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Scientific publications in laboratory medicine from mainland China, Hong Kong and Taiwan: A ten-year survey of the literature

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ABSTRACT

Background: We investigated scientific publications in laboratory medicine originating from mainland China, Hong Kong and Taiwan over the past 10 years.
Methods: The information about articles published in the included journals were determined by computer-searching on PubMed and data were extracted independently and analyzed in relation to the number of articles.
Results: From 2000 to 2009 there were 1166 articles published in laboratory medicine journals from the major Chinese regions (mainland China, Hong Kong and Taiwan). This exceeded Japan, Germany, the United Kingdom and France from 2005 onwards. Also, the number of articles from mainland China exceeded those from Hong Kong and Taiwan from 2004 onwards. The average impact factor (IF) from Hong Kong ranked the first, followed by mainland China, and then Taiwan. Clinica Chimica Acta seems to be the most popular laboratory medicine journal among Chinese authors.
Conclusion: Over the past 10 years, Chinese authors have been more and more active in the field of laboratory medicine. Mainland China seems to have caught up to Hong Kong and Taiwan regarding publication of papers in this field.

1. Introduction

Laboratory medicine, or clinical chemistry, is defined as the application of biochemistry, chemistry, molecular biology, haematology, immunology, microbiology, virology, and drug measurement to the clinical investigation and the diagnosis, therapy, and monitoring of human disease in body fluids, cells or tissues. It also covers evaluation of diagnostic markers, new reagents and systems, reference materials, and reference values. In general, publications in scientific journals are a reflection of research activity in a country. The past 30 years have seen significant growth in Chinese regions' laboratory medicine. According to the Essential Science Indicators SM (January 1997 to August 2007) [1], China ranked the sixth among the most-cited 146 countries in all fields, but the scientific publications in laboratory medicine from the three major Chinese regions (mainland China, Hong Kong and Taiwan) have not been reported. Therefore, we analyzed the contributions of articles from the three Chinese regions to laboratory medicine research.

2. Materials and methods

2.1. Data sources and searching

We checked the 2008 Journal Citation Reports (JCR) [2] to select the journals related to laboratory medicine. Journals not indexed in PubMed were excluded. Due to the nature of laboratory medicine, scientific articles could be published in professional journals (e.g. *Clinical Chemistry*) or relevant ones (e.g. *Journal of Clinical Microbiology*). The fifteen professional laboratory medicine journals included were *Clinical Chemistry, Clinica Chimica Acta, Clinical Biochemistry, Clinical and Laboratory Haematology, International Journal of Laboratory Hematology, Clinical and Vaccine Immunology, Clinical Laboratory Medicine, Journal of Laboratory and Clinical Medicine, Clinical Chemistry and Laboratory Medicine, Annals of Clinical and Laboratory Science; Journal of Clinical Laboratory Analysis, Archives of Pathology and Laboratory Medicine, Critical Reviews in Clinical Laboratory Sciences, Advances in Clinical Chemistry* and *LabMedicine.* The twelve relevant journals included were *Journal of Thrombosis and Haemostasis, Blood, European Journal of Haematology, British Journal of Haematology, Journal of Immunological Methods, Journal of Clinical Immunology, Journal of Clinical Microbiology, Clinical Microbiology and Infection, Clinical Microbiology Reviews, Journal of Antimicrobial Chemotherapy, Antimicrobial Agents Chemotherapy* and *Clinical Infectious Diseases.*

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As prescribed previously [3], data searching was conducted as follows. The ISSN (print) and publication date (print) were used to conduct searches in PubMed database in February 2010. Articles originated from mainland China, Taiwan and Hong Kong published during January 2000 to December 2009 in these journals were elicited. The search terms were "China[ad] not Hong Kong[ad] not Taiwan[ad]", "Hong Kong[ad]", "Taiwan[ad]" and "0009–9147 or 0009–8981 or 0009–9120 or 0141–9854 or 1751–5521 or 1556–6811 or 0272–2712 or 0022–2143 or 1434–6621 or 0091–7370 or 0887–8013 or 0003–9985 or 1040–8363 or 0065–2423 or 0007–5027 or 1538–7933 or 0006–4971 or 0902–4441 or 0007–1048 or 0022–1759 or 0271–9142 or 0095–1137 or 1198–743X or 0893–8512 or 0305–7453 or 0066–4804 or 1058–4838". Articles with the first author affiliated with the 3 Chinese regions were considered as research output from the regions. We also searched the articles from the top 5 countries: the United States of America (USA), Japan, the United Kingdom (UK), Germany and France. It is recognized that counting the nationality of each author would be more accurate, however it was noticed that currently many papers originating from the three regions of China have more co-authors from their own region than did papers from other parts of the world. So the data is more reliable than might be supposed with this group of papers and authors.

2.2. Data extraction

The number of articles originating from these countries and regions was examined from the professional laboratory medicine journals. Articles with the first author from the specialty of laboratory medicine from the 3 Chinese regions were identified from the relevant journals. The average impact factor (IF) was calculated using the accumulated IF divided by the accumulated number of articles and the distribution of articles in relation to IF was also examined for the 3 Chinese regions. IF from 2000 to 2009 were published by Thomson Reuters in their JCR. Articles published on the high-impact laboratory medicine journals (IF>2.000) were also generated. Furthermore, the most popular laboratory medicine journals of the 3 regions according to the publications were determined. Discrepancies were resolved by discussion.

2.3. Statistical analysis

We focused on the trends and scientific impact about the relative contributions of mainland China, Hong Kong and Taiwan. Therefore, only simple descriptive statistics (e.g. sum, average) were provided in this article.

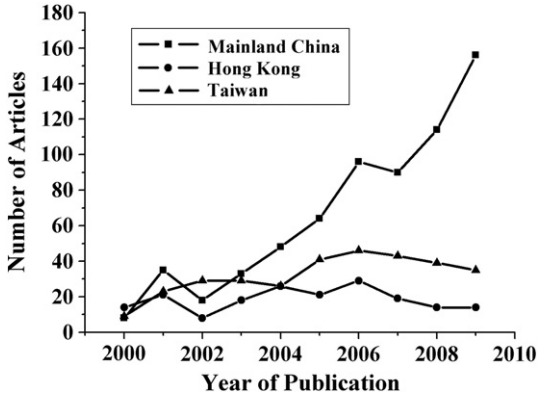

Fig. 2. The number of articles published in laboratory medicine journals from mainland China, Hong Kong and Taiwan during the past 10 years.

3. Results

3.1. Total number of articles

In the selected 15 professional laboratory medicine journals, there were a total of 13,554 articles published from 2000 to 2009 around the world. According to the number of articles, authors from the USA contributed the majority of the papers (66.9%, 9067/13,554 articles), followed by Chinese regions (1166 articles), Japan (1057 articles), Germany (1027 articles), UK (708 articles) and France (529 articles). According to Fig. 1, the annual total number of articles from Chinese regions showed a positive trend and exceeded Japan, Germany, UK and France from 2005 onwards.

There were 662 articles from mainland China published in the 15 journals during the 10 years, 184 articles from Hong Kong and 320 articles from Taiwan (Fig. 2). Since 2003, there had been a substantial increase in the number of articles published from mainland China (from 33 to 156 papers). From 2004 onwards, the number of articles from mainland China exceeded those from Hong Kong and Taiwan.

The selected 12 relevant journals published a total of 1288 articles from Chinese regions between 2000 and 2009. As shown in Fig. 3, Taiwan contributed 504 articles, followed by mainland China and Hong Kong with 468 and 316 articles, respectively. Furthermore, the percentages of articles by authors from the specialty of laboratory medicine were shown in Fig. 4. The authors from Hong Kong ranked the first (28.8%, 91/316 articles), followed by Taiwan (16.3%, 82/504 articles) and mainland China (6.4%, 30/468 articles).

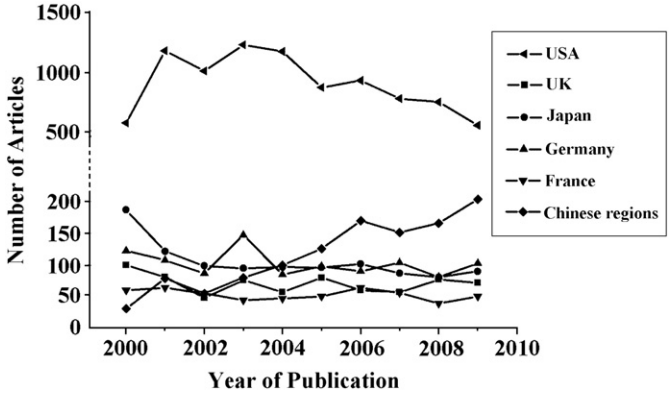

Fig. 1. The number of articles published in laboratory medicine journals from the USA, Chinese regions, France, Germany, Japan and the UK from 2000 to 2009.

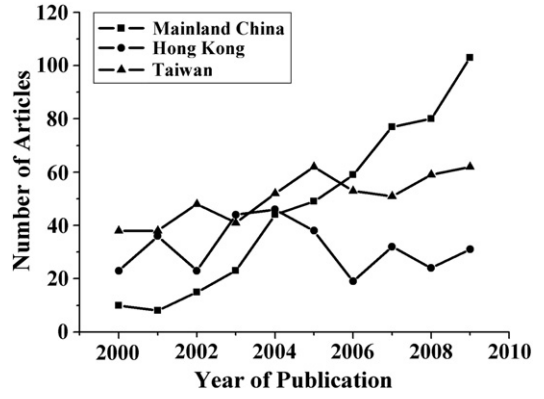

Fig. 3. The number of articles published in relevant journals from mainland China, Hong Kong and Taiwan during the past 10 years.

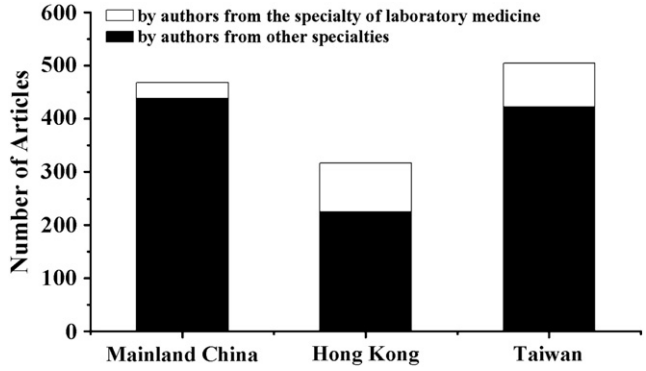

Fig. 4. The percentages of articles published in relevant journals by authors from the specialty of laboratory medicine in mainland China, Hong Kong and Taiwan during the past 10 years.

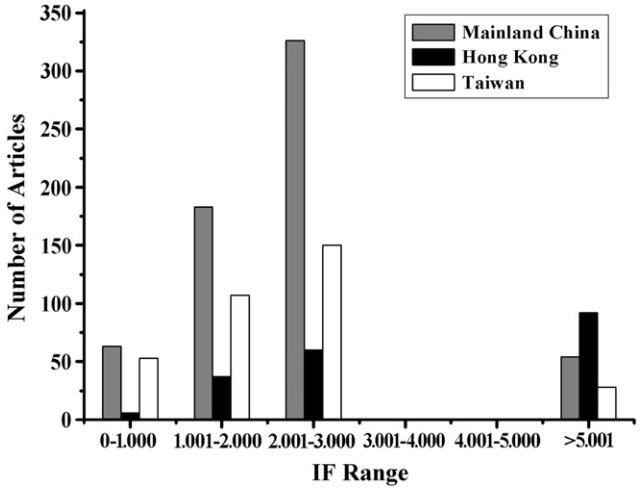

Fig. 5. Distribution of articles from the three Chinese regions during the past 10 years in relation to the IF of the laboratory medicine journals.

3.2. IF

Fifteen professional laboratory medicine journals were selected to assess the scientific impact of the 3 Chinese regions. The selected 15 journals ranged from 0.696 to 2.960, or >5.500 according to 2008 IF. As shown in Table 1, the average IF of published articles from Hong Kong ranked the first (4.054), followed by mainland China (2.240) and Taiwan (2.007). The distribution of articles from mainland China, Hong Kong and Taiwan in relation to the 2008 IF was shown in Fig. 5. In general, the journals with IF ranging from 2.001 to 3.000 published the most articles from the 3 regions (326 articles from mainland China, 60 articles from Hong Kong and 150 articles from Taiwan), followed by the journals with IF ranging from 1.001 to 2.000 (183 articles from mainland China, 37 articles from Hong Kong and 107 articles from Taiwan). It was necessary to mention that the major articles from Hong Kong were published in the journals with IF>5.001 (47.2%, 92/195 articles).

3.3. High-impact laboratory medicine journals

According to the 2008 JCR, 5 included laboratory medicine journals had the IF>2.000. Six hundred and ninety-eight articles from the 3 regions were published in the 5 journals over the past 10 years, of which 58.0% (405/698 articles) and 24.9% (174/698 articles) were published in *Clinica Chimica Acta* and *Clinical Chemistry*, respectively (Table 2). Mainland China published 376 articles in high-impact laboratory medicine journal, followed by Taiwan (174 articles) and Hong Kong (148 articles).

3.4. Popular laboratory medicine journals

The popular laboratory medicine journals for authors in the 3 Chinese regions were shown in Table 3. *Clinica Chimica Acta* published more articles from authors in mainland China and Taiwan, whereas *Clinical Chemistry* published more articles from authors in Hong Kong (followed by *Clinica Chimica Acta*). Considering the number of published articles, *Clinica Chimica Acta* could be the most popular laboratory medicine journal for authors in the major Chinese regions.

4. Discussion

Scientific papers in journals are the best way to introduce medical advances and clinical applications to a large audience of physicians, academic clinician-scientists, and laboratory consultants. The quality and quantity of the articles have become an index to evaluate the achievement of a staff in scientific research.

The present study focused on the contributions of Chinese authors in laboratory medicine. Since the scientific papers from the USA accounted for 66.9% among the 6 top countries, this country without doubt led all other 5 countries in research productivity in laboratory medicine. The most exciting evidence of change in Chinese regions was the total number of articles from Chinese regions in laboratory medicine journals, which had increased significantly during the past 10 years and finally exceeded Japan, Germany, UK and France from 2005 onwards. The positive trend might be attributed to an increase in research investment, the allocation of more research grants and other factors related to this field over the past 10 years.

Historically, it was known that medical research from Hong Kong and Taiwan had been more advanced than that from mainland China. Investigations showed that these 2 regions had contributed some excellent scientific papers in laboratory medicine. Since mainland China contributed the biggest part of world population and the patients, there was great room for practice of clinical medicine and

Table 1
Average IF of the journals where articles were published from mainland China, Hong Kong and Taiwan.

Year	Mainland China	Hong Kong	Taiwan
2000	1.907	2.001	1.923
2001	1.310	1.271	1.297
2002	1.545	1.444	1.463
2003	1.707	6.035	1.733
2004	2.387	3.960	1.822
2005	2.560	4.636	2.096
2006	2.306	5.281	2.189
2007	2.358	3.604	2.175
2008	2.229	3.333	1.671
2009	2.284	3.272	2.641
Average	2.240	4.054	2.007

Table 2
Articles published in high-impact laboratory medicine journals from mainland China, Hong Kong and Taiwan.

Rank	Journal	2008 IF	Mainland China	Hong Kong	Taiwan	Total
1	*Clinical Chemistry*	5.579	54	92	28	174
2	*Clinica Chimica Acta*	2.960	269	33	103	405
3	*Journal of Laboratory and Clinical Medicine*	2.795	7	3	25	35
4	*Archives of Pathology and Laboratory Medicine*	2.527	9	16	13	38
5	*Clinical and Vaccine Immunology*	2.237	37	4	5	46
Total			376	148	174	698

Table 3
The four most popular laboratory medicine journals for authors, based on accepted article numbers in mainland China, Hong Kong and Taiwan.

Rank	Mainland China	*n*	Hong Kong	*n*	Taiwan	*n*
1	*Clinica Chimica Acta*	269	*Clinical Chemistry*	92	*Clinica Chimica Acta*	103
2	*Clinical Chemistry and Laboratory Medicine*	67	*Clinica Chimica Acta*	33	*Journal of Clinical Laboratory Analysis*	47
3	*Clinical Biochemistry*	59	*Clinical Biochemistry*	19	*Clinical Biochemistry*	45
4	*Clinical Chemistry*	54	*Archives of Pathology and Laboratory Medicine*	16	*Annals of Clinical and Laboratory Science*	34

development of research with the huge investment from the government. According to the present study, the annual total number of articles published in laboratory medicine journals from mainland China increased markedly from 2000 to 2009 and exceeded Hong Kong and Taiwan from 2004 onwards. Although the IF of the journal is not the optimal parameter for determining the quality of articles published within them, it is probably the most accepted one for assessing the scientific impact of studies and is useful for backward comparison of data. Therefore, we also calculated the average IF of articles from the 3 regions and investigated the distribution of articles in relation to the 2008 IF. Mainland China ranked the second after Hong Kong in terms of average IF. According to our finding, this could be attributed to that the major articles from Hong Kong were published in the journals with IF>5.001, whereas those from mainland China were published in the journals with IF ranging from 2.001 to 3.000. Future studies could look at the wide variety of bibliometric tools becoming available such as SCOPUS, and the h-index, to name but two.

Because laboratory medicine is considered as a bridge between clinical practice and basic research, articles from this field could be published in journals apart from laboratory medicine publications. We made further efforts to illustrate the articles by authors from the specialty of laboratory medicine in the 3 Chinese regions. Consequently, the authors from Hong Kong ranked the first, followed by Taiwan and mainland China. Considering the above mentioned, it could be said that mainland China had recently narrowed the gap between the other 2 regions over the past 10 years.

In terms of number of articles, *Clinica Chimica Acta* was the most popular laboratory medicine journal for authors from mainland China and Taiwan and *Clinical Chemistry* for authors from Hong Kong. Hence, *Clinica Chimica Acta* might be seen as the best received laboratory medicine journal in the major Chinese regions. *Clinica Chimica Acta* was founded in 1956 published by Elsevier Science BV and is one of the most well-known publications in the field of laboratory medicine. *Clinica Chimica Acta* (2008 IF = 2.960) published more and more articles from Chinese regions each and every year during the past 10 years. It is believed that the further laboratory medicine in Chinese regions develops, then more articles will be published in international laboratory medicine journals.

The articles included in this study were retrieved by using the PubMed database, which is a comprehensive system containing articles from high-quality medical journals run by the National Center for Biotechnology Information at the National Library of Medicine in Bethesda, Maryland, USA. This study also used data from the JCR, a database composed of information about the number of times each year a journal is cited and the name of the citing journal, which was originally published by the Institute for Scientific Information and is now published by Thomson Reuters. The JCR represent the most comprehensive citation index to scientific literature, covering more than 6000 journals in 2009.

There were some limitations to the study which must be mentioned. Firstly, we investigated the data on Macao, another important region of China, but did not include these data due to the very small number of articles from Macao. Secondly, in spite of our best efforts to optimize the strategy of data searching and extraction, the number of publications elicited from the selected journals might remain a gross estimate of the situation in some degree. Thirdly, although we tried to include as many laboratory medicine journals or journals related to this specialty as possible as we could, we had to exclude some journals as they were not included by JCR or the PubMed database. Nevertheless, the selected 15 professional laboratory medicine journals and 12 relevant medical journals are the major international journals devoted to the discipline of laboratory medicine. Future studies, in say ten more years, should use the more advanced bibliometric tools that will have been developed by then, and determine even more about the changes in these past ten years and the ten years to come.

In conclusion, it is clear that authors from Chinese regions had been very active to enhance the clinical application and basic research of laboratory medicine over the past 10 years and mainland China has narrowed the gap between the other 2 regions in some topics and led in some aspects. But there is still much room for Chinese authors to excel in the field of laboratory medicine, compared with the developed countries, especially the USA, but the signs are there that this is starting to happen.

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