

Bibliometric Analysis of Nursing Research in Taiwan 1991–2004

Ya-Li Huang • Yuh-Shan Ho* • Kun-Yang Chuang*

ABSTRACT: This study examined nursing research performance in Taiwan from 1991 to 2004 by conducting bibliometric analysis of papers published by researchers affiliated with nursing institutes in Taiwan. Bibliometric information of papers that were published between 1991 and 2004 and had contact address including the words “Taiwan”, and “nursing” were downloaded from the ISI Web of Knowledge website. The information used for this research included number of papers, number of authors, number of references listed, impact factors of publishing journals, times cited, and whether the paper was written through international or domestic collaboration. The information was coded and tabulated. Bibliometric characteristics were compared between 1995–1999 and 2000–2004. Furthermore, an exponential model was fitted to show the past growth trend in research outputs. The results showed that there was a significant growth in quantity of papers from 1991 to 2004. In general, recent papers had averaged more authors, more domestic collaboration, more international collaboration, higher impact factors, and more references listed than earlier papers. Papers written with collaboration tended to have a higher average number of authors and more references listed, and tended to be published in journals with higher impact factors. The exponential model proved to be in good fit with the past growth pattern. The authors speculate that the recent increase in research collaboration, both internationally and domestically, may have contributed to the significant increase in output. It is not clear whether the growth in quantity of papers will continue or for how long. Based on past data, however, no sign of leveling off has been observed. More research is needed to understand what societal and individual level factors were involved in fueling such a dramatic increase in quantity in the last decade. Furthermore, as the quantity of papers has increased steadily, more focus can be placed on improving the quality of research papers.

Key Words: bibliometric, nursing, Taiwan.

Introduction

The increase in the number of scientific papers published in Taiwan in the past few years has been startling (Swinbanks, Nathan, & Triendl, 1997). Output papers in the Science Citation Index (SCI) leapt from just over 3,242 papers in 1991 to 12,392 in 2003 (National Science Council, 1995; National Science Council, 2004). Growing investment in science and technology by government and financial incentives tied to SCI publications have probably

contributed to such a dramatic increase in scientific papers (Swinbanks et al., 1997). While the overall increase in quantity has been noticed, few bibliometric studies have been conducted to identify the pattern of increase in research paper output in Taiwan. Bibliometric data has been used to describe and evaluate countries (Bonitz, Bruckner, & Scharnhorst, 1997; Braun, Glanzel, & Grupp, 1995; Cami, Sunen-Pinol, & Mendez-Vasquez, 2005; Ramos, Gutierrez, Masia, & Martin-Hidalgo, 2004), universities (Colman, Dhillon, & Coulthard, 1995), research institutes

MS, Instructor, Division of Public Health, School of Medicine, Taipei Medical University; *PhD, Assistant Professor, Department of Public Health.

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Address correspondence to: Kun-Yang Chuang, No. 250, Wu-Hsing St., Taipei 11031, Taiwan, ROC.

Tel: 886(2)2736-1661 ext. 6522; Fax: 886(2)2738-4831; E-mail: adinma@tmu.edu.tw

(Roy, 2004; Ugolini, Parodi, & Santi, 1997), journals (Arkhipov, 1999; Budilova, Drogalina, & Teriokhin, 1997), specific research topics (Ho, Chiu, Tseng, & Chiu, 2003), and specific disciplines (Beattie et al., 2004; Braun et al., 1995; Kim, 2001). It has also been used to identify factors associated with research performance (Sommer, 2005).

Thus, the purpose of this research is to provide a bibliometric analysis of nursing research from 1991 to 2004 in Taiwan. It aims to describe number of articles published, type of authorship, number of references listed, impact factor of journals publishing the articles, and collaboration patterns. Hopefully, this research will provide some additional insights into the current state of nursing research in Taiwan, and provide some basis for future projection.

Methods

Data used in this paper was obtained from three databases in the online version of ISI web of science: SCI (Science Citation Index), SSCI (Social Science Citation Index), and A & HCI (Arts & Humanity Citation Index). Downloaded information included names of authors, contact address, title and year of publication, keywords, year of publication, times cited, name of journal publishing the article, and publisher information. All publications listed in the three databases from year 1991 to year 2005 that had "Taiwan" and "nursing" in their contact addresses were downloaded. This would include all articles published by researchers in academic nursing institutes, professional nursing associations, and nursing departments in health care organizations, such as hospitals or nursing homes. A total of 1,166 publications met the criteria of selection. However, the criteria used would also include articles published by a nursing institute in another country which was in collaboration with a non-nursing institute in Taiwan. Furthermore, publications produced by a non-nursing department in a nursing institute would also be downloaded. Thus, all articles were screened manually and 225 articles that were found to be ineligible were excluded from the analysis.

Content analyses of the bibliometric information were carried out by a trained coder. While some bibliometric

information can be downloaded directly from the ISI website, some information needed to be coded manually. Information that can be downloaded directly were numbers of references (REF) listed in the article, and total times cited (TC) by other articles in the ISI database. Numbers of authors (AU) were counted. Impact factors (IF) of the journals publishing these articles were also coded manually based on the 2004 impact factor which was not published until 2005. IF in 2004 was defined as the average number of times cited in 2004 attributed to articles published in 2002 and 2003. For example, an IF of 2 for a journal would mean that papers published in this journal in year 2002 and 2003 would on the average be cited twice in year 2004. Contact addresses were used to verify whether the first or the corresponding author were from the nursing discipline. If the contact address was an academic nursing institute, a nursing professional association, or a nursing division within a health care organization, then it was assumed that the author was from the nursing discipline. Whether an article was written with international collaboration (IC) or domestic collaboration (DC) was also verified through the contact addresses of authors. If the contact address included two or more organizations in Taiwan, it was coded as having domestic collaboration. If the contact address included a foreign address, it was coded as having international collaboration.

Results

A total of 1,166 publications were downloaded from the ISI Web of Knowledge website, but only 941 publications met the selection criteria. There were 834 articles, 7 reviews, 42 letters, and 45 meeting abstracts. The remaining publications were book reviews, notes, corrections, and editorial materials. Among the 834 research articles, 23 (2.76%) were published before 1995, 142 (17.02%) were published from 1995 to 1999, and 669 (80.22%) were published after 2000. The average AU, REF, TC, and IF for the 834 articles were 4.53, 29.41, 3.02, and 1.584 respectively. About 149 (17.9%) articles were written through international collaboration and 549 (65.8%) articles were written through domestic collaboration.

Of the 834 research articles, 359 (43.05%) had a corresponding author or a first author affiliated with an aca-

demic nursing institute, a nursing association, or a nursing department in a hospital. Among the 359 articles, 6 (1.67%) were published before 1995, 66 (18.38%) were published between 1995 and 1999, and 287 (79.94%) were published after 2000. The average AU, REF, TC, and IF for the 359 articles were 3.38, 30.60, 2.33, and 1.157 respectively. Among them, only about 74 (20.60%) had international collaboration, while 50.42% had domestic collaboration.

Table 1 compares bibliometric characteristics of articles published between 1995 and 1999 to articles published between 2000 and 2004. Data was presented for all articles and for articles with a first or corresponding author from a nursing-affiliated institute. Due to the small number of articles published before 1995, they were not included in the table. Looking at all articles, those published in the 2000–2004 period had higher AU, REF, and IF. The percentage of papers with IC decreased while the percentage with DC increased. Articles published in the later period also had averaged fewer TC. However, this is probably due to the shorter length of time since their publication. Articles with a first or corresponding author from a nursing-affiliated institute showed similar trends except for IC. Contrary to the overall trend, the percentage of such papers written through international collaboration increased from 15.2% to 22.0%.

Compared to the trends for all articles, articles with first author or corresponding author from a nursing-affiliated institute in general had fewer authors, smaller impact factor, and fewer times being cited, but listed more references. They also had a higher percentage of papers written through international collaboration, but had a

smaller percentage of papers written through domestic collaborations.

Table 2 compared bibliometric characteristics of papers written through different types of collaboration, namely IC, DC, and those written with no collaboration

Table 1.
Comparison of Bibliometric Characteristics of Papers Published in 1995–1999 and 2000–2004.

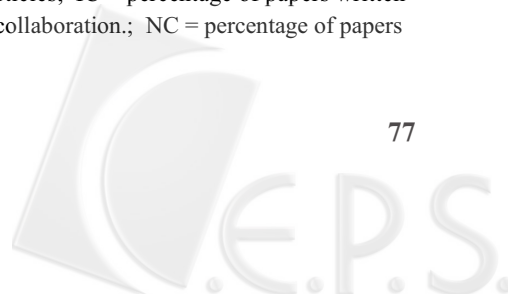
Bibliometric characteristics	Period	
	1995–1999	2000–2004
All Articles		
NP	142	669
AU	4.3	4.6
REF	26.6	30.0
TC	6.1	1.9
IF	1.3	1.6
IC	18.3	17.9
DC	58.5	66.5
First or Correspondence Authored Articles		
NP	66	287
AU	3.3	3.4
REF	26.4	31.8
TC	5.3	1.6
IF	1.0	1.2
IC	15.2	22.0
DC	45.5	50.9

Note. NP = number of papers; AU = average number of authors per paper; REF = average number of references listed in paper; TC = average times cited by other papers listed in SCI or SSCI; IF = average impact factor of journal publishing the articles; IC = percentage of papers written through international collaboration; DC = percentage of papers written through domestic collaboration.

Table 2.
Comparison of Bibliometric Characteristics of Papers by Types of Collaboration

Characteristics	IC (n = 63)		DC (n = 162)		NC (n = 134)	
	M	95%CI	M	95%CI	M	95%CI
AU	3.59	3.19– 3.99	4.02	3.74– 4.30	2.51	2.20– 2.83
REF	32.97	29.40–36.54	28.97	26.98–30.96	31.46	29.47–33.44
TC	2.24	1.46– 3.02	2.07	1.50– 2.65	2.67	2.06– 3.28
IF	1.15	0.94– 1.35	1.20	1.05– 1.35	1.10	0.97– 1.24

Note. AU = average number of authors per paper; REF = average number of references listed in paper; TC = average times cited by other papers listed in SCI or SSCI; IF = average impact factor of journal publishing the articles; IC = percentage of papers written through international collaboration; DC = percentage of papers written through domestic collaboration.; NC = percentage of papers with no formal collaboration.



(NC). DC papers had the highest average number of authors, followed by IC papers. Both types of papers had a much higher average number of authors than NC papers. Group comparisons showed that the difference was statistically significant at $p < .05$ level. In terms of references cited, IC papers were the highest at 32.97, followed by the NC and DC papers. In terms of times cited, NC papers were the highest at 2.67, followed by IC at 2.24 and DC at 2.07. In terms of impact factors, DC papers had the highest average impact factor, followed by IC and NC papers.

Figure 1 and Figure 2 show the number of publications from 1995 to 2004 for all articles and for articles whose first or correspondence author was affiliated with a nursing institute. Both trends were fitted with an exponential function. Again, due to the low number of articles from 1991 to 1994, those years were not included in the model. The exponential growth function for all articles was $y = 9.54 \times e^{0.32(t-1994)}$, where y was the number of papers at year t . It showed a reasonably good fit with an R^2 of 0.97. For articles with a first or a correspondence author affiliated with a nursing institute, it has a function of $y = 5.54 \times e^{0.28(t-1994)}$ and an R^2 of 0.96. Both trends showed similar patterns over the years. The numbers of papers sustained a constant annual growth rate of 32% and 28% respectively. In 1995, less than 10 first- or corresponding-authored papers were published. The numbers increased to 18 in 1999, and jumped to 91 in 2004.

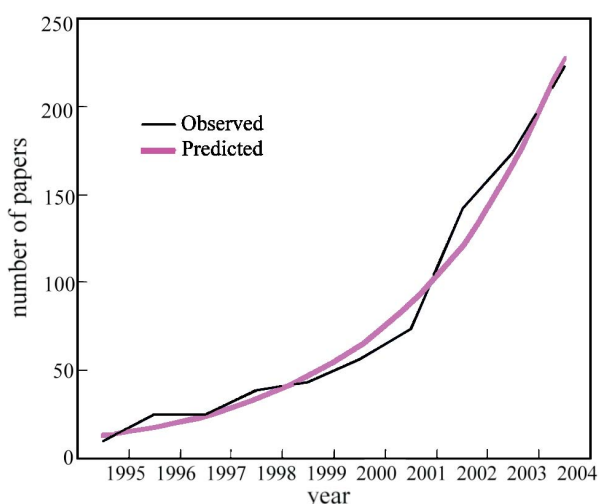


Figure 1. Observed and predicted number of all papers published from 1995 to 2004. Model: $y = 9.54 \times e^{0.32(t-1994)}$

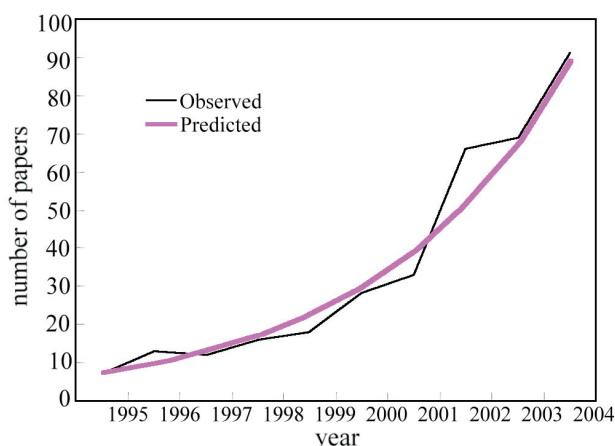
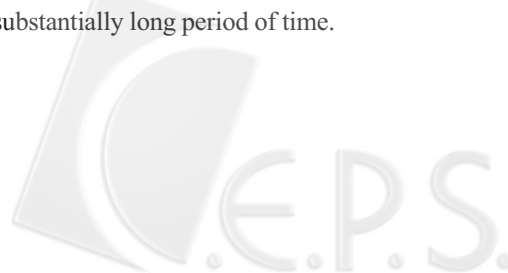


Figure 2. Observed and predicted number of first- or correspondence-authored articles from 1995 to 2004. Model: $y = 5.54 \times e^{0.28(t-1994)}$

Discussion

The number of scientific papers produced by researchers affiliated with nursing institutions has increased dramatically since 1991. Compared to the overall growth in scientific publications in Taiwan, it has increased at a much faster rate. The significant increase in research output can be viewed as the result of academic institutions placing more emphasis on research by offering financial incentives to researchers or by including research output as an evaluation criterion for promotion or tenureship (Swinbanks et al., 1997). The number of scientific papers written by Taiwan researchers in SCI increased from 8,944 papers in 1999 to 12,392 papers in 2003, an increase of about 39% (National Science Council, 1995; National Science Council, 2004). During the same period, the number of papers written by researchers affiliated with nursing departments has increased at a much faster pace, from 18 to 69, an increase of about 283%.

What are the reasons that may contribute to the much more rapid increase in research paper output among researchers affiliated with nursing institutes? One reason could be that the output of nursing researchers was lagging a few years behind the overall performance and was just beginning to take off. Thus, it was able to increase at a much faster pace. If the trend continues, it is estimated that in years 2005 and 2006, there would be 118 and 156 papers. While there is no sign of leveling off yet, it is unlikely that the trend will continue for a substantially long period of time.



Another reason could be international collaboration. During the last decade, papers with international collaboration increased from 15.2% to 22.0% of all papers published. The direct effect of international collaboration on research output cannot be estimated here. However, it would be reasonable to assume that more international collaboration would lead to more output due to the sharing of ideas and workloads. Since most of the SCI and SSCI journal publishers were located in United States or in Europe, and most of the papers were written in English, international collaboration (particularly with someone from the US or Europe) would give Taiwan researchers more information on topics that would be of interests to these journals. Furthermore, working with someone whose native language is English would also increase the efficiency and quality of writing, and hence, increases the chance of being published.

It also appeared that nursing researchers were reaching out to researchers in other fields. It was evident in the increasing number of papers in which researchers with a nursing background were not the first or corresponding author. Being multi-disciplinary in nature, nursing researchers can easily collaborate with other researchers from fields such as medicine, public health, or other life science related fields. This type of collaboration can help nursing researchers accumulate experience in publishing research papers, and to become the primary contributor of a research paper in the future.

The quality of nursing research appeared to be improving. Recent articles were being published in journals with higher impact factors than earlier articles. Papers written through collaboration also tended to be published in journals with higher impact factors. Furthermore, recent papers tended to include more references. However, there is no direct evidence linking quality of paper and number of references. As the quantity of research papers levels off, more efforts can be placed upon improving the quality of research papers. Efforts such as forming multi-disciplinary research teams and establishing formal networks to share research ideas and experience can be considered.

Overall, the characteristics of publications by nursing researchers changed significantly over the past decade.

More papers, higher impact factors, more connections with researchers internationally, more domestic collaborations, and more collaboration with other researchers. While the past growth has been impressive, how much longer such growth can be sustained is questionable. Given the much-better-than-average performance and the gradually improving quality, nursing research can provide insights into how to increase the number of scientific research papers and how to improve their quality in other fields of research.

This study has several limitations. Data used for this study included research papers published in SCI, SSCI, and A & HCI only. Many researchers in nursing institutes also write and publish papers in journals that were not included in the above index but were included in Medline or other databases. Thus, the results should be interpreted with the understanding that it is only applicable for observing the trends in SCI, SSCI, and A & HCI. Hence, the authors speculate that the results probably would have underestimated the research performance of researchers affiliated with nursing institutions. A second limitation is the insufficient information in contact address downloaded from ISI. While most contact addresses included the names of institutes and schools, some contact address included only names of schools. Thus, for example, a paper written by researchers from a non-nursing department in a nursing college would also be included unless the name of the institute was specified. The authors believed that including these articles would cause less bias in estimate than excluding them since nursing colleges tended to have more faculties in nursing departments than in other departments. This limitation indicated that researchers in Taiwan should give more attention to the contact address when submitting papers. Another limitation of this research is that it can describe the past trend very well, but has limited use in predicting the future performance of nursing research. To predict the future trend, a more sophisticated study needs to be undertaken. Many individual- and organizational-level characteristics are associated with performance. Information such as the demographic characteristics of researchers, length of research career, research environment, extensiveness of research collaboration, and individual aspirations towards research will be needed in order to predict the future performance of nursing research.

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1991 至 2004 年台灣護理研究之文獻計量分析

黃雅莉 何玉山* 莊坤洋*

摘要：本研究檢視在台灣的護理相關單位內研究學者的研究表現。下載 1991 至 2004 研究論文來自 ISI Web of Knowledge 網站，聯絡地址中含有「台灣」、「護理」兩個字彙的論文文獻計量資訊。本研究中擷取包含論文數量、作者數目、所列示參考文獻數目、出版期刊之影響係數、該論文被引用次數及該研究是否經由國內外合作產出等資訊進行編碼、表列。而且這些文獻計量資訊以 1995 至 1999 及 2000 至 2004 兩個時期進行比較，並利用指數模式來描述論文的成長趨勢。結果顯示 1991 至 2004 年論文數量有顯著的成長。而且普遍性看來，近期所發表的論文其作者、國內外研究合作、出版期刊影響係數、所列示參考文獻等指標平均值較早期研究來得高。經由合作研究產生的論文作者數較多、參考文獻較多、出版期刊影響係數也較高。指數模式被證實可適切描述論文過去的成長型態。作者推測國內外的研究合作增加可能挹注部分論文數量的遽增，但論文數量的成長是否會持續或會持續多久則不清楚。但根據過往的資料，仍觀察不到論文數量成長趨於平緩的徵象。欲瞭解哪些社會或個人因素挹注論文數量的遽增，則需要更多研究。隨著過去十餘年來論文數量顯著的成長，未來研究者應可將重點致力於論文品質的提升。

關鍵詞：文獻計量、護理、台灣。

台北醫學大學醫學系公共衛生學科講師 *公共衛生學系助理教授

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通訊作者地址：莊坤洋 11031 台北市吳興街 250 號