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ORIGINAL ARTICLE

Comparison of the Increasing Number of Published Systematic Reviews in Selected Countries in the Asia-Pacific Region

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Background: Health care systems have recognized the importance of clinical effectiveness as demonstrated by systematic reviews (SRs). However, related efforts for developing SRs and its subsequent outcomes vary among countries, particularly in the Asia-Pacific region.
Purpose: This study examines the development of SRs and compares the performance among 11 countries and regions in the Asia-Pacific in order to identify feasible promotion strategies for alliances in this part of the world.
Methods: We retrieved data on published SRs from PubMed by employing previously developed search strategies to examine the developing situation, not only in general but also in each country and region. We then compared the performance of each country with regard to SRs in terms of several predefined aspects. In addition to comparing the raw number of publications, this study also took into account other factors such as the total number of physicians and gross domestic product.
Results: Among the 11 countries and regions included in the study, Australia set an outstanding example in SR activities. New Zealand, Singapore, Hong Kong, China, and India also contributed significantly to this body of knowledge. Japan, South Korea, and Taiwan could improve by producing more Cochrane or non-Cochrane style SRs.
Conclusion: The findings reveal the importance of governmental support for the development of SRs. This includes providing the required resources such as research infrastructure, funding, and manpower. The principles and methods of SRs also need further promotion. In addition, it is crucial to bring together all research partners in the region, particularly those with already established Cochrane entities, to reduce unnecessary barriers to communication and to accelerate progress in SR research.

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1. Introduction

In 1972, the British epidemiologist Archie Cochrane wrote *Effectiveness and Efficiency: Random Reflections on Health Services*,[1] which provided a succinct description of his ideas for improving the National Health Service in Britain. He suggested that all existing and new interventions should undergo properly designed evaluations, in particular, randomized controlled trials (RCTs), to demonstrate reliable clinical effectiveness. RCT is a scientific method that employs an epidemiological experimental design to gain unbiased treatment results by using objectively collected data and statistical analysis. The intervention can be considered effective only if the benefits outweigh the cost.[1] RCTs became the "gold standard" for verification of the effectiveness of clinical care and the basis for the subsequent development of evidence-based medicine (EBM).

The number of RCTs has grown rapidly, with the Cochrane Central Register of Controlled Trials holding more than 600,000 entries.[2] Properly applying such a massive amount of medical knowledge to clinical practice, however, has proven to be a great challenge. Moreover, the trials vary in quality. A systematic review (SR) can offer critical exploration, evaluation, and synthesis of the unmanageable amount of information and separates that which is insignificant, unsound, or redundant deadwood in the medical literature from the salient and critical studies that are worthy of reflection.[3]

Cook and colleagues described SRs as scientific investigations in themselves, with preplanned methods and an assembly of original studies as their "subjects". By performing rigorous strategies to limit bias and random errors, SRs synthesize the results from multiple primary investigations.[4]

In response to Cochrane's call for systematic, up-to-date reviews of RCTs and in order to leverage the power of the international community in promoting Cochrane's ideals, 77 representatives and organizations from 11 countries came together and founded the Cochrane Collaboration in 1993. Since then, the core task of the Cochrane Collaboration has been to prepare, maintain, and disseminate SRs.[5] Full Cochrane SR reports are collected in the Cochrane Database of Systematic Reviews (CDSR) and, with other Cochrane databases, form the Cochrane Library.

Now that the science of SR has undergone decades of evolution, it is broadly agreed that SRs are the least biased and most reliable way to summarize research evidence and provide support for decision makers. Moreover, the development of SRs has significantly driven the global EBM movement.[6,7] The results of SRs are further presented in different evidence reports, to meet different demands and to different health care players. Decision-makers nowadays realize the importance of using the best evidence available to make better-informed decisions about health care. Thus, it is not surprising that EBM is now implemented in most developed countries. For example, the *Roundtable on Evidence-based Medicine*, convened by the Institute of Medicine in the United States, targeted that by 2020, over 90% of clinical decisions in the United States will be supported by accurate, timely, and up-to-date clinical information, and reflect the best available scientific evidence.[8] The European Union and the World Health Organization (WHO) have also emphasized EBM, and worked closely together to promote EBM research and its applications in policy- and decision-making.[9]

Although SRs synthesize many studies and serve as an important part of EBM implementation, SRs have not yet gained much attention from the health care professions in Asia. For instance, it was not until 1999 that the first Cochrane entity was established in China (Table 1).[10] And in Taiwan in the last decade, relatively few publications were conducted with an SR-related approach.[11,12] In addition, health care professionals did not make frequent use of the Cochrane Library. A 2001 study based in a medical center in Taiwan showed that only 51.4% of physicians had experience using the Cochrane Library.[13] A survey conducted in 2007 by the National Health Research Institutes among regional hospitals showed similar results.[14] On the other hand, other countries in the Asia-Pacific region, such as Australia and New Zealand, have performed well in SRs. It is worth knowing the SR performance among countries in the Asia-Pacific region and identifying related facilitating strategies. The most direct way of comparing the SR performance of various countries would be to compare the number of published SRs from each country. Previous studies, however, have noted that this approach does not take into account other contributing components such as the number of researchers and economic situation in each country. In addition, the relative development between SR publications and total biomedical publications among different countries is another important aspect.[15]

The purposes of this study were to evaluate national SR research performance by comparing the SR publications among selected countries in the Asia-Pacific region using objective measures, and to identify facilitating factors for promoting SR research accordingly.

2. Methods

2.1. Data sources

This study analyzed the SR literature indexed in PubMed (http://www.ncbi.nlm.nih.gov/sites/entrez) before the end of 2008. One of the challenges to identifying SRs in a medical database is the absence of a generally applied definition of SR. Although most SRs are generated by synthesizing many RCTs, RCT is a primary research result, which means that the term RCT is not, by itself,

Table 1 Cochrane Centres and relevant branches in the Asia-Pacific region*

Cochrane Centres and branches	Organization location/established year	Funding resources
Australasian Cochrane Centre	Based in Monash Institute of Health Services Research/Monash University (1994)	Funding from the Australian Government Department of Health and Ageing, as well as from not-for-profit health research funding agencies
New Zealand Branch	Located at the Department of Obstetrics and Gynaecology, The University of Auckland (February 2004)	Supported by the New Zealand Ministry of Health, The University of Auckland, and the New Zealand Guidelines Group
Singapore Branch	Hosted by the Singapore Clinical Research Institute (SCRI) (July 2005)	Funded by the National Research Foundation (NRF)
Thai Cochrane Network	Based in Khon Kaen University (2001)	Supported by the WHO, UK and Australasian Cochrane Centres, etc.
Chinese Cochrane Centre	Based in West China Hospital, Sichuan University (March 1999)	Supported by the Ministry of Health, National Natural Science Foundation of China, Sichuan University
Hong Kong Branch	Based in the Chinese University of Hong Kong (2002)	Supported by the Chinese University of Hong Kong
South Asian Cochrane Centre	Located at the Christian Medical College, Vellore, India (South Asian Cochrane Network since January 2005; officially registered as a center in July 2008)	The Indian Council of Medical Research (ICMR), Effective Health Care Research Programme Consortium UK (via DFID and the International Health Group, Liverpool School of Tropical Medicine), the Cochrane Schizophrenia Group (via the Department of Health, UK, and the University of Nottingham), Christian Medical College, Vellore, India, etc.

*The Cochrane Collaboration. *Cochrane Centres.* Available at: http://www.cochrane.org/contact/entities.htm#CENTRES [Date accessed: August 8, 2008]. WHO = World Health Organization; DFID = UK Department For International Development.

a sensitive key word for identifying SR literature. Mallett and Clarke's study reported that each SR included an average of 6.6 trials, but also that a considerable number of trials were not included in any SR study.[16] Since the article is on SRs, we decided to employ SR and related words as the search key words. Moher and colleagues estimated an annual frequency of 2500 published articles, with about one fifth of these being Cochrane reviews.[17] Montori et al suggested a more specific strategy to retrieve SRs from MEDLINE. Among the various terms, "Cochrane database of systematic review.jn" was the most precise single term.[18] Our previous experience showed that only a small fraction of CDSRs could be found by searching for "systematic review" OR "systematic literature review" in PubMed. In the present study, we took Montori et al's suggestion in relation to PubMed searching strategy, employing the following: MEDLINE [Title/Abstract] OR (systematic[Title/Abstract] AND review [Title/Abstract]) OR meta-analysis[Publication Type] OR Cochrane Database Syst Rev [TA]. All searches were limited to dates from January 1, 1989 to December 31, 2008, and only to articles published in English.

The publications from each country were extracted by restricting the "affiliation" field in PubMed searches to individual country names and matching these with prior search results for SRs by Boolean operators. The selected countries comprised Australia, China, India, Japan, South Korea, Malaysia, New Zealand, Singapore, Taiwan, and Thailand. Because of comparable patterns of social and health service development in advanced Asian economies, Hong Kong was added for comparison.[19,20] Duplicate literature from China, Hong Kong and Taiwan were eliminated.

2.2. Comparison indicators

The overall trend of development in the field of SR literature was first examined by applying Price's Law.[21,22] Price argued that the trend in a particular growing science production would be exponential. Countries were also compared with regard to their total number of SR publications.[23] Previous studies have suggested that, to some degree, the number of research publications is correlated with other social and health indices, such as the number of physicians and the per capita gross domestic product (GDP).[15] In the present study, except for Hong Kong and Taiwan, the number of physicians and GDP (adjusted by purchasing power parity) were retrieved from WHO's *World Health Statistics*.[24–27] Time spans and data resources are listed for each data set in

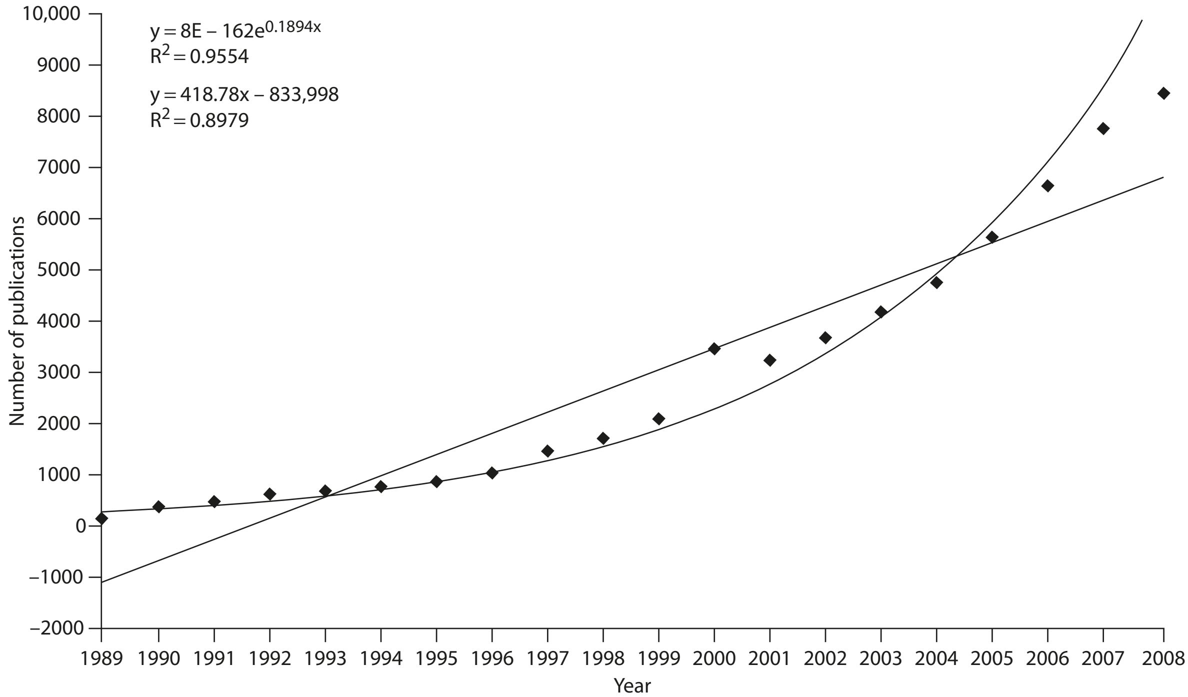

Figure 1 Growth in the output of systematic review literature from 1989 to 2008.

the results section. In addition, López-Muñoz et al proposed the participation index (PI) to further examine performance in a predefined subject.[15] PI is the quotient calculated by the ratio of the number of publications generated in a specific discipline or country to the total number of publications generated in that entity. We also examined the correlation between PI for SRs and PI for overall biomedical sciences in each country to determine the development of SR relative to all health sciences.[15]

3. Results

The publication of SR articles grew gradually until the end of the 20th century and climbed rapidly thereafter. In 1989, there were only 126 SR publications. The number had increased to 8501 in 2008. This indicates a total growth of 66.47 times over the 20-year period. Figure 1 gives the linear and exponential growth models for estimating the output of SR literature. The exponential model provides a correlation coefficient r^2 of 0.9554, which indicates that only 4.5% of the variability is unexplained by the model. As shown in the graph, the exponential curve is more suitable than the linear model for illustrating the trend in SR publications over the last 20 years.

Despite the great interest in producing SRs around the world, outputs differed among regions and countries (Table 2). In terms of the PI, nearly half of the SRs were produced by Australia (2554, PI = 0.51), followed by China (506, PI = 0.10), Japan (492, PI = 0.10), and New Zealand (429, PI = 0.09). Taiwan had 129 SRs (PI = 0.03), slightly more than South Korea (124, PI = 0.02), Thailand (117, PI = 0.02), and Malaysia (15, PI = 0.00). Ranking by the total number of biomedical publications presented a different picture, with Japan taking the lead (PI = 0.46), followed by Australia (PI = 0.14) and China (PI = 0.10).

Table 2 also provides the country profiles in relation to total number of physicians and GDP. The data were obtained primarily from WHO's *World Health Statistics*.[24–27]

In considering the different PI contributions in the field of SR and in overall health sciences production, Figure 2 shows the relationship between SR production and total production in biomedicine and health sciences among the subject countries. Australia, New Zealand, Hong Kong, Singapore, and Thailand had relatively higher productivity of SRs when compared to overall biomedicine and health science, while India, Malaysia, Taiwan, South Korea, and Japan had relatively low productivity.

Taking into account the social-health context of the different countries, the association between SRs and GDP per capita converted by purchasing power parity is drawn in the two-dimensional graph shown in Figure 3. There is no doubt that Australia ranks highest on both. Those countries located in the upper-left corner of the graph (such as Singapore, Hong Kong, Japan, and Taiwan) have adequate economic capabilities but show less interest in SRs.

Figure 4 further outlines the correlation between SR production and research manpower in terms of the total number of physicians. As we carried out the analysis by PI relative to the total number of physicians in

Table 2 Country profiles in relation to systematic reviews, total biomedical publications and other socioeconomic health indices

Country	SR	SR PI	TBP	TBP PI	Physician number*	GDP per capita (PPP) (US$)[†]
Australia	2554	0.51	180,796	0.14	47,875	35,885
China	506	0.10	126,196	0.10	1,862,630	7600
Hong Kong	244	0.05	32,366	0.03	11,739	35,550
India	260	0.05	107,096	0.08	645,825	2224
Japan	492	0.10	592,223	0.46	270,371	31,823
South Korea	124	0.02	81,975	0.06	75,045	22,877
Malaysia	15	0.00	7163	0.01	17,020	11,628
New Zealand	429	0.09	31,373	0.02	8190	26,032
Singapore	176	0.03	23,637	0.02	6380	36,118
Taiwan	129	0.03	77,009	0.06	34,899	30,291
Thailand	117	0.02	19,139	0.01	22,435	9886

*Except for Taiwan and Hong Kong, figures were obtained from Reference 24, while Taiwan's physician number was obtained from Reference 25; [†]except for Taiwan and Hong Kong, figures were obtained from Reference 24, while Hong Kong's GDP per capita (PPP) was obtained from Reference 26, and Taiwan's GDP per capita (PPP) was obtained from Reference 27. SR = systematic review; PI = participation index; TBP = total biomedical publications; GDP = gross domestic product; PPP = purchasing power parity.

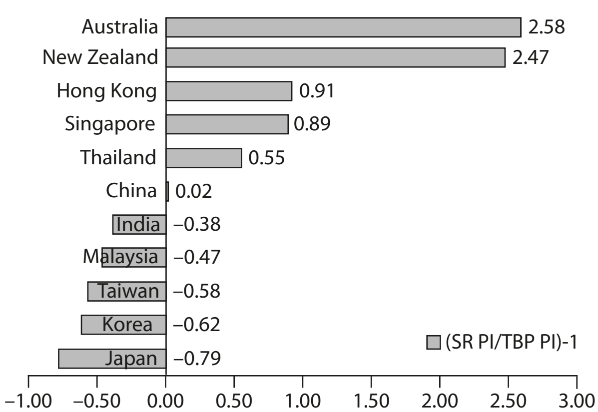

Figure 2 Country performance in systematic reviews (SR) compared to total biomedical publications (TBP). PI = participation index.

each country, the rankings echoed the results in Figure 2 and confirmed that the best performers were Australia, New Zealand, Singapore, Hong Kong, and Thailand. Figure 5 shows the proportion of CDSR and non-CDSR literature originating from the studied countries. Over half of the SRs were published in CDSR in Malaysia, followed by Thailand (40%), New Zealand (34%), Australia (26%), and India (15%). Fewer than 5% of SRs were published in CDSR in Japan, South Korea and Taiwan.

4. Discussion

After steady growth in the 1990s, SR production surged at the beginning of the 21st century. The increasing publication of SRs, as Price's Law suggests, highlights

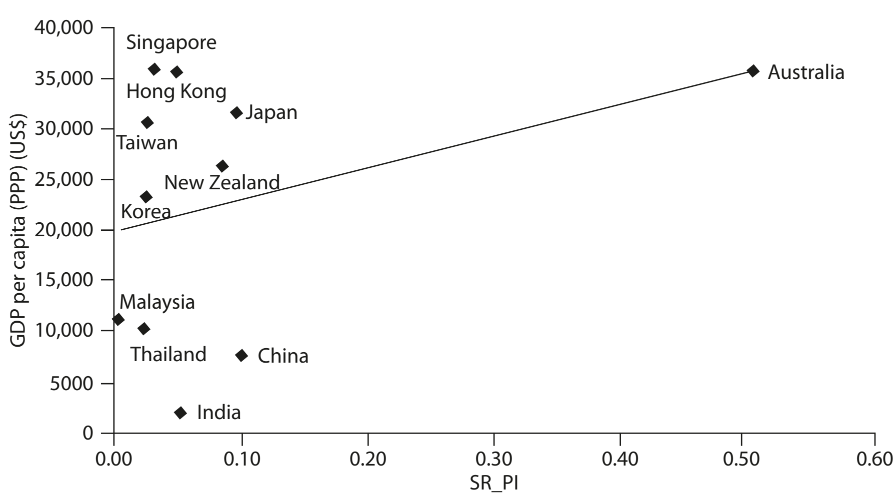

Figure 3 Relationship between systematic review (SR) participation index (PI) and per capita gross domestic product (GDP) adjusted by purchasing power parity (PPP) among the studied Asia-Pacific countries.

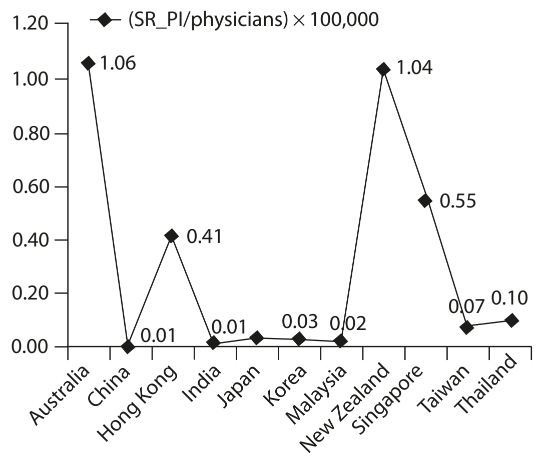

Figure 4 Relationship between systematic review (SR) participation index (PI) and physician numbers in the studied Asia-Pacific countries.

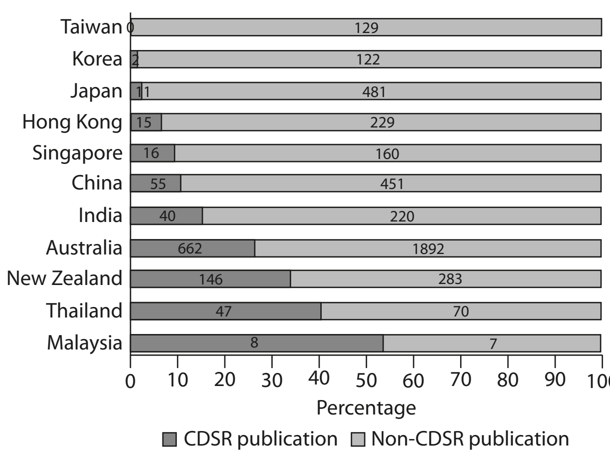

Figure 5 Cochrane Database of Systematic Reviews (CDSR) and non-CDSR publications among the studied Asia-Pacific countries.

the expansion of a developing area of science. In 2008, a total of 8501 new SR articles were found in PubMed. In other words, around 23.3 SR articles were released daily. In 1998, the equivalent figure was only 4.7, and in 1989 just 0.3.

Some factors have fostered the popularity of SRs in recent years. Each year, MEDLINE indexes over 560,000 new articles and Cochrane Central adds about 20,000 new randomized trials, approximately 1500 new articles and 55 new trials everyday.[28] It is therefore necessary to develop an effective way to organize medical literature. The best medical knowledge management structure has been deemed the "5S" form: studies, syntheses, synopses, summaries, and systems.[29] SRs, categorized in the syntheses level, play an important role in synthesizing primary studies and converting them to a form that can support clinical decision-making. The process is also meaningful to decision-makers at the policy and country levels.[30] The most influential driving force in this synthesis was the 1993 launch of the Cochrane Collaboration, which aimed to produce and disseminate SRs of health care interventions.[5] Mallett and Clarke's study estimated that at least 10,000 SRs would be needed to digest all the clinical trials in the Cochrane Central Register of Controlled Trials, not to mention the demand of regularly maintaining published SRs to keep them up-to-date.[16] More recently, the CDSR has been listed in the Science Citation Index (SCI) with an impact factor of 5.182 in 2008, the 12th highest in the "Medicine, General & Internal" category.[31] This recognition should attract more interest in the field of SRs within the academic society.

A peak in SR output appeared in 2000. This sudden rise was caused by a PubMed decision to list CDSR beginning in that year. Since then, PubMed has indexed around 400–500 CDSR articles annually, which account for one in 10 of the total SR articles retrieved from a PubMed search. The proportion of SRs in our study is relatively low compared with other studies. Using different inclusion criteria in November 2004, Moher et al identified an estimated annual frequency of 2500 publications of SRs indexed in MEDLINE, of which about 20% were Cochrane reviews.[17] Montori and colleagues, however, employed rigorous criteria and concluded that CDSR published 56% of all SRs during their study period in 2000.[32] Although we applied Moher et al's criteria, the variation is unavoidably larger than previous studies because of the long study period and the tremendous number of publications, which make it unfeasible to apply rigorous inclusion criteria such as an independent screening of all eligible articles.

Compared to the overall development of biomedical sciences in different countries, SR did not develop equally among the Asia-Pacific countries we studied. On the one hand, countries such as Australia and New Zealand made excellent progress, while on the other hand, countries in East Asia such as Taiwan, South Korea, and Japan lagged far behind their counterparts. It is noteworthy that the well-performing countries received strong support from the local Cochrane entity. According to the structure of the Cochrane Collaboration, several Cochrane Centres and relevant branches were founded to help coordinate and support members of the Collaboration and promote the objectives of the Collaboration at the national level. Within the Asia-Pacific region, related Cochrane branches were established in New Zealand, Singapore, and Thailand and supervised by the Australasian Cochrane Centre. Other centers include the South Asian Cochrane Centre, which is located in India, and the Chinese Cochrane Centre, which is situated in Sichuan, China, and which has a branch in Hong Kong. Most of the Cochrane entities mentioned above are funded by governments and consequently facilitate the output of SRs. The contribution of Cochrane entities is significant when analyzing the proportional distribution of CDSR and non-CDSR SR papers. Obviously, there is room for countries such as

Japan, South Korea, and Taiwan to improve their participation in generating and promoting SRs. One feasible way to address this is to call for cross-national cooperation across the East Asian region and to learn from the experiences of countries with well-established Cochrane entities such as Australia and New Zealand.

The correlation between scientific production of SRs and domestic economic circumstances in each country provides a way to examine governmental priorities. Generally speaking, the higher the socioeconomic status, the greater the research productivity. However, we did not observe this pattern with regard to SR publications. Advanced Asian health systems, such as those of Japan, Singapore, Hong Kong, and Taiwan, seemed to be underproductive in this regard. This finding points out that the scientific achievement of a country in a particular field might inevitably be influenced by its policies on scientific research and development.

When we considered the total number of physicians, as representative of the professional manpower directly related to clinical research, the leading places were Australia, New Zealand, Singapore, and Hong Kong. This interesting shift in order, particularly in the cases of Hong Kong and Singapore, may be because both have the advantage of English as their official language. For those countries in which English is not their official language, the strategies of paving the way for the generation of SRs may need to take into account language barriers and provide related support. This is important not only for those countries seeking to enhance their research capabilities, but also for the whole Cochrane society which is concerned with fostering greater diversity in the new century.

This study has some limitations. First, the search was limited to English-language literature and thus did not take into account what related literature there may be in other languages. We further examined the proportion of non-English literature based on our previous searching strategy. Among the selected countries and regions, China had 25% non-English SR publications, while the rest had non-English SR publications making up less than 6% of their totals. We believe that the most important and highest-quality studies have been published in English-language journals. Second, instead of comprehensively searching all databases, our search focused only on PubMed. The coverage of literature among different databases varies by topic.[33–36] Although common practice is to combine MEDLINE and EMBASE to get a thorough set of reviews, we did not search EMBASE as it includes more European literature which did not seem as useful in this study that focused on the Asia-Pacific region.[37] We believe that the trends we found would be the same even if we had included other databases.

In summary, over the past 20 years, health care professionals around the world have endeavored to develop, conduct, and publish SRs. The importance of SRs will continue into the foreseeable future. Among the Asia-Pacific countries and regions, Australia has set an outstanding example in the development of SRs as well as EBM activities. To some extent, New Zealand, Singapore, Hong Kong, China, and India have also contributed significantly to this body of knowledge. Japan, South Korea, and Taiwan can improve their participation by producing more Cochrane SRs. The findings from our research suggest that, as demonstrated by other neighboring Asia-Pacific counties, it is important to have governmental support for building the capacity of SR. The SR is inevitably resource-demanding, including research infrastructure, funding, and research manpower. Bringing together all research partners around the region, particularly those with already established Cochrane entities, is also crucial to reducing unnecessary barriers to communication and to accelerating progress in SR research.

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