Author’s response to reviews

**Title:** When the patient is a physician, more magnetic resonance imaging is used: a population-based cohort study in Taiwan

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**Version:** 2  **Date:** 14 April 2013

**Author’s response to reviews:** see over
April 14, 2013

Dr. Natalie Pafitis  
Executive Editor  
BMC Health Services Research  

Dear Dr. Pafitis,

We would like to resubmit our manuscript, entitled “When the patient is a physician, more magnetic resonance imaging is used: a population-based cohort study in Taiwan,” for publication in *BMC Health Services Research*. The manuscript was previously submitted as MS: 1528480730803390 (“Physician patients utilize more advanced radiology services than non-physician patients: a population-based cohort study”). We have revised the paper according to the reviewers’ comments (please see our response to the reviewers following this cover letter) and feel that the revisions substantially address the reviewers’ concerns.

Advances in radiology technology have contributed to a substantial increase in utilization of radiology services. In many previous studies exploring the rise in the utilization of radiology procedures, the role of physicians as providers has been investigated. In this study, we explored the role of physicians as patients and consumers. Physicians would be expected to be more knowledgeable than the general population about the use and misuse of radiological services. Thus, we conducted a study to analyze the utilization of radiology modalities among physician and non-physician patients. Differences in utilization rates of various radiology procedures between physicians and general adults may provide useful insights in defining the appropriate use of radiology services.

The manuscript comprises original, unpublished materials and is not under consideration for publication elsewhere, and the study has been subjected to appropriate ethical review. All authors participated in study conception and design, acquisition of data, data analysis and interpretation, and drafting and revising of the article. We declare that we have no conflicts of interest in connection with this paper. All authors have read and approved the manuscript to be published. We had full access to all data in the study and take full responsibility for the integrity and accuracy of the data analyzed.

Sincerely,

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Response to Reviewer 1: Dr. Oke Gerke

1. Is the question posed by the authors well defined?
I did not find the title self-explanatory enough (see comment no. 8 below). From the title I could not see what the paper is about. In the background section the research question is posed, but it is completely unclear to me why the utilization of radiology modalities should differ between ‘physician patients’ and ‘non-physician patients’? Isn’t the degree of sophistication and number of modalities applied in a patient still the call of the treating physician? How much influence does the individual patient have in order to wish for more and more sophisticated diagnostic procedures? The same applies to the discussion section where lower barriers for the use of more sophisticated methods are named. Could the conclusion of the study (partly) very well also be that physicians ‘fear’/respect colleagues more than ‘average’ (non-medical) patients? In order to prevent critics from their own peers, a tendency to use more advanced technologies like CT and MRI was observed more often in physicians (being patients) than in patients with other professions.

Recommendation (MajCR): Explain in the introduction why profession could make a difference when it comes down to physicians. How much influence does the individual patient have with respect to number and sophistication of (expensive) examinations?

Answer: Thank you for these comments. We have added the following to the Discussion: ‘Physicians’ care-seeking behavior, ranging from self-care to informal consultation, is an interesting topic that has been discussed in several studies. Physicians appear to be low users of formal services overall but high users of preventive care [23]. For example, the cesarean delivery rate is lower among physicians and their relatives, who may have greater access to medical knowledge [24], and the perforation risk of acute appendicitis is significantly lower among physicians than among general adults [25]. In addition, previous findings have indicated that physicians may treat their peers differently than their other patients, perhaps because the treating physicians feel pressure from these informed patients [26, 27]. On the other hand, they may also face greater medical scrutiny from their fellow doctors if treatments of questionable medical value are recommended [26,27]. The care-seeking behavior and utilization patterns of radiological services of physicians, medically savvy consumers who are familiar with the health care system, may provide useful insights into defining the appropriate use and quality of health care’ (page 13, paragraph 2, lines 1–13).

2. Are the methods appropriate and well described?
a)Yes. The section on ‘Statistical Analysis’ can though be sharpened by adding that incidence rates are compared.

Recommendation (MinER): Replace ‘The utilization rates of each modality between the two groups were compared.’ By ‘The utilization rates per modality were measured as number of applications per 1000 person-years, and the utilization rates of each modality were compared between the two groups.’

Answer: In accordance with your suggestion, we have replaced “The utilization rates of each modality between the two groups were compared” in the Methods with “The utilization rates of each modality were measured as the number of procedures per 1,000 person-years throughout the time period from 1997 to 2008” (page 9, paragraph 1, lines 10-12).

b) Though the design is fine and comparability of groups sought for to a satisfactory extent, the question arises whether the differences seen may, to some extent, stem from the huge difference in sizes of groups (physicians: N=1686, non-physicians: N=81627).

Recommendation (DR): ‘Nearest neighbour matching’ of 1686 non-physicians to the 1686
physicians (by means of propensity score techniques, using demographic variables like those from Table 1) and analyzing these 1686 ‘cases’ and 1686 ‘controls’ as a matched case-control study would give insight into the robustness of results seen (sensitivity analysis).

**Answer:** Following your thoughtful suggestion, we have used propensity score matching to select physician and non-physician patients for comparison. We have added the following to the Methods: “Although comparability of the groups was sought to a satisfactory extent, the question remained of whether any differences between groups might be caused by the huge difference in group sizes. Therefore, nearest-neighbor matching of 1,686 non-physicians to the 1,686 physicians was performed by propensity score technique [12]” (page 8, paragraph 2, line 1–4) and “Propensity score techniques with nearest-neighbor matching using the demographic variables of age, gender, major diseases, urbanicity and residential regions were used to select the post-matched controls [12]” (page 9, paragraph 2, lines 1–3).

c) Accuracy of p-values below 0.001 (all tables): Regarding decimals for p-values is the usual practice to use 2 decimals for p>=0.01, 3 decimals for 0.001<=p<0.01, and 4 decimals for 0.0001<=p<0.001 (e.g. p=0.0005). If p is smaller than 0.0001 use ‘p<0.0001’.

**Recommendation (MinER):** Replace ‘p<0.001’ by actual p-values when 0.0001<=p<0.001 or by ‘p<0.0001’ if the latter the case.

**Answer:** Thank you for this comment. However, Stata 10 (Stata Corporation, College Station, TX, USA) the software we used to perform statistical analyses, shows the p value results for chi-square tests and logistic regression with 3 decimals. In addition, according to the *Publication Manual of the American Psychological Association* (6th ed.), “significance levels in journal articles—especially in tables—are often reported as either ‘p > .05,’ ‘p < .05,’ ‘p < .01,’ or ‘p < .001.’ APA style dictates reporting the exact p value within the text of a manuscript (unless the p value is less than .001).” We have therefore shown exact p values only when p > 0.001 in showing our results.

### 3. Are the data sound?

Yes. The data material is comprehensive and most likely complete for the time period under investigation. Possible false classifications of some physicians as non-physicians do lead to an under-estimation of the true differences between the groups, as the authors also point out. Comparability of groups is sought for by adjusting the inclusion criteria for the group of nonphysicians (age, income).

### 4. Does the manuscript adhere to the relevant standards for reporting and data deposition?

Yes.

**Answer:** Thank you for the above comments.

### 5. Are the discussion and conclusions well balanced and adequately supported by the data?

Yes, but the discussion section seems a bit too long.

**Recommendation (MinER):** The discussion section would benefit from reducing its length by focusing on discussing your findings (without repeating them) in light of others may (or not may) have found earlier.

**Answer:** In accordance with your suggestion, we have reduced the overall length of the Discussion. We have also added, “The rapid increase in use of CT and MRI in recent years is regarded as one of the factors responsible for growing medical costs [4]. Increases in supply-side factors have been observed to significantly increase CT and MRI utilization [14], while physician and hospital characteristics have also been shown to be associated with repeated use of CT and MRI [15, 16]. However, when the physician becomes the consumer and not the provider, the
complex role of the physician as agent between insurers and patients no longer exists [17]”(page 12, paragraph 1, line 2-8) and “Compared to CT, MRI is relatively safe and free of radiation exposure characteristics [18-20], and MRI can offer a definitive diagnosis faster (thereby leading to earlier treatment) than less advanced modalities like X-rays and sonography” (page 12, paragraph 2, lines 6-9).

6. Are limitations of the work clearly stated?
Yes.

7. Do the authors clearly acknowledge any work upon which they are building, both published and unpublished?
Citations in the discussion section seem to largely refer to general aspects of safety in the application of radiologic examination procedures (e.g. 14-18). This study discusses issues of health inequity (or health inequality) as physicians demonstrated another utilization pattern than nonphysicians.

**Recommendation (MajCR):** Add a statement as to which degree health inequity in Taiwan was subjected to published literature before. If evidence is scarce, say so.

**Answer:** Thank you for this suggestion. We have added the following to the Discussion: ‘Physicians’ care-seeking behavior, ranging from self-care to informal consultation, is an interesting topic that has been discussed in several studies. Physicians appear to be low users of formal services overall but high users of preventive care [23]. For example, the cesarean delivery rate is lower among physicians and their relatives, who may have greater access to medical knowledge [24], and the perforation risk of acute appendicitis is significantly lower among physicians than among general adults [25] (page 13, paragraph 2, line 1-6).

8. Do the title and abstract accurately convey what has been found?
The title uses the terms ‘physician patients’ and ‘non-physician patients’ and the abstract names the utilization patterns of radiology modalities of these (without explaining what is meant by these two groups). It did not become clear to me until reading the introduction who the two groups are and, therefore, what the paper targets. Title and abstract shall spark interest in reading the paper. I had difficulties in interpreting the title when seen the first time.

**Recommendation (MajCR):** Make the title self-explaining, e.g. ‘When the patient is a physician, more magnetic resonance imaging is used: a population-based cohort study in Taiwan.’

**Answer:** We have changed the title, as suggested, to “When the patient is a physician, more advanced radiology services are used - a population-based cohort study in Taiwan.”

9. Is the writing acceptable?
Yes, but there are single occasions of spelling and grammar errors, e.g.
- p3, abstract, background: ‘Whether there are different utilization patterns of radiology modalities IN physicians and non-physicians…’
- p4, abstract, conclusions: ‘Physicians, especially THOSE without major diseases,…’
- p14: Modify ‘Stratified by Coexisting with or without Major Diseases’, e.g. ‘Stratified by coexistence of major diseases (yes/no)’ or ‘Stratified by coexisting major diseases (yes/no)’
- p18: ‘The physicians as patients play much roles of decision maker than other patients.’ – grammar wrong, can’t understand the sentence. Do you mean ‘The physicians play as patients a stronger role as decision maker than other patients with other professions.’?
- p19: ‘However, this misclassification bias would only underestimate our findings and lead
to the results here being more conservative than reality.’ Last phrase: ‘than they really are’, for instance.

**Recommendation (MinER):** Have the final revision cross-checked by a native speaker. I am not an English native speaker myself, so please do not consider above list of spelling and grammatical errors to be complete

**Answer:** We have followed your suggestion and have corrected the spelling and grammatical errors and had the manuscript edited for English usage.

**10. Other comments?**

**Recommendation (MinER):** Key words: use more general ‘profession’ instead of physician (which already appears in the title and does therefore not be named again as key word). Add ‘CT’ and ‘MRI’.

**Answer:** We have removed “physician” from the list of keywords and have added “profession,” “CT,” and “MRI.” Thank you for all of your valuable suggestions.

**Response to Reviewer 2: Dr. Evelina Pappa**

**Major Compulsory Revisions**

The aim of this study was to evaluate whether the different utilization patterns among physician patients and no physician patients is determined by the medical knowledge of the physician patients.

1. The theoretical background is underdeveloped. The use of radiology services and the huge increase in past decades have significant influence on health care cost, quality of health care and health status. The issue of utilization of radiology services could have been developed within the broader frame of the factors which according to the literature affect the use.

**Answer:** Thank you for this comment. In response, we have added a broader discussion of factors that, according to the literature, affect the use of radiology procedures. Specifically, we added “The large increase in use of radiology services in recent decades has had a significant influence on health care costs, quality of health care and individual health status” in the Background (page 5, paragraph 2, lines 1–2), “The utilization trends of radiology services among physicians and the comparison groups are shown in Figure 1” in the Results (page 10, paragraph 2, lines 1–2), and “Increases in supply-side factors have been observed to significantly increase CT and MRI utilization [14], while physician and hospital characteristics have also been shown to be associated with repeated use of CT and MRI [15, 16]” in the Discussion (page 12, paragraph 1, lines 3-6).

2. The scope of the study is insufficient and scientifically unsound. There are many factors that determine the use of radiology services concerning the provision side (i.e. access to radiology services, the referring physician e.t.c) and the demand side (i.e patients expectations e.t.c.). Authors used the occupation of the patients (physician or not) as the survey question with sex, age, major diseases, urbanicity and residential regions as control variables. I think that this hypothesis is very weak.

**Answer:** We agree that there are many factors on both the provider and demand sides that determine the use of radiology services. Therefore, we have added the following to the Discussion: “Increases in supply-side factors have been observed to significantly increase CT and MRI utilization [14], while physician and hospital characteristics have also been shown to be associated with repeated use of CT and MRI [15, 16]. However, when the physician becomes the consumer and not the provider, the complex role of the physician as agent between insurers and patients no longer exists [17]” (page 12, paragraph 1, lines 3-8) and “In addition, previous
findings have indicated that physicians may treat their peers differently than their other patients, perhaps because the treating physicians feel pressure from these informed patients [26, 27]. On the other hand, they may also face greater medical scrutiny from their fellow doctors if treatments of questionable medical value are recommended [26,27]” (page 13, paragraph 2, lines 6–10).

3. Authors stated that there is no referral system and patients have free choice of physician which means that patients choose the physician who will prescribe to them tests and other services. Referring physician has a central role in how radiology services used and the interaction with patients who are also physicians worth investigation. Results showed that physician patients used more CT and MRI services than no physician patients. Is it only the medical knowledge of the physician patients (indeed is an interesting element) that explains the above different utilization pattern? Whether physician patients have better access to radiology services (they are inside the health system as providers) or can persuade the (colleague) referring physician to prescribe an imaging test? And what could mean something like that for the health system?

**Answer:** Thank you for these thoughtful comments. In response, we have enhanced the Discussion by adding the following: “Medical knowledge, familiarity with the health care system, and better patient-doctor communication may have been the contributory factors for the preference of MRI among physicians [21, 22]” (page 12, paragraph 2, lines 9-11) and “Physicians’ care-seeking behavior, ranging from self-care to informal consultation, is an interesting topic that has been discussed in several studies. Physicians appear to be low users of formal services overall but high users of preventive care [23]. For example, the cesarean delivery rate is lower among physicians and their relatives, who may have greater access to medical knowledge [24], and the perforation risk of acute appendicitis is significantly lower among physicians than among general adults [25]. In addition, previous findings have indicated that physicians may treat their peers differently than their other patients, perhaps because the treating physicians feel pressure from these informed patients [26, 27]. On the other hand, they may also face greater medical scrutiny from their fellow doctors if treatments of questionable medical value are recommended [26,27]. The care-seeking behavior and utilization patterns of radiological services of physicians, medically savvy consumers who are familiar with the health care system, may provide useful insights into defining the appropriate use and quality of health care” (page 13, paragraph 2, lines 1–13).

4. A brief description of how radiology services are organized and provided in Taiwan is necessary.

**Answer:** We have followed this suggestion and have added to the Introduction, “Under NHI, patients have unlimited free choice of physicians and health care facilities. There is no mandated physician referral system or coordinated system of health care delivery in Taiwan. Every physician in charge has the right to prescribe radiological examinations” (page 5, paragraph 3, lines 9–10 to page 6, paragraph 1, line 1-2).

5. No data about the utilization trends of radiology services are provided. It is very important to see the extent of increase in imaging tests and other interventional procedures during the study period 1997-2008.

**Answer:** Thank you for this comment. We have added Figure 1, which shows the utilization trends of the seven types of radiology services from 1997 to 2008.

6. Another significant factor which needs investigation is whether the utilization of radiology services differs between the two settings: ambulatory care and inpatient care.

**Answer:** In accordance with your suggestion, we have further analyzed the utilization of
radiology services in ambulatory care and inpatient care settings; these results are presented in Table 2 (page 22).

7. I am confused with table 1. According to the authors, the total sample for the study period 1997-2008 was 1686 physician patients and 81627 no physician patients. Authors also state that “the characteristics of the study sample in 1997 are showed in table 1” But table 1 presents the total sample. This seems contradictory.

**Answer:** Since we conducted a cohort study from 1997–2008, Table 1 presents the baseline characteristics of this cohort in 1997. To avoid confusion, we have revised the reference to the table in the Results as “Table 1 shows the baseline characteristics of the 1,686 physicians and the comparison groups of 81,627 pre-matched and 1,686 post-matched samples” (page 10, paragraph 1, lines 1–2) and the Table 1 title to “Baseline characteristics of physicians and comparison groups” (page 20).

8. In Discussion, the first paragraph is better to Introduction.

**Answer:** We agree with this comment and have moved the first paragraph of the Discussion, about the National Health Insurance program in Taiwan, to the Background (page 5, paragraph 3, lines 1–10 to page 6, paragraph 1, lines 1–2).

9. Table 5 showed that differences in CT and MRI tests existed between physician and no physician patients with no major diseases. In Discussion, authors said that these results revealed that physician patients might be more alert and prefer to get more information from radiology services. There is another perspective. Whether this differential use implies a misuse or overuse of radiology services by physician patients?

**Answer:** Thank you for this helpful comment. We agree with the possibility you raise and have added the following to the Discussion: “Additionally, differences in use of radiology modalities between physicians and non-physicians may occur because physician patients are more knowledgeable about their illnesses and prefer to receive detailed information from radiology services departments, but the differences may also reflect misuse or overuse of radiology services by physician patients. It is a limitation of our study that we cannot make this differentiation because of a lack of information on participants’ decision-making processes and because no objective measure has been developed of the value of radiology modalities in improving health” (page 12, paragraph 2, lines 11–16 to page 13, paragraph 1, line 1-2). We also now write in the Discussion, “Second, as previously mentioned, this study might suffer from certain inherent limitations because of the use of administrative data, which do not provide information on the reasons why radiology modalities were chosen. Third, it is impossible to determine from our results whether the utilization of radiology modalities of the physicians or non-physicians represents more appropriate care, because there is no objective measure of the value of radiology modalities in improving health” (page 13, paragraph 3, lines 5-10 to page 14, paragraph 1, line 1).