PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form (see an example) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below. Some articles will have been accepted based in part or entirely on reviews undertaken for other BMJ Group journals. These will be reproduced where possible.

ARTICLE DETAILS

TITLE (PROVISIONAL)	Disparities in Mortality among Doctors in Taiwan: A 17-year follow-up study of 37,545 Doctors
AUTHORS	Tung-Fu Shang, Pau-Chung Chen and Jung-Der Wang

VERSION 1 - REVIEW

REVIEWER	Jow Ching Tu Professor HKUST No competeting Interests at all
REVIEW RETURNED	04/12/2011

The reviewer filled out the checklist but made no further comments.

REVIEWER	Olaf Gjerløw Aasland Director, The Research Institute, Norwegian Medical Association Professor, Department of Helth Management and Health Economics, Institute of Society and Health, University of Oslo, Norway Conflicts of interest: none
REVIEW RETURNED	31/12/2011

RESULTS & CONCLUSIONS	My main objection is that a paper that presents geographic location as a possible cause of premature death among doctors does not discuss the the possible causes of choosing a location, or moving from one location to another.
REPORTING & ETHICS	The question of approval is unclear. The authors state that they all "have complied with the Principles of Ethical Practice of Public Health", but is this the same as approval?
GENERAL COMMENTS	This is another study documenting that mortality differences between medical specialists hardly exist any more, as opposed to the situation a few generations ago, see e.g. Doll & Peto from 1977 (reference # 6 in the present paper). The authors find significant differences in doctor mortality between geographical areas with different population health and doctor to population ratios, and speculate that heavier workload and greater psychological demands, especially among younger doctors, may lead to a higher mortality. However, I am not convinced by their documentation, particularly since they have also shown in a previous study that the SMR of Taiwanese doctors compared to the general population is only 0.34 or below, and not increasing. It might be useful to explore a possible convergence in mortality between doctors and other segments of the population, like we did in our study on Norwegian doctors (Aasland OG, Hem E, Haldorsen T. Ekeberg Ø. Mortality among Norwegian

	doctors. BMC Health Serv Res. 2011 Mar 22; 11 (1):173). Below are some points that should be addressed for improvement of the paper: 1. Out-patient settings: Half of the doctor population in this study is categorized as internists. Since none of the categories are called family medicine or general practice, I assume that some of the internists are in effect general practitioners working outside hospitals, but such information is not given. One should think that ”patient load”, or doctor to population ratio, as a possible confounding variable for stress etc., is more important for doctors in outpatient settings? More information on the work pattern for doctors in Taiwan is needed! (See also point 5 below.) 2. Doctor mobility: In this study the present working location (by region) for each doctor is used as a predictor for mortality. In my own country doctors move around quite a bit, mainly from rural to urban areas, but also from urban to rural. The analyses in this study presuppose no such movements – is this realistic? And linked to this argument, why do some doctors choose rural and other urban areas, or different geographical locations in general? Can such reasons be causes of variation in health and mortality? 3. Cohort and age: A distinction is made between the doctors who started their practice before and after 1995, respectively. We are told that in 1995 a National Health Insurance System was implemented, and that the younger doctors, because of this (?), ”might possibly suffer from highly stressed work during their practice” (page 11). The meaning of this is unclear: didn’t also the older doctors, at least those still in practice, have to comply with the new insurance system? Also, ”age for beginning practice” is used as the general age variable in the models. Why not use biological age? 4. Why are anesthesiologists always singled out? I am aware that there may exists an impression internationally that anesthesiologists have a higher mortality than other medical specialists, although the documentation for this is not very convincing (see e.g. the special issue of Acta Anaesthiol Scand from 2002 on this topic (p. 1183 ff)). The quote from Bruce et al. (# 17) describing ”the hazards of operation rooms” is 44 years old and hardly relevant today. I can not see the rationale for tabulating the 16 deaths among anesthesiologists across a large number of causes, as in table 3. Also, even if I understand that another publication (# 11) may have tabulated the differeneces between doctors and the general population in causes of death, I miss some of these comparative data in the present paper. 5. Internists as reference: The large – and possibly quite heterogeneous – group of internists is used as reference throughout the paper. Is this optimal? Wouldn’t the contrasts be clearer if one of the smaller more homogeneous groups were used, e.g. the surgeons? And where are the family doctors?

VERSION 1 – AUTHOR RESPONSE

For Reviewer

Comment # 1
My main objection is that a paper that presents geographic location as a possible cause of premature death among doctors does not discuss the possible causes of choosing a location, or moving from one location to another.

RESPONSE: The authors would like to thank the reviewer for your comment. The retrospective cohort was established from the registry of the doctor file maintained by TMA (Taiwan Medical Association). The registry has been required by the governmental regulation for verification of credentials of all practicing doctors. The data only indicates the latest status on the date of December 31, 2006, or on the date of deceased or termination of membership. Although moving location of practice for doctors in Taiwan may not be very prevalent in general, we have included the limitation in the “Discussion” section as recommended by you in another comment as well. Please kindly see the revised paragraph as follows: (Please see page 13, ll. 7-11)

clarification. Secondly, information was limited by the hospital level and the locations which the doctor has ever 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.

Comment # 2
The question of approval is unclear. The authors state that they all "have complied with the Principles of Ethical Practice of Public Health", but is this the same as approval?

RESPONSE: We would like to thank the reviewer for your comment. Yes, this study was approved by the Ethics Review Board of the National Taiwan University College of Public Health. For further clarification, please kindly see the revised “Competing interests” (page 14) as follows:

Competing interests:
All authors of this manuscript indicate no conflicts of interest and have complied with the Principles of Ethical Practice of Public Health. The Ethics Review Board of our institute (Institute of Occupational Medicine and Industrial Hygiene College of Public Health, National Taiwan University, Taiwan) approved the protocol before the commencement of this study.

Comment # 3
It might be useful to explore a possible convergence in mortality between doctors and other segments of the population, like we did in our study on Norwegian doctors (Aasland OG, Hem E, Haldorsen T. Ekeberg Ø. Mortality among Norwegian doctors. BMC Health Serv Res. 2011 Mar 22; 11 (1):173).

RESPONSE: The authors would like to thank the reviewer for the constructive comment, which advice us to prevent potential confounding from education and/or socioeconomic status by using other comparable segments of population. In Taiwan, doctors have much higher average earnings per month than all the other health professionals like nurses. It is different from a more socialist country like Norway. The relevant data can be found in The Labor Statistics Database of the International Labor Organization, as summarized below:
Taiwan 112,658 NT (Average earnings per month_Physician); 35,461 NT (Average earnings per month_Professional Nurse)

Norway 58,059 Krone(Average earnings per month_Physician) ; 32,214 Krone(Average earnings per month_Professional Nurse)

Physician vs Nurse 3.17(Taiwan); 1.80(Norway)

Source: The Labour Statistics Database of the International Labor Organization (1999-2008).

Moreover, since our previous study found that the overall and cause-specific SMRs (Standardized Mortality Ratios) of doctors of all different specialties in Taiwan were generally less than 0.30-0.34 in comparison with the general population (Reference # 11, Shang TF, et al. Mortality of Doctors in Taiwan, 1990-2006. Occup Med (Lond) 2011;61(1):29-32. in the manuscript), it would be very difficult for us to choose a much less confounded occupation as the referents for comparison. In fact, we have tried to adopt school teachers, professors, or other health professionals as the reference population. However, doctors could keep on practice without retirement in Taiwan due to our culture and the system of health care, which is dominated by private sectors (85% of the hospitals and 97% of the clinics) and no age limit in the reimbursement policy of the National Health Insurance. Thus, doctors often practice until a very old age, even up to 70-80 years old, while all other professional groups are required to retire before the age of 65-70 and their names are usually removed from the registries after retirement. The comparability of information would be a big problem and difficult to be tackled. To prevent potential confounding by different socioeconomic status profession-related knowledge, health-related behaviour and different ages of retirement, we decided to use “internal comparison”, namely, selecting internists who are of the biggest size as the reference population for SMR calculation in this study, instead of other segments of population. And time after practice is also considered as a risk factor to replace age because of co-linearity in the model construction. Thus, we have revised several sentences in the manuscript, as follows: (Please see page 11, ll. 9-14)

(Table 4). Because doctors in Taiwan generally have higher earnings than all other segments of professionals and there is no upper limit of retirement age, we have decided to select “internal comparisons” among doctors with the same socioeconomic status, profession-related knowledge and health-related behaviour, to prevent confounding and would leave the effects of mortality to the other two main factors, occupational workload or practice environment.

Comment # 4-1
Out-patient settings: Half of the doctor population in this study is categorized as internists. Since none of the categories are called family medicine or general practice, I assume that some of the internists are in effect general practitioners working outside hospitals, but such information is not given. One should think that ”patient load”, or doctor to population ratio, as a possible confounding variable for stress etc., is more important for doctors in outpatient settings? More information on the work pattern for doctors in Taiwan is needed! (See also point 5 below)

RESPONSE:Thanks for the constructive comment. In Taiwan, traditionally the family medicine (family doctor) or general practitioners used to be under the name of general medicine, which have been included in the internists group. In fact, we have a table detailing the definition for different specialties in our previous paper (Reference # 11, Shang TF, et al. Mortality of Doctors in Taiwan, 1990-2006. Occup Med (Lond) 2011;61(1):29-32. in the manuscript), which is shown as below for clarification:

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: Orthopaedics surgery,
ANAESTHESIOLOGISTS: Anaesthetics.

In addition to this above clarification, we also add Reference # 11in the “Methods” section as follows: (Please see page 6, ll. 6-9)

for verification of credentials of all practicing doctors. It contains the name of each individual, date and place of birth, gender, national identification number, medical school attended, date of graduation, self-designated specialty11, place of practice, vital status, date of death for decedents, and date of ceasing the membership. The cohort

Comment # 4-2
Doctor mobility: In this study the present working location (by region) for each doctor is used as a predictor for mortality. In my own country doctors move around quite a bit, mainly from rural to urban areas, but also from urban to rural. The analyses in this study presuppose no such movements – is this realistic? And linked to this argument, why do some doctors choose rural and other urban areas, or different geographical locations in general? Can such reasons be causes of variation in health and mortality?

RESPONSE: Again, thank you for the comment. The retrospective cohort was established from the registry of the doctor file maintained by TMA (Taiwan Medical Association). The registry has been required by the governmental regulation for verification of credentials of all practicing doctors. The data shows the latest status only on the date of December 31, 2006, or on the date of deceased or termination of membership.
As I mentioned in one of the earlier responses, the health care system of Taiwan is dominated by private sectors (85% of the hospitals and 97% of the clinics) and doctors have been allowed to select practicing location freely and enjoy a higher income by the universal coverage of compulsory national health insurance. While there may be moving of practicing locations, most doctors usually stay in a location for a long time because it generally takes several years to develop his/her regular clients in a community. However, we appreciate this comment and make following revision in the “Discussion” section as our response to the comment # 1: (Please see page 13, ll. 7-11)

clarification. Secondly, information was limited by the hospital level and the locations which the doctor has 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.

Comment # 4-3
Cohort and age: A distinction is made between the doctors who started their practice before and after 1995, respectively. We are told that in 1995 a National Health Insurance System was implemented, and that the younger doctors, because of this (?), ”might possibly suffer from highly stressed work during their practice” (page 11). The meaning of this is unclear: didn’t also the older doctors, at least those still in practice, have to comply with the new insurance system? Also, ”age for beginning

practice" is used as the general age variable in the models. Why not use biological age?

RESPONSE:Thank you for your comment. Yes, both young and old doctors have been influenced by the establishment of the National Health Insurance program. However, most older doctors have already established their community practice, while young doctors would be more likely to have a higher stress during the initial stage of developing his/her clients in a community. Moreover, the cohort in our study was established during 1990-2006, which may have selected healthy survivors among the older doctor group in this registry.
The statistical analysis shows that the practicing duration is highly collinear to the biological age (i.e. age at censoring in the study). We chose the latter to be included in the final model, because there is no upper limit of retirement for doctors in Taiwan and doctors who are still practicing are generally healthier than those who retired. Moreover, the use of practicing time can be a more accurate measurement of workload and/or occupational exposure in terms of duration.
In our study, years of beginning practice were used as independent variables to control the potential confounding from a specific group. This group consists of doctors who practiced at an older age experienced higher HR of mortality. Most of them are veteran doctors who took ad-hoc medical mission during the world II and did not receive an academic medical education. Following your constructive advice, we have added this information in the Methods section to clarify for our future readers, as follows: (Please see page 7, ll. 19-23)

beginning practice, and doctor to population ratio. In Taiwan, some of our doctors were veteran who took ad-hoc medical missions during the world II and did not receive an academic medical education. They generally began their practices at an age older than most other doctors and deserved for this study to control as a potential confounder. We applied the stepwise strategy for variable selection with the

Comment # 4-4
Why are anesthesiologists always singled out? I am aware that there may exists an impression internationally that anesthesiologists have a higher mortality than other medical specialists, although the documentation for this is not very convincing (see e.g. the special issue of Acta Anaesthiol Scand from 2002 on this topic (p. 1183 ff)). The quote from Bruce et al. (# 17) describing "the hazards of operation rooms" is 44 years old and hardly relevant today. I can not see the rationale for tabulating the 16 deaths among anesthesiologists across a large number of causes, as in table 3. Also, even if I understand that another publication (# 11) may have tabulated the differeneces between doctors and the general population in causes of death, I miss some of these comparative data in the present paper.

RESPONSE: Thanks. Although we had some hypotheses in mind before this study, the condition in Taiwan might not necessarily be the same as previous reports. Thus, we used the national cohort data to analyze the mortality risks or hazard ratios (HRs) for all formally registered specialties tabulated above (response to the comment # 4-1), including radiologists, pathologists, psychiatrists, dentists, surgeon and anesthesiologists, etc. And we consistently detected significantly increased HRs for surgeons and anesthesiologists. Hence, we would like to know whether any specific diseases would happen among these two specialties who were well known to be exposed to the hazards of operation rooms and the results have been showed in Table 3.

Comment # 4-5
Internists as reference: The large – and possibly quite heterogeneous – group of internists is used as reference throughout the paper. Is this optimal? Wouldn't the contrasts be clearer if one of the smaller more homogeneous groups were used, e.g. the surgeons? And where are the family doctors?

RESPONSE: Thank you again for your comment. To achieve maximal statistical efficiency, we had better select a reference group with a sufficient size of subjects and take the advantage of employing the software of Life Table Analysis System (LTAS) produced by the U.S. NIOSH (National Institute of Occupational Safety and Health) to calculate the standardized mortality ratios (SMRs). This software tabulates the underlying causes of death as well as the person-year of follow-up into age-, gender-, and race-specific strata. Therefore, since there are 18,664 internists as contrast to 4,571 surgeons, we use the largest number of referents to detect potential hazards for other subspecialties, as our study in the reference No. 11 has indicated that there were small variations of SMR's among different specialties of doctors. Please also kindly refer to the table included in our response to the Comment # 4-1 for the definitions of family doctors (family medicine), general practitioners, or general medicine in Taiwan.

VERSION 2 – REVIEW

REVIEWER	Olaf Gjerløw Aasland Director, The Research Institute of The Norwegian Medical Association, Professor, Institute of Health and Society, Depertment of Health Management and Health Economics, University of Oslo, Norway No conflicts of interest
REVIEW RETURNED	17/01/2012

GENERAL COMMENTS	The authors have argued well on all my intervention points, and I realise that their data do not allow for some of the changes I suggested earlier (e.g. migration). I have two points though: 1) They choose to keep the large group of internal medicine doctors as the reference in their statistical models, the argument for this being htat this is the largest group. However, it is clear from other comments that this is also a very heterogeneous group, so I still maintain that it might be better to use a more homogeneous group for reference, alternatively to choose another contrast function. 2) I still have problems with understanding how the Taiwanese doctors work in relation to hospitals; are all doctors affiliated with hospitals? Don't you have any "real" general practitioners who only work only in their own "surgery" (to use the UK-expression)? And if so, isn't this a group that should be identified in the statistical modelling?

VERSION 2 – AUTHOR RESPONSE

For Reviewer

Comment # 1
They choose to keep the large group of internal medicine doctors as the reference in their statistical models, the argument for this being htat this is the largest group. However, it is clear from other comments that this is also a very heterogeneous group, so I still maintain that it might be better to use a more homogeneous group for reference, alternatively to choose another contrast function.

Response: Thanks for your comments. We have followed your advice and decided to use a more homogeneous group, surgeons, as the referent alternatively in the Cox regression model. The results appear the same (i.e., all hazard ratios of covariates except those of specialties) and summarized in the following table:

Table. Hazard ratios with 95% CI (confidence interval) estimated through Cox regression model to control relevant risk factors on mortality among Taiwan doctors 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
Internist / Surgeon 0.81 0.69-0.96
Dermatologist / Surgeon 0.97 0.67-1.40
Otolaryngologist / Surgeon 0.69 0.49-0.96
Ophthalmologist / Surgeon 0.59 0.42-0.83
Pathologist/ Surgeon 0.65 0.27-1.59
Pediatrician / Surgeon 0.74 0.54-1.01
Psychiatrist / Surgeon 0.65 0.41-1.03
Radiologist / Surgeon 0.71 0.43-1.15
Obstetrician / Surgeon 0.97 0.74-1.26
Orthopedist / Surgeon 0.61 0.35-1.05
Anesthesiologists/ Surgeon 1.60 0.96-2.69
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
Doctor-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

Please kindly see the revised 1st paragraph of the Discussion section, as follows: (Please see page 11, ll. 9-17)

(Table 4). Because doctors in Taiwan generally have higher earnings than all other segments of professionals and there is no upper limit of retirement age, we have decided to select “internal comparisons” among doctors with the same socioeconomic status, profession-related knowledge and health-related behaviour, to prevent confounding and would leave the effects of mortality to the other two main factors, occupational workload or practice environment. In additional to internists, we have tried to use surgeons as a possibly more homogeneous reference group and the hazard ratios of all covariates are the same except those of specialties, demonstrating a robust result for our inference.
Comment # 2
I still have problems with understanding how the Taiwanese doctors work in relation to hospitals; are all doctors affiliated with hospitals? Don't you have any "real" general practitioners who only work only in their own "surgery" (to use the UK-expression)? And if so, isn't this a group that should be identified

in the statistical modelling?

Response: Again, thanks for your comment. Since 1995, Taiwan has implemented mandatory universal health insurance program with a single-payer system. Bureau of national health insurance only contracts with hospitals or clinics and doctors were only allowed to practice at one contracted hospital or run a private clinic. That is a closed system and it comes up with the lowest administration cost of health care in the world (at less than 2% of the total premium). Generally, surgeons as well as anesthesiologists in Taiwan must choose hospital as a workplace to perform major operations, rather than own a clinic. In other words, we do not have general practitioners who can undertake major operations outside hospitals. And family doctors or general practitioners in Taiwan usually open their clinics after their residency training in hospitals and they are included in the internists group.
As my response to your first comment, I have re-run the statistical analysis with surgeons as a more homogeneous reference group and the results appear the same.