目：臺灣醫師與牙醫師死亡風險之研究

Mortality Rates and their Determinants among Physicians and Dentists in Taiwan

考試委員簽章：

陳保中　郭育良　陳秀熙
[illegible]　[illegible]　王榮德

※成績評量定義：Definition of Grades

A+：所有目標皆達成且超越期望 (All goals achieved beyond expectation)

A ：所有目標皆達成 (All goals achieved)

A-：所有目標皆達成，但需一些精進 (All goals achieved, but need some polish)

B+：達成部分目標，且品質佳 (Some goals well achieved)

B ：達成部分目標，但品質普通 (Some goals adequately achieved)

B-：達成部分目標，但有些缺失 (Some goals achieved with minor flaws)

C+：達成最低目標 (Minimum goals achieved)

C ：達成最低目標，但有些缺失 (Minimum goals achieved with minor flaws)

C-：達成最低目標但有重大缺失 (Minimum goals achieved with major flaws)

F ：未達成最低目標 (Minimum goals not achieved)

X ：因故不核予成績 (Not graded due to unexcused absences or other reasons)

致　謝

六年前在衛生署國際合作處前處長張武修教授的鼓勵下，離開長達 20 年的臨床工作，踏入國際衛生的領域，卻在一個偶然的機會碰到擔任衛生署國際衛生顧問的王榮德教授，在他的積極推薦下領表考入碩士班。離開學校二十二年之後可以回到校園讀書確實是福報，我十分珍惜，也記得我的父母一向最喜歡看到我讀書，所以，一年後就直升博士班，繼續當一個老學生。期間歷經代理衛生署國際合作處處長、接任 APEC Health Working group(亞太經濟合作衛生工作小組)副主席等重要工作，都沒有放棄學校的學習，大概就是抱著感恩惜福的心，撐了下來。

在學的過程中，十分感謝所上的老師們熱忱地教導，我真心感受他們的用心。還有學長、同學們無私地分享他們的學習，讓我面對跟三十年前大學時期全然不同的選課、修課方式時毫無困難。

在準備論文的階段裡，也獲得胡賦強老師及葉正沛顧問、黃彥彰、黃元惠醫師、楊南屏醫師、陳志成醫師、盧道揚醫師等多位朋友的寶貴意見，使我的論文內容更加完善。

也感謝家人這一段時間的支持，包括我的太太吳慧琳醫師、女兒沛宇、兒子沛頡。每當別人知道我在讀書，大半都會猜說家中一定有一個人支撐著我，才可能如此愜意地享受學校生活，所以，謝謝老婆！

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中文摘要

前言：雖然有某些專科別醫師被分析出是自殺、藥物濫用及癌症的高風險職業，國外學者的研究大多發現醫師的死亡率比一般老百姓來的低。不過醫師的工作時間長、壓力也大，某些專科別的醫師甚至有長期暴露在感染性血液，體液，空氣或低量放射線的職業風險之中，所以，臺灣醫師的死亡風險是否比一般人民高一直都是民眾關切的事情。2003 年 SARS 疫情也讓人想到各專科別醫師接觸科別常見癌症及傳染性疾病，可能透過病毒、細菌傳遞致病，例如治療肺癌專家罹患肺癌，肝膽專家死於肝癌等等。因此，本研究應用流行病學的方法並以社經地位相當的內科醫師做為對照，來分析臺灣醫師、牙醫師及不同專科醫師的死亡風險。

研究方法與對象：本研究對象取自中華民國醫師及牙醫師公會全國聯合會會員檔，包括民國 79 年到 95 年間曾經在臺灣執業的 37,545 位醫師，及民國 74 年到 98 年的 11,700 位牙醫師。本研究使用身份證字號和衛生署建立的死亡原因檔，進行比對及記錄死亡原因；以民國 60 年到 95 年間的台灣人及同一資料庫的 18,664 位內科醫師為對照族群，使用生命表分析系統計算不同死因的標準化死亡比；並運用 Cox 比例風險回歸模式，考慮執業的時間，校正包括執業地區、開始執業時年齡及年代等因素，評估不同專科別與死亡的相關性。

結果：校正分析性別、執業年齡、年代等因素後，本研究發現臺灣醫師包括各專科別醫師、牙醫師各種疾病的標準化死亡比比一般老百姓低，自殺與藥物濫用的標準化死亡比遠低於 1，分別為 0.14 與 0.16。當我們比較不同專科醫師之間的死亡風險差異時，發現麻醉科、外科醫師，比內科醫師高，麻醉醫師又高於外科醫師，死亡風險分別為 1.97 與 1.23。當用內科醫師做為對照族群時牙醫師各種疾病的標準化死亡比略高於 1 (1.13) ，心臟病及溺水的標準化死亡比也高分別為 1.66 和 6.62。進一步控制相關影響因素之後牙醫師的死亡風險高於內科醫師為 1.17。另外以醫師人口比 1:500 為對照，醫師人口比愈低，該地區執業醫師的死亡風險

也愈高。

結論：臺灣醫師、牙醫師整體疾病的死亡風險都明顯低於一般老百性，而且也沒有存在國外研究所發現的高自殺死亡風險。本研究可以澄清臺灣坊間長期以來關於醫師短命的傳言與印象。若以內科醫師做為對照，牙醫師以及外科、麻醉科醫師的死亡風險高，進一步針對死亡原因的分析，除了牙醫師心臟疾病及溺水意外的標準化死亡比較高，其餘可能與職場暴露有關的癌症和感染的標準化死亡比並未發現增加的情形。醫師執業地區的地域差異和醫師人口比除了影響該地區居民的健康，也對醫師本身的死亡風險產生同步影響，增加執業醫師人力有助於地區民眾與醫師本身的健康。

關鍵字: 醫師，牙醫師，死亡，不均，期望壽命，標準化死亡比，生命表分析系統，醫師人口比，死亡決定因子，Cox 比例風險回歸

Abstract

Background and Purpose: There have been many studies in industrialized countries that demonstrate that medical professionals experience lower overall mortality rates than other occupations. However, there are also controversial claims on the potentially higher mortality rates among physicians than the general public due to long working hours in high stress environments with frequent exposure to physical and biological agents. During 2003 SARS epidemic further linked some of the physicians are at the risks of infection or cancer due to physical contacts of the related diseases. For example, the Pulmonologists, especially experts for lung cancer suffered from lung malignancy. And liver cancer specialists died from hepatoma. Several studies have described larger health problems and higher death rates in certain specialties such as surgery, with causes being attributed to suicide, drug abuse, cancer, etc. The aim of the study is to analyze the survival data of all Taiwanese physicians by department, clarify the suspicion of premature mortality among physicians exposed to different agents, and further identify predictors of mortality among them.

Methods: Data from 37,545 physicians registered in the database of Taiwan Medical Association (TMA) during 1990 to 2006 and data from 11,700 dentists registered in the Taiwan Dental Association (TDA) during 1985 to 2009 were enrolled for analysis. Overall and cause-specific standardized mortality ratios (SMRs) of these individuals were obtained from the National Mortality Database using the IDs of the cases. Using the Life Table Analysis System (LTAS), the mortality rates and associated figures of these cases were compared with first the national death rates of all Taiwan citizens in 1971 to 2006 and then a set of 18,664 internists. A multivariate mortality rate analysis was also performed by the Cox's proportional hazards regression, using survival and

years of practice to calculate relationships to specialties, gender, geographic region of practices, regional health resources, ages of initial practices, and years of initial practice

Results: Compared with all Taiwanese citizens, physicians of all medical specialties and departments in Taiwan were found to be less likely to die from all causes regardless of age, gender, or years of occupation. In particular, the SMRs for suicide and drug abuse were generally below 0.50, with suicide's SMR at 0.14 (95% Confidence Interval =0.09 - 0.21) and drug abuse's SMR at 0.16 (95% CI= 0.07 - 0.32).

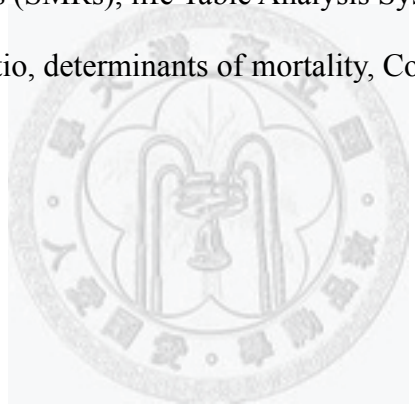
The Cox regression model showed that the anesthesiologists had the highest hazard ratio (HR) of 1.97, seconded by surgeons at 1.23. However, the overall SMRs for surgeons and anesthesiologists were only marginally elevated at 1.15 (95% CI=0.98-1.34) and 1.62 (95% CI=0.93-2.64) respectively.

When internists were chosen as the reference group, significant excess mortalities (greater than 1) were observed in dentists, with the overall cause SMR at 1.13 (95% CI = 1.00-1.26), drowning SMR at 6.62 (95% CI=2.15-15.45), and heart disease SMR at 1.66 (95% CI = 1.22-2.21). The Cox regression model showed that the dentists experienced a higher HR of 1.17 (95% CI, 1.01 to 1.37) when compared to internists as well. In addition, compared with a physician to population ratio of 1:500, it was discovered that the lower the number of physicians in a population, the higher the HR of physicians are.

Conclusions: The risks of cause-specific mortality of physicians with different medical specialties were found to be significantly lower than those of the general population in Taiwan, which serves to rectify the perception that physicians are subject to premature mortality. Additionally, the study found that physicians in Taiwan do not have the significantly raised suicide HR as previously published overseas. Compared with internists, Taiwanese dentists had significantly elevated SMRs for overall causes,

drowning, and heart disease. Careful precaution should be taken to reduce the trend. Future studies and analysis should be performed to explore the mechanisms of how professional stress and exposures contribute to the increased mortality risks in Taiwanese dentists. The physician to population ratio and the geographic region of physician's practice may result in disparities of physician mortality. Increasing the numbers of physicians and/or improving the practice environment may help to reduce the health disparities of both the general public and physicians residing in a region with poor resources.

Keywords: Physician (physician), dentist, disparity, mortality rate, life expectancy, standardized mortality ratios (SMRs), life Table Analysis System (LTAS), the physician (physician) to population ratio, determinants of mortality, Cox’s proportional hazards regression.



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Chapter 1. Background and Paper Reviews

1.1 Mortality rates among Physicians

There have been continuous concerns regarding higher mortality risks in physicians as compared with those of the general public in Taiwan. These include shorter life expectancy, particularly in surgeons[1]. It was further evidenced by the Severe Acute Respiratory Syndrome (SARS) epidemic in 2003 that within 346 confirmed cases nationwide, 106 were healthcare workers in the hospitals. Among 73 fatalities, there were 12 healthcare workers including 3 physicians[2]. Physicians widely labeled with high mortality.

There were many clinical practices which are considered harmful to health practitioners, including psychological stress, prolonged and irregular job shifts, deprivation of sleep, as well as exposure to environmental hazards like radiation, anesthetic, and biologically hazardous substances[3-4]. On the other hands, studies in many industrialized countries revealed that medical professionals experienced lower overall mortality rates than other occupations. That was claimed to be due to relative advantages on socioeconomic status and better access to healthcare[5-7].

It was suggested that profession-related-knowledge, behaviors and stable socioeconomic status could also contribute to lower health risks among physicians.

1.2 The specific potential hazards in medical work

The specific potential hazards in medical work include stress, radiation, anesthetic gases or agents and other biologically hazardous blood, body fluids or air are concerned in many studies. Surgeon and anesthesiologist spent a lot of time and work in the operating room, an environment that remain a number of potential health hazards that are different

from those encountered by physicians who work outside of the operating room. Dentists have appreciable occupational exposure to saliva, blood and the risk of blood-borne infection because of frequent handling of sharp instruments, scaling machine during operative procedures. Due to the adverse effects of such occupational exposures, several studies have described higher death rates in certain specialties including radiologists, pathologists, psychiatrists, dentists, and anesthesiologists[8-12].

1.3 Human resources of medical professions in Taiwan

The number of western medicine physicians is around 35,000. By the end of 2004, the number of western medicine physicians per 10,000 is 14.7; that is, one western medicine physician on average served 671 persons. There are also 590 medical institutions, including: medical centers, regional hospitals, district hospitals, and clinics. Together, they make up Taiwan's well-woven network of medical resources. In regards to medical facilities and staff, there are more than 550 hospitals, including 22 medical centers. Also there are 190,000 plus professional medical personnel, including 35,000 western medicine physician, 4,500 Chinese medicine physician, and more than 10,000 dentists, 120,000 plus nurses[13-14].

1.4 National Health Insurance (NHI) program in Taiwan

In 1995, Taiwan launched the National Health Insurance (NHI) program. Because of the increased demand for health care, the health professionals have encountered heavy workload strains and greater psychosocial demands. The provision of universal health care coverage has increased the health care demand[15-17]. For example, the number of outpatient visit per person increased from 7.89 in 1992 to 11.46 in 2003[18]. The annual number of outpatient visits per physician in Taiwan increased to 8,807 in 2003, from only 6,621 in 1992[8].

Lin, Chang, and Tsai (2004) reported that approximately 10 percent of the physicians practicing at a medical center in central Taiwan have high-strain jobs. This high-strain group reported a significantly lower quality of life, especially on the psychological scale, compared with the low strain group. In another study, Lee et al. (2005) reported an inverse relationship between the level of job stress and quality of life among physicians at primary health care centers across the nation[19-20].

Chapter 2. Specific Aims

There were many clinical practices which are considered harmful to health practitioners, including psychological stress, prolonged and irregular job shifts, deprivation of sleep, as well as exposure to environmental hazards like radiation, anesthetic, and biologically hazardous substances[3-4]. On the other hands, studies in many industrialized countries revealed that medical professionals experienced lower overall mortality rates than other occupations. That was claimed to be due to relative advantages on socioeconomic status and better access to healthcare[5-7]. However, in Taiwan there have been continuous concerns regarding higher mortality risks in physicians as compared with those of the general public in Taiwan. These include shorter life expectancy, particularly in surgeons[1].

Thus we propose to analyze the database of TMA from 1990 to 2006 and TDA from 1985 to 2009 and examine the following objectives or hypotheses:

1. Profession-related-knowledge, behaviors and stable socioeconomic status could also contribute to lower health risks among physicians in Taiwan.

2. In addition to the occupation exposures other factors might account for the mortality rates among physicians in Taiwan.

To test these hypotheses, we propose several nation- based studies with the following specific aims:

1. To investigate the mortality rates and causes among physicians in Taiwan.

2. To investigate the mortality rates and causes among dentists in Taiwan.

3. To investigate whether the occupational exposures, the geographic differences, gender, health policy and professional education have affected the mortality of physicians in Taiwan.

Chapter 3. Research Design and Methods

3.1 Data sources and sample selection

3.1.1 Taiwan Medical Association (TMA) physician file

The retrospective cohort population of physicians was established from the enrollment and registration of all the physicians in Taiwan, maintained by the Taiwan Medical Association (TMA). The registry contained demographic information like professional qualifications and training profiles of each physician and was useful for the estimations of human resources of medical professions. It also contained detailed information including the name of each individual, date and place of birth, gender, nationality identification number (NIN), attended medical school(s), date of medical school graduation, medical specialties, places of practice, vital status, date of death and date of termination of membership.

3.1.2 Taiwan Dental Association (TDA) physician file

The retrospective cohort population of dentists was established from the enrollment and registration of all the dentists in Taiwan from 1985 to 2009, maintained by the Taiwan Dental Association (TDA). The registry contained demographic information like professional qualifications and training profiles of each physician and was useful for the estimations of human resources of medical professions. It also contained information including date and place of birth, gender, NIN, places of practice, vital status, date of death and date of termination of membership.

3.1.3 National Death Index (NDI)

The underlying and contributing causes of death were obtained from the National Death Index (NDI), which was maintained by Taiwan's Department of Health since 1980. The

cause of death of each deceased individual was matched through the NDI via the NIN. For those without definite causes of death, they were reported as deceased with unknown cause. Person-year was accrued until 2006, the date of decease, or termination of membership.

3.1.4 NHI sample files

In Taiwan, the National Health Insurance (NHI) program provides mandatory universal health insurance, offering comprehensive medical care coverage to all civilian Taiwanese residents. The NHI sample files, constructed and managed by the National Health Research Institute, consist of comprehensive utilization and enrollment information for a random sample of 185 889 NHI beneficiaries out of a population of 21 400 826 enrollees throughout Taiwan in 2000. A multistage stratified systematic sampling design according to the degree of urbanization, geographic location, and administrative boundaries was used by the National Health Research Institute to select a representative sample. Details of the design and sampling scheme have been reported elsewhere[21-22].

The NHI sample files include the NHI enrollment files, the NHI claims data, the NHI medical-personnel registry, and the hospital/clinic registry. NHI enrollment and payment of premiums is mainly through payroll deduction for people with well-defined monthly wages and through individual tax payments for farmers, fishermen, and people without a well-defined monthly wage. The enrollment file tracks each beneficiary's insurance status (the insured or the dependent) and the policy holder's insurable wages and occupation. By law, the dependents of the insured are generally the insured's spouse, lineal ascendants (parents/grandparents) who are unemployed, or lineal blood descendants within a second degree of relationship children/grandchildren) who are

either <20 years of age and not employed or are >20 years of age but incapable of making a living, including those who are attending school without employment. Relevant fields in the NHI claims data include diagnosis, date of medical service, drugs prescribed and filled, dispensing method and anonymous identifiers of the patient, the hospital/clinic, and the physician providing the service. The NHI claims data also have the birth date and gender of each patient recorded. The NHI medical-personnel registry maintains data on each medical professional in Taiwan and records the type of medical profession, birth date, gender, and specialty. The NHI hospital registry maintains data on each medical institution in Taiwan and provides information on certification level and geographic location. Unique but anonymous personnel and hospital identifiers were used to link the claims data to these provider registries.

3.2 Data and Statistical analysis

3.2.1 SAS

SAS is a powerful statistical package. We used SAS Version 8.1 (SAS Publishing, 1999) to execute data transformation, processing and basic analysis. Descriptive statistics such as number, mean, and standard deviation were used to compare physicians' demographics.

3.2.2 Standardized mortality ratios (SMRs) via Life Table Analysis System (LTAS.NET).

After The all-cause and cause-specific mortality rates of physicians were compared to those of the general public. All-cause and cause-specific SMRs were obtained by employing the new version of Life Table Analysis System (LTAS.NET). The LTAS was originally developed by the National Institute for Occupational Safety and Health (NIOSH) during the 1970's. The original LTAS software was developed on IBM

mainframe computer systems. A subsequent version of LTAS, known as PC LTAS, was released for MS-DOS based PC's. The current version of LTAS, known as LTAS.NET, has been developed for use on Windows 98/NT/2000/XP compatible PCs. This version of LTAS is more interactive and provides more user options than prior versions. This program tabulates the underlying causes of death and person-year of follow-up into age-, gender-, and race-specific strata. SMRs and 95% confidence intervals (CIs) were calculated using 119 underlying-cause Taiwan death rates with 1971-2007 as a reference. The classifications of cause-specific deaths were limited to those available in the reference data. 39 different medical specialties were provided in the physician file used for the study and were grouped further into12 specialties for the analyses.

3.2.3 Cox regression model.

Cox regression analysis was use to describe how hazard (risk) changes over practice time for the mortality of Taiwan physicians from January 1990 to December 2006. Control variables such as gender, specialty, geographic location (region) of practice, health care resources, age of practice starting, year of practice starting were included. Health care resources were divided into 4 categories according to physicians per 1000 persons, degrees of urbanization and presence of medical center. Geographic location was categorized according to the branches of national insurance bureau.39 different specialties were provided in the physician file used for the study and grouped into12 groups of specialties for the analyses (see appendix).We used SAS Version 8.1 (SAS Publishing, 1999) to link and analyze the data. In this study, we set the significance level at 0.05.

Chapter 4. Mortality of Physicians in Taiwan, 1990-2006

4.1 Introduction

In 1996, Wright et al.[23] calculated from obituaries published in the British Medical Journal that anesthesiologists and physicians born on the Indian subcontinent appear to die at a younger age. However, the validity of the study's methods and results were questioned due to the lack of real denominators[24-25]. Because clinical practices involve exposures to many harmful agents, including psychological stress, prolonged and irregular job shifts, sleep deprivation, radiation, anesthetic gases, and biologically hazardous substances[3-4], there are persisting concerns of a higher mortality among physicians than the general public[26-29]. During the Taiwanese Severe Acute Respiratory Syndrome (SARS) epidemic of 2003, 106 of the 346 cases confirmed nationwide were hospital healthcare workers. Among the 73 fatalities, 3 of the 12 healthcare workers were physicians[2].

In contrast[6-7, 30-32], studies from industrialized countries have revealed that medical professionals experience lower overall mortality rates than other occupations. This outcome is attributed to the relative advantages of socioeconomic status, better access to healthcare, and possible profession-related knowledge.

Taking the above controversies into account, this study was conducted on a national basis with 17 years of follow-up and presents the standardized mortality ratios (SMRs) for all physicians in Taiwan. These results will also provide formal feedback to the Taiwan Medical Association after a peer-review process.

4.2 Material and methods

The cohort population of physicians in Taiwan was established from the enrolment and registration data of all the physicians in the Taiwan Medical Association (TMA), which

has been regularly maintained since 1990. The registry contains information on the physicians' demographics, including professional qualifications and training profiles. This information proved to be useful in estimating the human resources of the medical professions. The registry also contains the following information on each physician: name, date and place of birth, gender, personal identification (ID) number, medical school enrolment, medical school graduation date, medical specialties, places of practice, vital status, date of death, and date of termination of membership or retirement. Before the commencement of this study, the Ethics Review Board of our institution approved the protocol. The underlying and contributing causes of death are regularly obtained from the National Mortality Registry (NMR), which has been maintained by Taiwan's Department of Health since 1981. The cause of death for each deceased individual was obtained through the NMR via the personal ID number. Those without a definite cause of death are reported as deceased with unknown cause. The cohort was followed until 2006 and the total person-years were calculated based on whether each physician was deceased or censored.

The all-cause and cause-specific mortality rates for physicians were compared to those of the general public. All-cause and cause-specific SMRs were obtained by employing the personal computer version of Life Table Analysis System (LTAS.NET). The LTAS was originally developed by the National Institute for Occupational Safety and Health (NIOSH) during the 1970s and was later converted for use on Windows 98/NT/2000/XP-compatible PCs. This program tabulates the underlying causes of death as well as the person-year of follow-up into age-, gender-, and race-specific strata. SMRs and 95% confidence intervals (CIs) were calculated using the mortality rates of 119 underlying causes of death for the general population of Taiwan from 1971-2007 as a reference. The classifications of cause-specific deaths were limited to those available

in the reference data. Originally, there were 38 different medical specialties recorded in the physician registration file, and these were further categorized into 12 major specialties for the final analyses (Appendix). Because SMR is influenced by the particular age distributions for physicians with different specialties, we further calculated the cumulative mortality rates (CMRs) for every 10-year period between ages 20 and 79 for direct comparison of mortality using the formula as follows: $CMR_{20\text{-}79} = 1\text{-}e^{-x}$,

$CMR_{20\text{-}79}$ denotes cumulative mortality rate for ages 20 to 79;

x was obtained by multiplying the interval of age stratum(10) by the sum of the age-specific mortality rates for ages 20-29,30-39,40-49,50-59,60-69 and 70-79[33-35].

4.3 Results

From January 1990 to December 2006, 37,545 physicians were enrolled in the study registry for a total of 624,132.84 person-years of follow-up. During this period, 1,686 deaths occurred, including 1,190 (of 18,664) internists and 161 (of 4,571) surgeons. The segment of the population over 60 years old represented 4% of all anesthesiologists, which was lower than the other specialties (surgeons, 13%; internists, 22%; and obstetricians, 16%).

In general, the overall SMRs and CMRs for physicians with different specialties were relatively small when compared to the general population of Taiwan. As summarized in Table 4-1, all of the SMRs of different medical specialties were below 0.34. Among different specialties, higher $CMRs_{20\text{-}79}$ were found for dermatologists (0.34), internists (0.27), and surgeons (0.27), and lower $CMRs_{20\text{-}79}$ were found for pathologists (0.06) and orthopedists (0.10). Table 4-2 shows that physicians in Taiwan were less likely to suffer from nearly all specific causes of disease, although the main causes of death among physicians were generally the same as those of the general public

in 2003. Physicians were also more likely to die from hypertensive diseases (SMR 4.06, 95% CI, 2.36 to 6.50) but less likely to experience other diseases, including cerebral vascular disease, accidents, suicide, chronic obstructive pulmonary disease, pneumonia/influenza, or liver disease. The SMRs for suicide and drug abuse were well below 1 (SMR 0.14, 95% CI, 0.09 to 0.21 and SMR 0.16, 95% CI, 0.07 to 0.32, respectively).

4.4 Discussion

To our knowledge, this is the first nationwide study on the long-term mortality of physicians showing that physicians actually have a significantly smaller SMR than the general population. However, when we searched for "physician's life expectancy" in Chinese on the internet, the first page of results showed that Taiwanese physicians died ten years earlier than general population and that the surgeons generally lived five years less than all other physicians. This message was repeatedly visible on the obituaries in the news and publications of professional societies, which might have created an erroneous impression among people in Taiwan. Because the results of our study seem to be contrary to the observations detailed above, we first needed to rule out any potential confounding factors before making further inferences. While our study already included calendar year, age, and gender in the SMR calculation, these factors cannot explain the magnitude of reduced mortality. Because calculation of SMR generally adopts the age distribution of the index population, different SMRs cannot be directly compared[35]. We further calculated the $CMR_{20\text{-}79}$ for different specialties in Table 4-1; all were below 0.34 and smaller than those of the general population of Taiwan, which was 0.53 in 1990, 0.48 in 2000, and 0.44 in 2006. The two indicators corroborate with one another, and through the results, we can tentatively conclude that physicians in Taiwan are healthier than the general population. This study also empirically demonstrates that

without obtaining the real denominators for different age groups, the age at death cannot reflect the real mortality rates.

After adjusting for age, gender, and calendar year, the SMRs of Taiwanese physicians in different medical specialties and the main causes were all well below 1, with the exception of hypertensive disease, as summarized in Table 4-2. However, there were only 17 cases coded for hypertensive disease, which would not have influenced the SMR estimates for stroke, heart disease, or renal disease if they had been coded into any of these three hypertension-related causes of death. Thus, we conclude that this figure might be a reflection of enhanced healthcare and completion of death certificates for physicians in Taiwan.

We found a significantly decreased SMR (0.14) for suicide among physicians in Taiwan (Table 4-2), which was quite different from reports in other countries[10-11]. As a sensitivity analysis, we tried to re-classify all of the non-traffic related injuries into suicides; however, the SMR did not increase to more than 0.20. Thus, we can tentatively conclude that the possibility of mis-coding or mis-classifying suicides into accidental injuries is unlikely.

The lower overall death rate of Taiwanese physicians than the general population may be partially attributed to the Healthy Worker Effect (HWE) phenomenon, which is the tendency of the actively employed to live longer than the population at large[36-37]. However, most studies indicate that HWE will reduce the association between exposure and outcome by a magnitude of 20 to 30%. In our study, the SMRs and CMRs for mortality among Taiwanese physicians in different specialties were less than 50%, which might imply a continued accumulation of professional-related knowledge.

Nevertheless, there are two limitations to this study. First, in addition to those mentioned above, possible contributors to lower health risks among physicians include

profession-related knowledge, health-related behavior, and stable socioeconomic status. However, information on education and socioeconomic status within different strata of the reference population was not available, and therefore adjustments for these potential confounders were not possible. Second, because the current regulations in Taiwan allow for two registered specialties, misclassification of self-reported specialties might be a source of bias in the analysis of mortality rates among different specialties. For example, a surgeon who worked in a district hospital or a clinic may go on to practice general medicine after retirement from the medical centre. However, because the SMRs and CMRs for all different specialties showed a consistently lower trend than those of the general population, this potential misclassification is not sufficient to influence the conclusion.

4.5 Conclusions

The total mortality rates of physicians with all specialties in Taiwan were much lower than those of the general population, and physicians were less likely to die from nearly all causes, including suicide and drug abuse. We hope that our findings can help to correct the false perception in Taiwan of a higher mortality rate for physicians than the general public.

Chapter 5. Mortality among Dentists in Taiwan, 1985-2009

5.1 Introduction

Dentists are potentially exposed to hazardous chemical, physical and biological agents such as amalgam, anesthetics, noise, vibration, radiation and viruses[38-42]. Notably, dentists are at risk for exposure to the hepatitis B virus and the Human Immunodeficiency Virus (HIV)[43], of which the potential routes of exposure are from sharp injuries to body fluids[44-45]. Furthermore, dentists have been reported to be subjected to severe stress, burnout, substance abuse, and commit suicide among the health care professionals[46-48].

There were also studies[49-50] reported increased relative risks in dentists for cancers of the brain, lung, reproductive organs, and all cancers combined. These elevated risks might represent the impact of potential hazards in the workplace; however, the relations between mortality among dentists and hazardous agents could not be clearly elaborated. As the risk of death from cancer increases with advanced age, the assessment of true cancer risks requires a longer period of follow-up. In order to improve the validity of the studies mentioned above, a more socio-economically comparable reference group should be recruited and the years of follow up must be extended to detect any increased mortality.

In this study, the cohort was established through the dentist registry file of the Taiwan Dental Association (TDA), beginning in 1985 and followed till 2009. And they were compared with internists recruited from the Taiwan Medical Association (TMA) to evaluate the survival outcome and determine if the above potential exposures to harmful agents lead to premature mortality among dentists.

5.2 Material and methods

The study was approved by the Ethics Review Board of National Taiwan University. The registry file of the TDA has regularly provided the basic demographic information of the study cohort, which was initiated in January 1985 and terminated at the end of December 2009. The information includes the name, date and place of birth, gender, personal identification (ID) number, the enrolment, graduation details, medical specialties, locations of practice, vital status, date of death, and date of termination of membership or retirement of each individual. The termination of practice was defined as the end of the study, the date of deceased or the termination of membership. There were 410 subjects without the dates of license acquisition, which were assumed and imputed as the July1st of his/or her age of 24.

The causes of death were regularly obtained from the National Mortality Registry (NMR) at the Department of Health Taiwan through the ID number of each deceased individual. 26 from 289 deceased dentists without a definite cause of death were reported as deceased with unknown cause. The all-cause and cause-specific mortality rates for dentists were compared to those of the reference groups. The person years and Standardized mortality ratios (SMRs) were calculated with the Life Table Analysis System (LTAS.NET), which was first developed by the National Institute for Occupational Safety and Health (NIOSH), SMRs and 95% CIs were calculated using the mortality rates of 119 underlying causes of death for the general population and internists of Taiwan as the reference group, respectively. We used SAS Version 9.1 (SAS institute) to edit and analyze the data. In this study, we set the significance level at $P<0.05$. While the mortality rates of the general population can be directly retrieved from the tables of vital statistics of Taiwan, we recruited similar data of all practicing internists from the TMA who were followed from 1990 to 2006 as an alternative

reference group[51].

Cox proportional hazard analysis was conducted to determine the hazard ratios and 95% confidence intervals for the following risk factors: age, gender, specialty, geographic region of practice, age of beginning practice, calendar year of beginning practice (before or after 1995 when the NHI system established), and physician to population ratio. The ratios of the physician to population were categorized into 4 levels: larger than 1:500, from 1:500 to 1:700, from 1:700 to 1:900, and less than 1:900 (Table 5-1). We applied a stepwise strategy for variable selection with the significance level for entry and the significance level for stay set at 0.15. Regression diagnostics were also run, including examination of proportional hazard assumption, residual analysis, detection of influential cases, and check for multi-co-linearity to assure the quality of analysis and goodness of fit for the model.

5.3 Results

A total of 11,700 dentists with 207,831.11 person-years were accrued until 31 December 2009, when the follow up terminated. During this period, 289 members were deceased. There were 18,664 internists with 963,791.51 person years up to the censored date, or, 31 December of 2006.

The basic demographic information of the study subjects is summarized in Table 5-1.The gender ratio of the subjects was 3.25 (male/female), which seems to be lower than that of internists. More than half (53.2%) of the dentists practiced in the north region, and 47.8% of the subjects were registered in the area of high physician to population ratio. About two-thirds of the subjects initiated their practice before 1995, and over 90% began at age below 30.

The observed number of deaths and cause specific SMRs for dentists were summarized in Table 5-2. Nearly all SMRs of dentists were below 0.5 when compared

with the general population of Taiwan. The crude death rate of internists was higher than that of dentists (6.4% vs. 2.5%, in Table 5-1), but such a discrepancy disappeared after adjustment for age, gender, and calendar year of beginning practice (Table 5-2). When we applied a socioeconomically more comparable population, the internists, as the reference group, the overall SMR of dentists was significantly increased (SMR =1.13; 95% CI = 1.00 - 1.26), and the SMR of drowning was 6.62 with 95% CI from 2.15 to 15.45 (Table 5-2). Dentists were also more likely to die from heart diseases (SMR 1.66; 95% CI = 1.22 - 2.21). The SMR of malignant neoplasm and cerebral vascular disease were marginally increased, although they did not reach a statistically significant level. We did not detect any significant increase of SMR for suicide, accidents, chronic obstructive pulmonary disease, pneumonia/influenza, the human immunodeficiency virus (HIV) related disease, and liver cirrhosis.

To further adjust for other risk factors among dentists and internists, Cox proportional hazard model was constructed and the results were summarized in Table 5-3. Using the internists as the referents, the dentists appeared to show a higher overall hazard ratio of 1.17 (95% CI = 1.01 - 1.37).

5.4 Discussion

To our knowledge, this is the first nationwide study on the long-term mortality of dentists. The dentists actually have a significantly lower SMR than the general population after adjustment for age, gender, and calendar year. Additionally, the SMR for major causes of mortality were nearly all well below 0.5 as showed in Table 5-2. The lower overall death rate of Taiwanese dentists than the general population may be partially attributed to the Healthy Worker Effect (HWE) phenomenon, which is the tendency of the actively employed to live longer than the population at large. However, HWE has been reported to reduce the association between the exposure and outcome by

a magnitude of 20 to 30%[36-37]. In our study, the SMRs for mortality among Taiwanese dentists were less than 0.5, which might imply a continued accumulation of professional-related knowledge like other Taiwanese physicians.

However, a misleading conclusion might be generated by using the general population as the reference group because of higher socioeconomic states in dentists, which appeared to be similar to physicians[52]. To control of such a potential confounding, we adopted internists as the reference population for SMR calculation, and found significantly increased SMRs (1.13, 6.62 and 1.66 respectively) for the overall causes, drowning, and heart diseases (Table 5-2). After adjusting for additional risk factors through construction of Cox proportional hazard model, the dentists still showed a higher hazard ratio of 1.17 (95% CI = 1.01 - 1.37) in comparison with internists (Table 5-3), indicating a consistent trend. In other words, the younger average age for the deceased dentists than that of deceased internists in the Table 1 might be partially attributed to their premature mortality, after adjustment for age, gender, and other risk factors.

The elevated SMRs in dentists of Taiwan were found for heart diseases, including ischemic heart diseases and hypertension, which corroborates the hypothesis of increased stress proposed by some investigators[46, 48, 53-54]. Different from reports in other countries[55-56], dentists in Taiwan had a similar SMR (1.45, 95% CI=0.58 - 2.99) for suicide compared with internists. Our study also detected 5 dentists died of drowning and a higher cause specific SMR (6.62, 95% CI=2.15 - 15.45) for dentists, compared to the internists. Deaths by drowning have been considered as cases highly suspicious of suicide. As a sensitivity analysis, we re-classify all of the non-traffic related injuries including drowning into suicides; however, the SMR did not increase significantly. Thus, we tentatively concluded that the possibility of mis-coding or mis-classifying suicides

into accidental injuries seemed unlikely. From our qualitative enquiry, many dentists have a hobby of fishing in the ocean surrounding Taiwan. The unexpected tides and weather condition might partially explain the increased SMR of drowning in dentists and careful precaution should be taken to reduce the trend.

There are several limitations in this study. First, the exact dates of obtaining the dentist license were absent among 410 dentists out of 117,000 members. Most of them were very old and began their practices before 1985. We accrued the time of practice from the date of obtaining a license till December 31, 2009, or the date of deceased or termination of membership. For those with incomplete information on date or month of obtaining the license, we assumed to be on July 1 of his/or her age of 24 when most dentists were graduated from dental schools. Thus, we might have slightly overestimated the time of practice and could result in underestimation of the risk of dentists' mortality. Therefore, this assumption might not affect the conclusion. Second, because the follow-up periods between the two cohorts of dentists and internists were different, namely, 1985-2009 and 1990-2006, respectively, it raises a concern of comparability and potential bias. However, since there was no catastrophic event (such as epidemic of severe acute respiratory syndrome or earthquakes larger than 6-7 Richter magnitude scale, etc.) in Taiwan during both periods of 1985-1989 and 2007-2009, the likelihood of a potential bias may be minimal. Third, the analyses did not incorporate the information on the levels of clinics and hospitals being practiced. Thus, we had to assume that it might be a random effect and only lead toward the null or under-estimation.

5.5 Conclusions

Taiwanese dentists had significant elevated SMRs for the overall causes, drowning, and heart diseases, particularly from ischemic heart diseases and hypertension compared

with internists, and careful precaution should be taken to reduce the trend. Future studies are also indicated to explore more in depth about the mechanism of how professional stress contributes to the increased mortality risks in Taiwanese dentists.

Chapter 6. Disparities in Mortality among Physicians in Taiwan: A 17-year follow-up study of 37,545 Physicians

6.1 Introduction

During practices, health care providers were already noted to suffer from certain specific potential hazards like stress, radiation, anesthetic gases or agents and other biologically hazardous blood or body fluids, which have been documented in many previous studies among radiologists, pathologists, psychiatrists, dentists, and anesthesiologists[10, 26, 28, 57-59].

Beginning in 1995, Taiwan launched the National Health Insurance (NHI) program and attempted to mitigate the health disparity among the general population living in different geographic regions. The provision of universal health care coverage has increased the health care demand[16-17]. For example, the number of outpatient visits per person increased from 10.56 in 1995 to 14.88 in 2008, and the numbers of hospitalized patients and outpatient visits per physician increased as well[60-61]. , Thus, all the healthcare professionals, including physicians, have encountered a heavier workload and a greater psychosocial demand than before. However, an SMR (standardized mortality ratio) study using the general population as the reference for comparison did not detect any increased mortality among physicians in Taiwan[51].

From an alternative perspective, the association between demographic characteristics of human resources in health and the health of population served has received considerable attention[62-63]. There is a growing evidence that the density of the health workforce is directly correlated with positive health outcomes in the population they serve, such as maternity mortality, infant mortality and life expectancy[64]. Other factors like geographic location, socioeconomic states and distribution of current health

care resources might also affect health outcome and incline to inter-correlate with each other.

As all factors leading to health disparities are affecting people within respective locality[65], we hypothesized that they also influence the mortality rates of healthcare providers, including physicians who practiced in such locality. In the present study, we used the cohort data from the registry of the physician file maintained by the Taiwan Medical Association (TMA) and recruited internists, the largest group, as referents to determine if the effect of health disparities exists after control of potential confounding by different occupational exposures in different specialties.

6.2 Material and methods

6.2.1 Subjects and data collection

The retrospective cohort was established from the registry of the physician file maintained by the Taiwan Medical Association (TMA). The registry has been required by the governmental regulation for verification of credentials of all practicing physicians. It contains the name of each individual, date and place of birth, gender, national identification number, medical school attended, date of graduation, self-designated specialty, place of practice, vital status, date of death for decedents, and date of ceasing the membership. The cohort was established beginning in January 1990 and followed up to December 2006. Practice time was accrued until 2006, or the date of deceased or termination of membership. There were 29 decedents with incomplete information on date or month of death, of which this study assumed to be on the first day of the month or year. Since all practicing physicians must be registered in compliance to the Physicians Act in Taiwan, the dataset is very comprehensive and accurate.

6.2.2 Statistical analysis

Geographic data in physicians per 10,000 persons, per capita disposable income (US$), education, infant mortality rate (per 1000 live births), and life expectancy at birth were collected and analyzed from national statistics of the Directorate General of Budget, Accounting and Statistics (Taiwan) in 1998, 2002, and 2006. Geographic region was categorized into northern, central, southern and eastern region following the naming of branches of Bureau of National Health Insurance. Education indicated the percentage of people aged more than 15 attained an education level of college or above.

All-cause and cause-specific standardized mortality ratios (SMRs) were obtained by employing the personal computer version of Life Table Analysis System (LTAS.NET). The LTAS was originally developed by the National Institute for Occupational Safety and Health (NIOSH) during the 1970s and was later converted for use on Windows 98/NT/2000/XP-compatible PCs. This program tabulates the underlying causes of death as well as the person-year of follow-up into age-, gender-, and race-specific strata, and allows users to apply internal controls as referents to replace general population from vital statistics. SMRs and 95% confidence intervals (CIs) were calculated using the mortality rates of 119 underlying causes of death of the internists of Taiwan as the reference group. We used SAS Version 9.1 (SAS institute) to edit and analyze the data. In this study, we set the significance level at $p<0.05$.

Cox regression analysis was conducted to determine the hazard ratios for the following risk factors: age, gender, specialty, geographic region of practice, age of beginning practice, calendar year of beginning practice (before or after 1995 when the NHI system established), and physician to population ratio. The ratios of the physician to population were categorized into 4 levels: larger than 1:500, from 1:500 to 1:700, from 1:700 to 1:900, and less than 1:900. Since the northern region of Taiwan leads

development for the last half a century, it was chosen to be the reference in the statistical model. The covariates considered in the regression analysis were gender, specialty, geographic region of practice, age of beginning practice, calendar year of beginning practice, and physician to population ratio. We applied the stepwise strategy for variable selection with the significance level for entry and the significance level for stay set to 0.15. Regression diagnostics were also run, including examination of proportional hazard assumption, residual analysis, detection of influential cases, and check for multi-co-linearity to assure the quality of analysis and goodness of fit for the model.

6.3 Results

With the physician to population ratio above 1:500 as the reference level, we found that a lower ratio significantly increased the HR of physician mortality; there was also an independent effect of regional difference of higher HR for southern and eastern regions, as summarized in the Table 6-4. The differences among localities seemed to correlate well with higher average levels of income and education, lower infant mortality rates, and longer life expectancies across Taiwan. And such disparities did not appear to have any change during the last decade (Table 6-1).

A total of 37,545 physicians were tabulated in the study from January 1990 to December 2006. During the above period, there were 1642 deaths among 32,713 male physicians and 44 deaths among 4822 female physicians. The overall mean age at death was 69.88± 14.28 years old, with 70.06±14.04 for males and 62.96±20.21 for females, respectively. (Table 6-2) Approximately half (49.7%) of the cohort had been internists, 48.1% were practicing in the north region. Among all physicians, there were 30.8% working in the area of low physician to population ratio. About two-thirds began their practice before 1995, and over 90% started practice at age below 40.

As for the control for socioeconomic status in the analysis, we used the internists as the reference population and found that the all cause specific SMRs for surgeons and anesthesiologists were marginally elevated with an SMR of 1.15 (95% CI: 0.98-1.34) and 1.62 (95% CI: 0.93-2.64), respectively (Table 6-3). Among the surgeons, the SMR of "Neoplasm of lymphatic and hematopoietic tissue" was increased but without statistical significance (SMR = 2.17, 95% CI: 0.94 to 4.28). The observed numbers of deaths from malignant neoplasm of digestive organs and peritoneum were significantly lower than corresponding expected values (SMR =0.54, $p < 0.05$, 95% CI: 0.29 to 0.92). Among the anesthesiologists, the SMR of "malignant neoplasm of other and unspecified sites" was significantly increased (SMR =8.73, $p < 0.05$, 95% CI: 1.06 to 31.53), although there were only 2 cases on the observed number.

To further adjust for other risk factors, the Cox regression model was constructed and the results were summarized in Table 6-4. The anesthesiologists appeared to show the highest hazard ratios (HR) of 1.97 (95% CI, 1.20 to 3.25), followed by surgeons with a HR of 1.23 (95%CI, 1.04 to 1.46). The HR of ophthalmologists was significantly lower than all other specialists, of which the HR was 0.72 (95%CI, 0.53 to 0.98).. In addition, physicians living in the northern region and the central region experienced lower HR's. And physicians who worked in the area with physician to population ratio below 1:500 showed higher mortality or HR.

The physicians who began practice at an older age had a higher HR of 1.12 (95%CI, 1.12 to 1.13) for every single year increment. Overall, physicians who began practice after the implementation of National Health Insurance Program (NHIP), or the year of 1995, showed a higher HR of 6.17 (95%CI, 4.27 to 8.92).

6.4 Discussion

Based on Cox's Model analysis, we found physicians practicing in southern and eastern regions of Taiwan suffered from statistically significant premature mortality (Table 6-4), and such a geographic disparity appeared to correspond to the lower life expectancy and higher infant mortality rate in Taiwan (Table 6-1). To our limited knowledge, this study is the first to show that physicians practicing in the area of a low physician to population ratio or in the less resourceful regions experienced a higher HR of mortality after adjustment for gender, age of beginning practice, and specialties (Table 6-4). Since the study is conducted exclusively among physicians with the same socioeconomic status, it raises the question about whether the other two main factors: occupational workload or practice environment, which might have played an important role.

Lowest average income, educational level and life expectancy, and the highest infant mortality rate in Taiwan were found in the eastern region (Table 6-1). Traditionally, this mountainous region impedes transportation tremendously, and plays a significant role in reduced healthcare accessibility for people, including health care providers themselves. Although the physician to population ratio has improved since the promulgation of Medical Care Act in 1986 and implementation of NHI in 1995, physicians living in this region still suffer from a higher HR. It may indicate that the health disparity still exists. Moreover, in analyzing the central and southern regions, where similar levels of the average income and the education were found, a significant increased hazard ratio was detected in the southern region only. As noted in Table 6-1, the physician to population ratio has been consistently found to be lower in the southern region compared with those of the northern and central regions. These findings indicate persistent health disparities in different regions of Taiwan, and suggest that occupational workloads might play some role on the increased mortality of physicians.

In a previous study, we found that the overall and cause-specific SMRs of physicians in Taiwan were less than 0.34 for different specialties[51], which could be confounded by using the general population as the referents for comparison[52]. In this study, we use internists as the reference population for SMR calculation to minimize the potential confounding by different socioeconomic states (Table 6-3). Although no increased mortality was found among radiologists, pathologists, and psychiatrists, as reported from other countries[26, 28, 57], we detected significantly increased HRs for surgeons and anesthesiologists (Table 6-4). A further analysis only detected slightly elevated SMR for malignant neoplasm of lymphatic and hematopoietic tissues among surgeons, which appeared to corroborate the hazards of operation room reported by others[66]. However, the trend was less apparent because of the small sample size of anesthesiologists. Since the current mortality data in Taiwan only allowed for coding single underlying cause of death, it may further decrease the power of detection of occupational related illnesses.

Our study also demonstrated the HR of mortality was higher in the group beginning their practice since 1995, when the National Health Insurance system was implemented. This group belonged to a younger generation of physicians, who might possibly suffer from highly stressed work during their practice[1]. Such a stress might arise from their clinical training program or the newly implemented health policy. However, since the cohort was established during 1990-2006, which might impose a selection of healthy survivors on the physicians. They began their practice before 1995 in comparison with those entered the workforce after 1995. Thus, more study is needed to explore the above hypothesis.

Several limitations of this study should be noted. Firstly, possible misclassification of self-claimed specialty may be a source of bias while comparing the

mortality rates among different specialties. For instance, a surgeon shifted to general practice after retiring from a medical center may result in overestimation of the practice duration and possible underestimation of the effect of specialty. Thus, the higher HR's among surgeons and anesthesiologists may need to be further studied for clarification. Secondly, information was limited about the hospital level and location practiced, i.e., misclassification of the region of practice without differentiating primary/referral hospital and urban/rural setting. Thus, we had to assume that it might be a random effect and only lead to the null or under-estimation.

6.5 Conclusions

Disparities both in the geographic region of physician's practice and the ratio of physician to population regionally are the primary determinants to the HR of physician mortality. Thus, we recommend to increase the number of physicians and to improve the practice environment of eastern and southern regions of Taiwan, which may possibly mitigate the health disparities among physicians and people. Further, more studies are needed to explore and reduce the potential hazards among workplaces of anesthesiologists and surgeons in Taiwan.

Tables and Legends

Table 4-1. Standardized mortality ratio (SMR) and cumulative mortality rate for ages 20 to 79 (CMR_{20-79}) for Taiwanese physicians with different specialties, 1990-2006.

Specialty	Total number	No. deaths observed	No. deaths expected	SMR	CMR_{20-79}
All physicians	37,545	1686	5623.3	0.30**	0.25
Surgeon	4571	161	541.3	0.30**	0.27
Internist	18,664	1190	3577.8	0.33**	0.27
Dermatologist	901	35	104.0	0.34**	0.34
Otolaryngologist	2000	45	217.0	0.20**	0.22
Ophthalmologist	1584	42	200.4	0.21**	0.24
Pathologist	414	5	36.7	0.14**	0.06
Pediatrician	2883	54	272.5	0.20**	0.16
Psychiatrist	1214	21	110.9	0.19**	0.15
Radiologist	1076	18	97.4	0.18**	0.14
Obstetrician	2278	85	302.9	0.28**	0.23
Orthopedist	1128	14	102.2	0.14**	0.10
Anesthesiologist	832	16	60.3	0.27**	0.24

** P<0.01

CI = confidence interval

Table 4-2. Main causes of death in Taiwan in 2000 and the physicians standardized mortality ratios (SMRs) (compared with the general population of Taiwan) for each cause.

Causes of death	No. deaths observed	No. deaths expected	SMR	95% CI
Malignant neoplasm	490	1234.3	0.40**	0.36 - 0.43
Cerebrovascular disease	149	544.6	0.27 **	0.23 - 0.32
Heart disease	139	212.3	0.65 **	0.55 - 0.77
Accidents	66	551.8	0.12 **	0.09 - 0.15
Diabetes mellitus	69	192.3	0.36 **	0.28 - 0.45
Chronic liver disease	48	286.5	0.17 **	0.12 - 0.22
Kidney disease	31	95.5	0.32 **	0.22 - 0.46
Pneumonia	55	163.6	0.34 **	0.25 - 0.44
Suicide	23	166.1	0.14 **	0.09 - 0.21
Chronic lung disease	32	115.4	0.28 **	0.19 - 0.39
Hypertensive disease	17	4.2	4.06 **	2.36 - 6.50

** P<0.01

CI = confidence interval

Table 5-1 -- Characteristics of Taiwanese dentists included in the study from 1985 to 2009.

	Taiwanese dentists		Deceased dentists	
	No.(%)	**Mean censored age**	**No.(%)**	**Mean age at death**
Total	11,700 (100)	44.77±12.01	289(100)	62.81±17.38
Status				
Alive	11,411(97.5)	44.31±11.49		
Deceased	289(2.5)	62.81±17.38		
Sex				
Male	8945 (76.5)	46.79±11.86	272(94.1)	63.27±17.04
Female	2755 (23.6)	38.19±10.00	17(5.9)	55.43±21.44
Age of beginning practice				
age<30	10,640 (90.9)	44.01±11.80	259(89.6)	61.75±17.39
30<=age<40	971(8.3)	51.32±10.65	17(5.9)	64.22±11.66
age>=40	89(0.8)	69.53±13.91	13(4.5)	83.76±9.88
Region				
Northern	6224(53.2)	44.36±12.03	134(46.4)	61.39±17.06
Central	2279(19.5)	45.29±12.12	76(26.3)	63.70±17.23
Southern	3008(25.7)	44.96±11.91	75(26.0)	64.37±18.10
Eastern	189(1.6)	48.72±10.87	4(1.4)	64.38±20.90

Physician-population ratio				
＞1：500	5590 (47.8)	45.27±12.33	137(47.4)	61.62±16.64
1：700 to 1：500	1667(14.2)	44.05±11.42	41(14.2)	64.01±17.52
1：900 to 1：700	1860(15.9)	45.60±12.21	71(24.6)	66.25±18.65
＜1：900	2583(22.1)	43.53±11.42	40(13.8)	59.54±16.97
Years of Practice				
Before 1995	7292(62.3)	52.07±8.62	285(98.6)	63.26±17.08
After 1995	4408(37.7)	32.69±5.12	4(1.4)	30.94±4.19

Table 5-2 --The observed number of deaths and cause specific standardized mortality ratios (SMRs) with confidence interval for dentists, using internists and general population of Taiwan as the reference group, respectively.

Reference group		Internists	General population
Causes of death	**No. observed**	**SMR (95% CI)**	**SMR (95% CI)**
All causes	289	1.13(1.00 - 1.26)	0.31(0.28 - 0.35)
All malignant neoplasm (MN)	96	1.16(0.94 - 1.41)	0.42(0.34 - 0.51)
MN of digestive organs and peritoneum	50	1.03(0.77 - 1.36)	0.41(0.31 - 0.54)
MN of respiratory system	20	1.33(0.82 - 2.06)	0.56(0.34 - 0.86)
MN of urinary organs	5	1.63(0.53 - 3.81)	0.99(0.32 - 2.31)
Neoplasm of lymphatic and hematopoietic tissue	7	1.04(0.42 - 2.15)	0.55(0.22 - 1.13)
MN of other and unspecified sites	8	1.69(0.73 - 3.34)	0.69(0.30 - 1.37)
Cerebrovascular disease	26	1.50(0.98 - 2.20)	0.35(0.23 - 0.52)
Heart disease	47	1.66(1.22 - 2.21)	0.70(0.51 - 0.93)
Ischemic Heart disease	28	1.65(1.10 - 2.39)	0.90 (0.60 - 1.30)
Conductive disorder	1	1.34(0.03 - 7.47)	0.25 (0.01 - 1.41)
Hypertension with heart disease	6	10.55(3.87 -22.96)	7.05(2.59 -15.35)

Diabetes mellitus	5	0.60(0.19 - 1.39)	0.16(0.05 - 0.37)
Chronic liver disease	9	1.23(0.56 - 2.34)	0.12(0.06 - 0.23)
Kidney disease	3	0.87(0.18 - 2.53)	0.23(0.05 - 0.67)
Pneumonia	3	0.29(0.06 - 0.86)	0.18(0.04 - 0.52)
Chronic lung disease	4	2.18(0.60 - 5.59)	0.39(0.11 - 0.99)
Transportation injuries	13	0.87(0.46 - 1.49)	0.15(0.08 - 0.25)
Fall	1	0.47(0.01 - 2.59)	0.06(0.00 - 0.32)
Other injury	10	1.19(0.57 - 2.19)	0.16(0.08 - 0.29)
Drowning	5	6.62(2.15 -15.45)	0.36(0.12 - 0.84)
Suicide	7	1.45(0.58 - 2.99)	0.16(0.06 - 0.33)

Table 5-3 – Hazard ratio and confidence interval estimated from Cox regression model for mortality of dentists and internists in Taiwan.

Covariate	Hazard ratio	95% CI	P
Age of beginning practice			
	1.12	1.11-1.13	<.0001
Sex			
Female/ Male	0.84	0.62-1.15	0.2753
Specialty			
Dentist/ Internists	1.17	1.01-1.37	0.0405
Region			
Central / Northern	1.12	0.97-1.30	0.1355
Southern / Northern	1.27	1.13-1.43	<.0001
Eastern / Northern	1.48	1.09-2.00	0.0120
Physician-population ratio			
1：700 to 1：500 / ＞1：500	1.22	1.04-1.42	0.0120
1：900 to 1：700 / ＞1：500	1.18	1.04-1.34	0.0088
＜1：900 / ＞1：500	1.10	0.92-1.31	0.2988
Year of beginning practice			
After 1995/ Before 1995	3.20	1.87-5.48	<.0001

Table 6-1 -- Geographic disparities in physicians per 10,000 persons, per capita disposable income (US$), education, infant mortality rate (per 1000 live births), and life expectancy at birth in 1998, 2002, and 2006.

Region	Physicians per 10,000 persons			Per capita disposable income			Education [§]			Infant mortality rate			Life expectancy		
	1998	2002	2006	1998	2002	2006	1998	2002	2006	1998	2002	2006	1998	2002	2006
Northern	14.7	16.5	17.4	8394.8	8912.6	9853.0	24.8	30.1	36.1	6.2	4.9	4.4	77.4	78.6	79.5
Central	14.1	16.5	18.3	7044.2	6940.0	7817.6	18.8	23.2	28.6	6.9	5.8	4.5	75.1	77.0	77.6
Southern	12.9	14.5	16.5	6928.8	7157.5	7891.2	18.4	22.8	27.7	6.4	5.4	4.8	74.7	76.0	76.5
Eastern	13.3	15.4	18.3	6542.2	6683.0	7987.6	11.8	14.4	20.0	12.4	8.3	7.6	70.6	72.9	73.2

[§]**Education**: The percentage of people aged more than 15 attained an education level of college or above

Table 6-2 -- Characteristics of Taiwan physicians included in the study from 1990 to 2006.

	Taiwan physicians		Deceased physicians	
	No.(%)	**mean censored age**	**No.(%)**	**mean age at death**
Total	37,545(100)	46.41±14.47	1686(100)	69.88±14.28
Status				
Alive	35,859(95.5)	45.31±13.51		
Deceased	1686(4.5)			69.88±14.28
Sex				
Male	32,722(87.2)	47.68±14.56	1642(97.4)	70.06±14.04
Female	4823(12.8)	37.81±10.30	44(2.6)	62.96±20.21
Age of beginning practice				
age<30	29,753 (79.2)	43.39±11.99	566(33.6)	59.03±14.98
30<=age<40	5573(14.8)	52.28±14.10	472(28.0)	73.81±11.92
age≧40	2219(5.9)	74.24±10.91	648(38.4)	76.37±8.62
Specialty				
Surgeon	4571(12.2)	45.20±13.20	161(9.5)	65.83±14.54
Internist	18,664(49.7)	48.76±15.97	1190(70.1)	71.92±12.70
Dermatologist	901(2.4)	43.00±12.92	35(2.1)	69.79±16.25
Otolaryngologist	2000(5.3)	44.28±11.99	45(2.7)	65.46±14.36
Ophthalmologist	1584(4.2)	44.72±12.33	42(2.5)	72.28±19.56

Pathologist	414(1.1)	42.21±12.04	5(0.3)	49.78±10.87
Pediatrician	2883(7.7)	42.35±11.59	54(3.2)	66.32±17.12
Psychiatrist	1214(3.2)	40.37±11.81	21(1.2)	61.85±20.52
Radiologist	1076(2.9)	41.59±11.79	18(1.1)	63.23±18.18
Obstetrician	2278(6.1)	48.84±12.10	85(5.0)	63.48±14.44
Orthopedist	1128(3.0)	43.56±11.07	14(0.8)	58.78±18.32
Anesthesiologist	832(2.2)	40.91±10.23	16(0.9)	45.21±15.67
Region				
Northern	18,046(48.1)	45.71±14.52	659(39.1)	68.90±14.32
Central	7054(18.8)	46.25±13.70	300(17.8)	70.04±15.58
Southern	11,376(30.3)	47.64±14.81	667(39.6)	70.97±13.57
Eastern	1069(2.8)	46.24±14.12	60(3.6)	67.67±13.96
Physician-population ratio				
＞1：500	17,185(45.8)	45.29±14.34	620(36.8)	68.21±15.11
1：700 to 1：500	6429(17.1)	45.55±14.50	285(16.9)	69.71±14.19
1：900 to 1：700	11,233(29.9)	47.91±14.21	589(34.9)	70.92±13.61
＜1：900	2698(7.2)	51.08±14.53	192(11.4)	71.90±13.02
Years of practice				
Before 1995	24,337(64.8)	53.62±12.71	1640(97.3)	70.60±13.52
After 1995	13,208(35.2)	33.13±5.06	46(2.7)	44.28±16.86

Table 6-3 -- The observed number of deaths and cause specific SMRs (standardized mortality ratios) for surgeons and anesthesiologists.

	Surgeon			Anesthesiologist		
Causes of death	**O**	**SMR**	**95%CI** [§]	**O**	**SMR**	**95%CI**
All causes	161	1.15	(0.98 - 1.34)	16	1.62	(0.93 - 2.64)
All malignant neoplasm (MN)	37	0.84	(0.59 - 1.16)	5	1.57	(0.51 - 3.66)
MN of digestive organs and peritoneum	13	0.54	(0.29 -0.92)	2	1.18	(0.14 -4.26)
MN of respiratory system	11	1.16	(0.58 - 2.07)	0	0.00	(0.00- 6.56)
MN of urinary organs	2	1.05	(0.13 - 3.79)	0	0.00	(0.00 - 20.42)
Neoplasm of lymphatic and hematopoietic tissue	8	2.17	(0.94 - 4.28)	1	3.41	(0.09 -19.03)
MN of other and unspecified sites	1	0.48	(0.01 -2.68)	2	8.73	(1.06 - 31.53)
Cerebrovascular disease	7	0.59	(0.24 - 1.22)	3	3.95	(0.82 - 11.55)
Heart disease	9	0.83	(0.38 -1.57)	0	0.00	(0.00 - 7.34)
Accidents	11	1.81	(0.90 -3.24)	1	1.58	(0.04 - 8.79)
Diabetes mellitus	8	1.49	(0.65 -2.94)	1	1.84	(0.05 -10.25)
Chronic liver disease	7	1.60	(0.64 -3.30)	0	0.00	(0.00 -13.75)
Kidney disease	1	0.36	(0.01 -2.01)	0	0.00	(0.00 -21.26)
Pneumonia	5	0.97	(0.32 - 2.27)	0	0.00	(0.00 -12.23)
Suicide	3	1.36	(0.28 - 3.98)	1	3.34	(0.08 -18.60)

Chronic lung disease	4	2.19	(0.60 - 5.60)	0	0.00	(0.00 -116.04)
Hypertensive disease	2	1.45	(0.18 - 5.25)	0	0.00	(0.00 - 30.76)

§ **CI: confidence interval**

Table 6-4 -- Hazard ratios with 95% CI (confidence interval) estimated through Cox regression model to control relevant risk factors on mortality among Taiwan physicians from 1990 to 2006.

Covariate	Hazard ratio	95% CI
Age of beginning practice		
	1.12	1.12-1.13
Gender		
Female/male	0.76	0.56-1.02
Specialty		
Dermatologist / Internist	1.19	0.85-1.67
Otolaryngologist / Internist	0.85	0.63-1.15
Ophthalmologist / Internist	0.72	0.53-0.98
Pathologist/ Internist	0.81	0.33-1.94
Pediatrician / Internist	0.91	0.69-1.20
Psychiatrist / Internist	0.81	0.52-1.24
Radiologist / Internist	0.87	0.55-1.39
Surgeon / Internist	1.23	1.04-1.46
Obstetrician / Internist	1.19	0.95-1.50
Orthopedist / Internist	0.75	0.44-1.27
Anesthesiologists/ Internist	1.97	1.20-3.25
Region		
Central / Northern	1.12	0.97-1.29
Southern / Northern	1.30	1.17-1.45
Eastern / Northern	1.68	1.28-2.20

Physician-population ratio		
1：700 to 1：500 / ＞1：500	1.23	1.06-1.42
1：900 to 1：700 / ＞1：500	1.20	1.06-1.34
＜1：900 / ＞1：500	1.18	1.00-1.39
Year of beginning practice		
After 1995/ Before1995	6.17	4.27-8.92

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Appendices

1. Grouping of individual specialty claims used in analysis

Specialty	Individual Specialties
Surgeon	General surgery, Pediatric surgery, Plastic surgery, Cardiothoracic surgery, Traumatic surgery, Emergency surgery, Neurosurgery,
Internist	General medicine, Cardiology, Physical medicine, Nephrology, Endocrinology, Clinical genetics, Gastroenterology, Hematology, Oncology, Occupational medicine, Chest medicine, Neurology, Infectious disease, Epidemiology, Intensive care medicine, Forensic medicine, Hematology.
Dermatologist	Dermatology,
Otolaryngologist	Ear nose throat surgery,
Ophthalmologist	Ophthalmology,
Pathologist	Clinical pathology, Pathology,
Pediatrician	Pediatric,
Psychiatrist	Psychiatry,
Radiologist	Nuclear medicine, Radiotherapy, Radiation oncology, Radiology,
Obstetrician	Obstetrics, Gynecology,
Orthopedist	Orthopedics surgery,
Anesthesiologist	Anesthetics.

2. Bibliography of my work

2.1 Publications (Thesis related)

1. **Tung-Fu Shang**, Pau-Chung Chen, Jung-Der Wang. Mortality of Doctors in Taiwan. Occup Med (Lond) (2011) 61(1): 29-32
2. **Tung-Fu Shang**, Pau-Chung Chen, Jung-Der Wang. Mortality of Dentists in Taiwan, 1985-2009. (Accepted by J Formos Med Assoc on 24 June 2011.)
3. **Tung-Fu Shang**, Pau-Chung Chen, Fu-Chang Hu, Jung-Der Wang. Disparities in Mortality among Doctors in Taiwan: A 17-year follow-up study of 37,545 Doctors.(Reviews completed by Int Arch Occup Environ Health on 1 July 2011)
4. 黃元惠、張北葉、洪志洋、**商東福**等：全民健保外科手術項目新支付標準之分析，台灣醫界 2005；48：43-6
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2.2 Abstracts of Meeting (Thesis related)

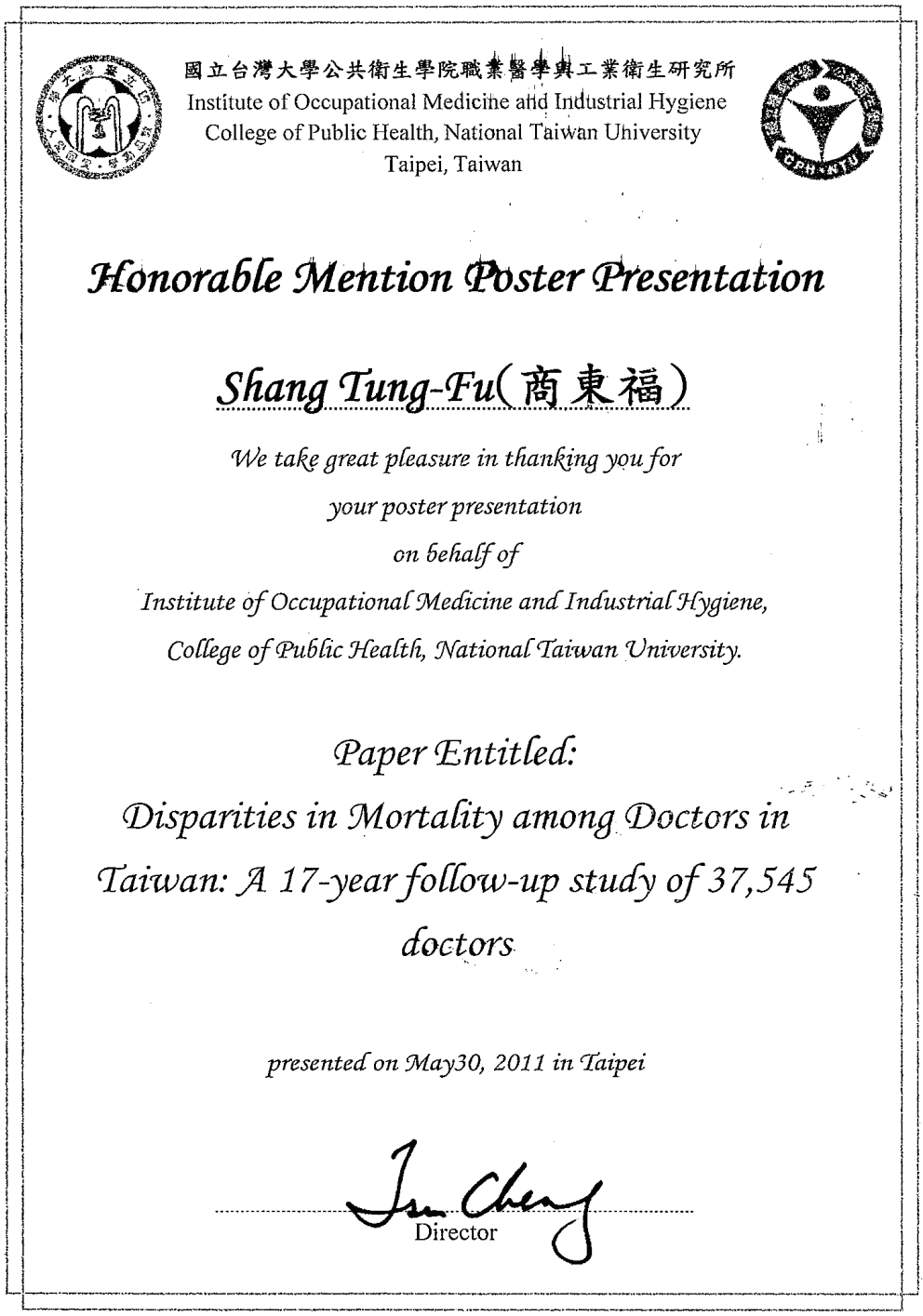
1. 商東福；2010；Determinants of Mortality among Physicians in Taiwan；Program Book of EPICOH-Medichem 2010: pp.65. Session Code: Fr-O-8. Abstract Number: 00025.

2.3 委託研究報告

1. 行政院衛生署九十一年度委託研究計畫；全民健康保險醫療費用支付標準手術項目科內相對值建立模式及影響因素研究----------以外科各次專科為例；計畫主持人：張北葉、洪志洋；研究人員：黃元惠、**商東福**

2. 行政院衛生署九十三年度委託研究計畫；全民健康保險醫療費用手術項目支付標準之訂定模式----------以外科各次專科為例；計畫主持人：張北葉；偕同主持人：洪志洋；研究人員：黃元惠、**商東福**

2.4 Honorable Mention Poster Presentation



國立台灣大學公共衛生學院職業醫學與工業衛生研究所
Institute of Occupational Medicine and Industrial Hygiene
College of Public Health, National Taiwan University
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Honorable Mention Poster Presentation

Shang Tung-Fu(商東福)

We take great pleasure in thanking you for
your poster presentation
on behalf of
Institute of Occupational Medicine and Industrial Hygiene,
College of Public Health, National Taiwan University.

Paper Entitled:
Disparities in Mortality among Doctors in Taiwan: A 17-year follow-up study of 37,545 doctors

presented on May30, 2011 in Taipei

Director

2.5 Published Paper in Occupational Medicine

Occupational Medicine 2011;61:29–32
Advance Access publication on 21 October 2010 doi:10.1093/occmed/kqq159

Mortality of doctors in Taiwan

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Background	Working in clinical practice involves exposure to many hazards, resulting in ongoing concerns regarding mortality in doctors when compared with the general public.
Aims	To evaluate the survival data of all Taiwanese doctors and to ascertain whether doctors experience premature mortality.
Methods	Death and census data from 1990 to 2006 were obtained for all practising doctors in Taiwan. Cause-specific standardized mortality ratios (SMRs) were calculated via the Life Table Analysis System using the general population of Taiwan as the reference.
Results	All the SMRs of different medical specialties were below 0.34. Doctors in Taiwan were found to be less likely to die from all causes, including suicide and drug abuse. The SMRs for suicide and drug abuse were generally below 0.50 [SMR = 0.14, 95% confidence interval (CI) 0.09–0.21 and SMR = 0.16, 95% CI 0.07–0.32, respectively].
Conclusions	The risks of all-cause and cause-specific mortality of doctors were found to be lower than those of the general population in Taiwan.
Key words	Doctors; mortality; standardized mortality ratios.

Introduction

In 1996, Wright *et al.* [1] calculated from obituaries published in the *British Medical Journal* that anaesthetists and doctors born in the Indian subcontinent appeared to die at a younger age. However, the validity of the study methods and results were questioned due to the lack of real denominators [2,3]. Because clinical practice involves exposures to many hazards [4,5], including psychological stress, prolonged and irregular job shifts, sleep deprivation, radiation, anaesthetic gases and biologically hazardous substances, there continue to be concerns that there may be higher mortality rates in doctors when compared with the general public [6–9]. For example, during the Taiwanese Severe Acute Respiratory Syndrome epidemic of 2003, 106 of the 346 cases confirmed nationwide were hospital health care workers. Among the 73 fatalities, 3 of the 12 health care workers were doctors [10].

In contrast, studies [11–15] from industrialized countries indicate that medical professionals experience lower overall mortality rates than other occupations. This outcome is attributed to the relative advantages of socioeconomic status, better access to health care and possible profession-related knowledge.

In view of these discrepancies, this study was conducted to evaluate the standardized mortality ratios (SMRs) for all doctors in Taiwan.

Methods

The cohort population of doctors in Taiwan was established from the enrolment and registration data of all the doctors in the Taiwan Medical Association. This has been regularly maintained since 1990 and contains information on doctors' demographics, including professional qualifications and training profiles. The registry also contains the following information on each doctor: name, date and place of birth, gender, personal identification (ID) number, medical school enrolment, medical school graduation date, medical specialties, places of practice, vital status, date of death and date of termination of membership or retirement.

The underlying and contributing causes of death are regularly obtained from the National Mortality Registry (NMR), which has been maintained by Taiwan's Department of Health since 1981. The cause of death for each deceased doctor was obtained through the NMR via the

personal ID number. Those without a definite cause of death were reported as deceased with unknown cause. The cohort was followed until 2006 and the total person-years were calculated based on whether each doctor was deceased or censored.

The all-cause and cause-specific mortality rates for doctors were compared with those of the general public. All-cause and cause-specific SMRs were obtained by employing the personal computer version of Life Table Analysis System (LTAS.NET). This programme tabulates the underlying causes of death as well as the person-year of follow-up into age-, gender- and race-specific strata. SMRs and 95% confidence intervals (CIs) were calculated using the mortality rates of 119 underlying causes of death for the general population of Taiwan from 1971 to 2006 as a reference. The classifications of cause-specific deaths were limited to those available in the reference data.

Originally, 38 different medical specialties were recorded in the doctor registration file; these were then categorized into 12 major specialties for the final analyses (Table 1). Because the SMR is influenced by the age distributions for doctors with different specialties, the cumulative mortality rates (CMRs) for every 10-year period between ages 20 and 79 were calculated for direct comparison of mortality using the following formula: $CMR_{20-79} = 1 - e^{-x}$, CMR_{20-79} denotes CMR for ages 20 to 79; x was obtained by multiplying the interval of age stratum(10) by the sum of the age-specific mortality rates for ages 20–29, 30–39, 40–49, 50–59, 60–69 and 70–79 [16–18].

Table 1. Groups of individual specialty claims used in the analysis

Specialty	Individual specialties
Surgeon	General surgery, Paediatric surgery, Plastic surgery, Cardiothoracic surgery, Traumatic surgery, Emergency surgery, Neurosurgery
Internist	General medicine, Cardiology, Physical medicine, Nephrology, Endocrinology, Clinical genetics, Gastroenterology, Haematology, Oncology, Occupational medicine, Chest medicine, Neurology, Infectious disease, Epidemiology, Intensive care medicine, Forensic medicine
Dermatologists	Dermatology
Otolaryngologists	Ear nose throat surgery
Ophthalmologists	Ophthalmology
Pathologists	Clinical pathology, Pathology
Paediatricians	Paediatric
Psychiatrists	Psychiatry
Radiologists	Nuclear medicine, Radiotherapy, Radiation oncology, Radiology
Obstetricians	Obstetrics, Gynaecology
Orthopaedists	Orthopaedic surgery
Anaesthesiologists	Anaesthetics

The study was approved by the Ethics Review Board of the National Taiwan University College of Public Health.

Results

From January 1990 to December 2006, 37 545 doctors were enrolled in the study registry for a total of 624 133 person-years of follow-up. During this period, 1686 deaths occurred, including 1190 (of 18 664) internists and 161 (of 4571) surgeons. The segment of the population over 60 years old represented 4% of all anaesthesiologists, which was lower than the other specialties (surgeons, 13%; internists, 22% and obstetricians, 16%).

In general, the overall SMRs and CMRs for doctors with different specialties were relatively small when compared with the general population of Taiwan. As summarized in Table 2, all the SMRs of different medical specialties were below 0.34. Among different specialties, higher $CMRs_{20-79}$ were found for dermatologists (0.34), internists (0.27) and surgeons (0.27) and lower $CMRs_{20-79}$ were found for pathologists (0.06) and orthopaedists (0.10).

Table 3 shows that doctors in Taiwan were less likely to suffer from nearly all specific causes of disease, although the main causes of death among doctors were generally the same as those of the general public in 2003. Doctors were also more likely to die from hypertensive diseases (SMR 4.06, 95% CI 2.36–6.50) but less likely to experience other diseases, including cerebral vascular disease, accidents, suicide, chronic obstructive pulmonary disease, pneumonia/influenza or liver disease. The SMRs for suicide and drug abuse were well below 0.5 (SMR

Table 2. SMR and CMR for ages 20–79 (CMR_{20-79}) for Taiwanese doctors in different specialties, 1990–2006

Specialty	Total number	No. of deaths observed	No. of deaths expected	SMR	CMR_{20-79}
All doctors	37 545	1686	5623	0.30**	0.25
Surgeon	4571	161	541	0.30**	0.27
Internist	18 664	1190	3578	0.33**	0.27
Dermatologist	901	35	104	0.34**	0.34
Otolaryngologist	2000	45	217	0.20**	0.22
Ophthalmologist	1584	42	200	0.21**	0.24
Pathologist	414	5	37	0.14**	0.06
Paediatrician	2883	54	273	0.20**	0.16
Psychiatrist	1214	21	111	0.19**	0.15
Radiologist	1076	18	97	0.18**	0.14
Obstetrician	2278	85	303	0.28**	0.23
Orthopaedist	1128	14	102	0.14**	0.10
Anaesthesiologist	832	16	60	0.27**	0.24

**$P < 0.01$.

Table 3. Main causes of death in Taiwan in 2000 and the doctor's SMRs compared with the general population of Taiwan

Causes of death	No. of deaths observed	No. of deaths expected	SMR	95% CI
Malignant neoplasm	490	1,234	0.40**	0.36–0.43
Cerebrovascular disease	149	545	0.27**	0.23–0.32
Heart disease	139	212	0.65**	0.55–0.77
Accidents	66	552	0.12**	0.09–0.15
Diabetes mellitus	69	192	0.36**	0.28–0.45
Chronic liver disease	48	287	0.17**	0.12–0.22
Kidney disease	31	96	0.32**	0.22–0.46
Pneumonia	55	164	0.34**	0.25–0.44
Suicide	23	166	0.14**	0.09–0.21
Chronic lung disease	32	115	0.28**	0.19–0.39
Hypertensive disease	17	4	4.06**	2.36–6.50

**$P < 0.01$.

0.14, 95% CI 0.09–0.21 and SMR 0.16, 95% CI 0.07–0.32, respectively).

Discussion

Our study found that doctors in Taiwan have a significantly lower SMR than the general population. This is in contrast to the general perception; when we searched for 'doctor's life expectancy' in Chinese on the Internet, the first page of results showed that Taiwanese doctors died 10 years earlier than the general population and that the surgeons generally died 5 years earlier than all other doctors. This message was repeatedly visible in obituaries in the news and publications of professional societies, which might have created an erroneous impression among people in Taiwan. Because the results of our study seem to be contrary to the observations detailed above, we first needed to rule out any potential confounding factors before making further inferences.

While our study already included calendar year, age and gender in the SMR calculation, these factors cannot explain the magnitude of reduced mortality. Because calculation of SMR generally adopts the age distribution of the index population, different SMRs cannot be directly compared [18]. We further calculated the CMR_{20-79} for different specialties in Table 2; all were below 0.34 and smaller than those of the general population of Taiwan, which was 0.53 in 1990, 0.48 in 2000 and 0.44 in 2006. The two indicators corroborate with one another, and through the results, we can tentatively conclude that doctors in Taiwan are healthier than the general population. This study also empirically demonstrates that without obtaining the real denominators for different age groups, the age at death cannot reflect the real mortality rates.

After adjusting for age, gender and calendar year, the SMRs of Taiwanese doctors in different medical specialties and the main causes were all well below 1, with the exception of hypertensive disease. However, there were only 17 cases coded for hypertensive disease, which would not have influenced the SMR estimates for stroke, heart disease or renal disease, if they had been coded into any of these three hypertension-related causes of death. Thus, we conclude that this figure might be a reflection of enhanced health care and completion of death certificates for doctors in Taiwan.

We found a significantly decreased SMR (0.14) for suicide among doctors in Taiwan, which is different to reports in other countries [19,20]. As a sensitivity analysis, we tried to reclassify all the non-traffic-related injuries into suicides; however, the SMR did not increase to >0.20. Thus, suggesting that the low SMR of suicide cannot be explained by the potential confounding of coding errors or misclassification of certification process.

The lower overall death rate of Taiwanese doctors than the general population may be partially attributed to the healthy worker effect (HWE), which is the tendency of the actively employed to live longer than the population at large [21,22]. However, most studies indicate that HWE will reduce the association between exposure and outcome by a magnitude of 20–30% [23,24]. In our study, the SMRs and CMRs for mortality among Taiwanese doctors in different specialties were <50%, which might imply a continued accumulation of professional-related knowledge.

Nevertheless, there are two limitations to this study. First, in addition to those mentioned above, possible contributors to lower health risks among doctors include profession-related knowledge, health-related behaviour and stable socio-economic status. However, information on education and socio-economic status within different strata of the reference population was not available, and therefore, adjustments for these potential confounders were not possible. Secondly, because the current regulations in Taiwan allow for two registered specialties, misclassification of self-reported specialties might be a source of bias in the analysis of mortality rates among different specialties. For example, a surgeon who worked in a district hospital or a clinic may go on to practice general medicine after retirement from the medical centre. However, because the SMRs and CMRs for all different specialties showed a consistently lower trend than those of the general population, this potential misclassification is not sufficient to influence the conclusion.

In conclusion, the total mortality rates of doctors in all specialties in Taiwan were much lower than those of the general population, and doctors were less likely to die from nearly all causes, including suicide and drug abuse. It is hoped that these findings will help to correct the false perception of a higher mortality rate in doctors in Taiwan.

2.6 Accepted Letter from Journal of the Formosan Medical Association

Date: Jun 24, 2011
To: "Jung-Der Wang" jdwang121@gmail.com
cc: lmhuang@ntu.edu.tw;turfu@ntu.edu.tw
From: "JFMA" jfmaed@fma.org.tw
Subject: Your Submission

Ms. Ref. No.: JFMA-D-11-00144R1
Title: Mortality among Dentists in Taiwan, 1985-2009
Journal of the Formosan Medical Association

Dear Dr. Jung-Der Wang,

I am pleased to inform you that your paper "Mortality among Dentists in Taiwan, 1985-2009" has been accepted for publication in Journal of the Formosan Medical Association .

Below are comments from the editor and reviewers.

Thank you for submitting your work to Journal of the Formosan Medical Association .

Yours sincerely,

JFMA Editorial Office
Editorial Office
Journal of the Formosan Medical Association

Comments from the editors and reviewers:

Reviewer #1: The revised manuscript can be accepted now.