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Publication Output and Growth of Korean Medical Papers Published in Science Citation Index Journals During the 1980s: A Comparison with SCI Korean Chemistry Papers

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= Abstract = **The number of papers published in Science Citation Index(SCI) medical journals between 1980 and 1989 by authors at Korean institutions are measured for each of 47 medical specialties by publication year. Publication output of Korean chemistry, a scientific field which produces the Bulletin of the Korean Chemical society (BKCS), the only Korean SCI journal indexed during the 1980s, is also measured. A total of 1, 236 mainstream medical papers(i.e., an average of two or three papers a year for each medical specialty) were published during the ten-year study period. The overall mainstream publication activity of Korean medicine was insignificant, yet it has improved over the years. The growth was slow in the first half of the 1980s, then since around 1986, there has been a big increase in the growth rate. In total 1, 629 chemistry papers were published during the 1980s. If the BKCS papers are excluded, 738 papers were published in the SCI non-Korean chemistry journals. Inclusion of a Korean journal into the SCI database more than doubles the mainstream output of Korean chemistry, and increased the total mainstream output of Korean sciences at least by 10%. Among all SCI Korean papers, medical papers comprise 17.5%, and chemistry, 23.1%(or 10.5% if the BKCS papers are excluded). Only 2.4% of all Korean medical papers published during the 1980s are SCI papers, whereas 66.1%(or 30.0% if the BKCS papers are excluded) of chemistry papers are SCI papers. Chemistry papers have continuously increased over the years at a constant rate much higher(24.7 times in 10 years, or 11.2 times if the BKCS papers are excluded) than that of medicine(6.9 times) and that of all sciences combined(9.0 times).**

Key words : *Mainstream publication output, SCI publication output, Korean medical papers, Korean chemistry papers, Scientometrics*

INTRODUCTION

Most researchers would rather publish their best research results in highly cited "mainstream" journals. Especially scientists working in "peripheral" countries tend to view international journals as more important - and more

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prestigious- than local journals (Altbach, 1989). The publication of a paper in a "mainstream" international journal has great significance to Korean researchers in the following two respects.

First, papers published in "mainstream" journals are generally recognized as papers "of quality" which have survived strict peer judgement of international standard (i.e., a fair referee system). A major criticism of Korean journals is that there is no adeguate referee system to select papers to be published in them (Chi, 1994 ; Lee, 1992). It is inevitable that these journals are filled with (or as Chi puts it, maintained by) papers that are of no significant value. Chi points out, and no one would disagree, that it is because these papers are often written by authors under pressure to fulfill publication requirements needed, for example, for promotion or to take National Board Examinations. These authors do not bother too much to produce quality papers as long as they are publishable somewhere. Publication of papers should be a natural consequence of research activity, but is not necessarily in these cases. It follows almost logically that no one, even Korean colleagues, will pay any attention to these papers, and thus to these Korean journals. Conversely, Korean authors prefer to publish in non-Korean "mainstream" journals when they have a quality research report. Korean papers published in "mainstream" journals are obviously differentiated by Korean scientists from papers in Korean journals - the reason why publication of a paper in a "mainstream" journal is often considered as an indicator of "quality" of a Korean paper, and the publication activity in "mainstream" journals is regarded as an indicator of the "quality" of a Korean scientist.

Second, the surest way for Korean medical researchers to disseminate their findings internationally is to publish in non-Korean "mainstream" journals. This is because Korean medical journals are rarely covered in international databases (Lee, 1993; Yoon, 1993) in spite of the efforts of Korean medical journal publishers to integrate themselves into the international medical communication network, and because it is very unlikely that even an internationally-indexed Korean journal would attract many foreign readers.

Acknowledging the need and importance of the internationalization of Korean papers as a means to upgrade their quality, several universities in Korea have recently adopted policies which demand their faculty members to publish in internationally renowned "mainstream" journals. In particular, effective as of 1994, Seoul National University College of Medicine requires a professor to publish as a principal author at least one paper in Science Citation Index (SCI) or MEDLINE non-Korean journals in order to qualify for promotion to a higher rank position (SNU, 1993).

Frame, Narin and Carpenter (1977) used the SCI database for their survey of world science and referred to the database as "representing world science or 'mainstream science', i.e., the most heavily utilized science". SCI journals are selected on the basis of several criteria, including citation analysis, resulting in coverage of the most frequently cited publications in the scientific, technical and biomedical literature (DIALOG, 1987). By this measure, the SCI database covers the top 10% of all scientific journals published worldwide (Hamilton, 1991). Hence, journals indexed in the SCI are certainly "mainstream journals" and papers published in those SCI journals are "mainstream papers" Consequently, the study of Korean papers published in SCI medical journals is the study of mainstream Korean medical papers.

As of 1994, there are two Korean journals indexed in the SCI-the Bulletin of the Korean Chemical Society (BKCS) indexed from 1981, and the Journal of the Korean Physical Society (JKPS) indexed from 1993. During the 1980s, the period examined in this study, the BKCS was the only journal covered by the SCI. In other words, there were, and are, no Korean medical journals covered in the SCI. Therefore, in terms of the restrictive definition given above, there are no mainstream Korean medical journals.

Consequently, none of the papers published in Korean medical journals are mainstream papers despite their sheer volume. It is estimated

Table 1. Number of medical papers indexed in the Korean Index Medicus

Years covered		No. of journals[b]	No. of papers	No. of papers per year
1982-83	(2 years)	92(3)	8,864	4,432.0
1984-85	(2 years)	107(5)	10,024	5,012.0
1986	(1 year)	115(10)	5,727	5,727.0
1987	(1 year)	116(10)	5,868	5,868.0
1988	(1 year)	118(11)	6,036	6,036.0
1989	(1 year)	120(11)	6,150	6,150.0
			Total 42,669	

COMPILED FROM: Korean Index Medicus. Seoul: Korean Medical Library Association, 1986-. The 1989 volume published in 1992 is the latest edition (as of January 1994).
NOTE: No. of English-language journals in ( ).

that approximately 50,000 papers were published in Korean medical journals during the 1980s (Lee, 1993). Between 1982 and 1989, Korean Index Medicus (KMLA, 1986-) indexed 42, 669 papers published in 120 journals: the number of papers published each year ranged from 4,400 to 6,200 (Table 1).

On the other hand, the number of mainstream Korean medical papers published in SCI journals (i.e., non-Korean journals) seemed to be very small. According to Braun et al's data summarized in Table 2 (1987a, b, c, 1988a, b, c), 103 life science[1] papers, or 34 papers per year, were published in SCI journals between 1978 and 1980, and 271 such papers, or 54 papers per year, were published between 1981 and 1985. These numbers are only one hundredth of the non-mainstream medical papers published in Korean journals during the same period.

The Braun data also indicate that while there is growth in Korean mainstream science in general over the studied years, medicine shows a slower increase than other scientific fields in the production of research papers published in mainstream journals. During the period 1978-1980, the life sciences comprised 29.1% (103/354), a major portion of mainstream Korean scientific publication output. Chemistry was next in proportion, with 20.9% (74/354) of total Korean output in mainstream journals covered in the SCI. However, the ranking has changed over the years, with chemistry producing the most publications, 33.4% (522/1, 561), and the life sciences comprising 17.4% (271/1, 561) in the 1980-1985 period. Eisemon and Davis' data (1989)[2] also illustrate this point: where chemistry has increased 1138.9% over the years from 1981 to 1985, medicine increased by a more modest 315.4%, and biology increased by only 214.3%.

In the absence of studies dealing specifically with Korean mainstream medical research, a meaningful alternative is to gather information on SCI Korean medical papers. In the present

[1] Braun et al. grouped clinical medicine, biomedical research and biology into life sciences. However in the present study, clinical medicine and biomedical research are defined as medicine.

[2] Medicine together with biology in the Eisemon and Davis survey correspond to life sciences by Braun, Glänzel and Schubert's studies.

Table 2. Publication output in SCI journals

Country	1978-1980 Rank	1978-1980 Output	1978-1980 % share	1981-1985 Rank	1981-1985 Output	1981-1985 % share
All science fields combined						
Korea	51(107)	354	0.031	42(100)	1,561	0.08
USA	1	407,726	36.34	1	751,635	36.67
Japan	4	70,794	6.31	4	139,645	6.81
Life sciences						
Korea	65(102)	103	0.017	58(89)	271	0.024
USA	1	250,941	40.34	1	460,861	40.33
Japan	5	31,557	5.07	3	64,663	5.66
Chemistry						
Korea	48(66)	74	0.047	35(53)	522	0.198
USA	1	32,302	20.7	1	59,596	22.57
Japan	3	16,084	10.31	3	29,348	11.12
Physics						
Korea	44(73)	86	0.048	39(60)	389	0.100
USA	1	58,742	32.55	1	134,937	34.71
Japan	3	13,542	7.50	3	26,761	6.88
Mathematics						
Korea	51(51)	11	0.038	44(47)	57	0.108
USA	1	11,895	41.06	1	21,423	40.60
Japan	7	1,229	7.50	6	2,630	4.98
Engineering						
Korea				36(55)	434	0.199
USA				1	85,494	39.21
Japan				2	20,851	9.56

COMPILED FROM: T. Braun, W. Glnzel and A. Schubert, "One more version of facts and figures on publication output and relative citation impact" and "The newest version of the facts and figures on publication output and relative citation impact", Scientometrics 11: 9-15, 127-40, 12: 3-16, 13: 181-88, 14: 3-15, 14: 365-82.

NOTE: Numbers in ( ) are numbers of countries which produced at least 10 first-authored papers in each field during the investigated time period 1978-1980, and at least 50 such papers during the 1981-1985 period.

study, the publication output in the SCI medical journals published by authors at Korean institutions from 1980 to 1989 is measured by medical specialty for each publication year. Publication output of Korean chemistry, a scientific field which showed the greatest mainstream output in the earlier part of the 1980s as presented in Braun et al's and in Eisemon and Davis' studies, is also measured. It is mentioned above that the only Korean journal indexed in SCI was a chemistry journal, the BKCS. The inclusion of the journal into SCI must have affected the mainstream publication output and growth of Korean chemistry to a great, but unknown, extent. Natur-

ally, one of our interests is to determine what proportion of SCI Korean chemistry papers is attributable to the Korean journal. The growth rate of mainstream publication output of these two disciplines over the ten years of the 1980s is then compared. It is expected that the comparison study will expose the degree of mainstream publication activity of Korean medicine in the last decade in relation to an internationally active science in Korea.

MATERIALS AND METHODS

The major task of the present study is to identify Korean medical papers indexed in the SCI. This requires two definitions: What is a Korean paper and what is a medical paper? A Korean paper is defined as a paper written by researchers, at least one of whom has an address in Korea. A medical paper is defined as a paper in any of the 47 scientific subfields listed under clinical medicine (32) or under biomedical research (15) for the tabulation of science literature indicators in Science and Engineering Indicators (NSB, 1973-). Each subfield corresponds to a Subject Category (SC) code used in the SCI database (ISI, 1989b). Two subfields, dentistry and veterinary medicine, will not be included in the study. Nursing constitutes neither a subfield in S &E Indicators nor a SCI subject category, so it is not included in the present study either.

As a first step in searching the SCI database, all the Korean papers in the databases are identified. This is straightforward with the SCI database, because the Geographic Location (GL) field identifies the country of the authors. The field was obviously derived from the Corporate Source (i.e., address) field, and covers every author, not just the first author of a paper. The GL = SOUTH KOREA is therefore a very comprehensive and powerful search statement that retrieves all papers contributed from institutions located in Korea. (This search statement will also retrieve papers written by authors at foreign institutions located in Korea, such as US Air Force Hospital in Osan, Korea. However, the number of such records will be extremely small, so that we may ignore them.) The next step is identification of papers in each medical subfield. This is a rather complicated process in SCI, because each of 47 SC codes must be individually searched. Korean medical papers in each medical subfield are identified by the intersection of the two sets: all the Korean papers and all the papers in a medical subject category. In order to obtain the number of Korean medical papers in each specialty by publication year, each combined set is limited by publication years from 1980 to 1989 (e.g., (SC = ALLERGY AND GL = SOUTH KOREA)/1980). All the Korean medical papers found in the SCI are from non-Korean journals, so a separation of papers into two groups (one from Korean journals and the other one from non-Korean journals) is not necessary.

The identification of Korean chemistry papers in the SCI database is performed, employing a strategy similar to that described above. All the scientific subfields of the chemistry field contain the word "chemistry" as part of the SC code[3]. Therefore, one search statement SC = CHEMISTRY would be sufficient to retrieve all the chemistry records in the database. However, because we need to obtain publication output in mainstream journals by Korean chemists in each chemistry subfield, the six chemistry SC codes are individually searched. Korean chemistry papers in each subfield are identified by the intersection of each of six chemistry SC codes and GL = SOUTH KOREA. Since there is one Korean chemistry journal covered in the database during the study period, it is necessary to differentiate records from that journal from records from non-Korean journals. This is done by performing a search JN = BULLETIN OF THE KOREAN CHEMICAL SOCIETY (i.e., all the records in the Korean journal), and excluding the retrieved records from the total Korean chemistry records found, leaving the records of papers in non-

[3] Polymer science is not included in the study even though it is a subfield of chemistry in S & E Indicators.

Korean journals.

RESULTS

Publication output in SCI journals

The frequency counts of SCI Korean medical papers in 47 specialties are presented by publication year in Table 3. Similarly, the frequency counts of SCI Korean chemistry papers in six subfields are presented in Table 4. They are, in essence, the number of postings returned by the DIALOG system after each search statement was entered into the SCI database. A row total is an exact sum of individual years for each specialty. On the other hand, a column total for each year is always less than the sum of individual rows for a column because some records are coded more than once in different subjects. For instance, a SCI journal, Contact Dermatitis, is classified into two subject categories, Allergy, and Dermatology & Venereal diseases, so a paper published in the journal appears twice in the table. Due to such incidences, the number of papers in all fields for 1980 adds up to 54, although the total number of Korean medical papers retrieved from SCI for that year is only 47.

Table 5 summarizes the numbers of Korean papers for all scientific fields indexed in SCI databases by publication year. They are verified as a natural byproduct in the process of identifying Korean medical and chemistry papers: The preliminary search statement GL = SOUTH KOREA retrieves all the Korean papers. The numbers of Korean papers in medicine or chemistry are total sums of number of papers in all medical specialties or chemistry subfields for each publication year as reported in Tables 3 or 4.

The numbers in Table 5 (Tables 3 and 4 also) are larger than those in Table 2 (i.e., Braun et al' s data). According to Table 5, the sum of SCI Korean papers for five years from 1981 to 1985 is 2,287, whereas it is reported in Table 2 that 1, 561 Korean papers were identifiable for all sciences combined for the 1981-1985 period. We have identified 389 medical papers and 546 chemistry papers published between 1981 and 1985, whereas Braun et al. have reported 271 life science and 522 chemistry papers published during the same period.

The major source of discrepancies is that Braun et al. counted the publication output of a country by the corporate address of the first author only. In the present study, a paper is counted as a Korean paper if at least one of the authors has an address in Korea whether he is the first author or not. There are debates on possible accounting bias associated with credit allocation in the case of multiauthored works (Lindsey, 1980, 1982; Long & McGinnis, 1982a, b). However, for our purpose, it is clear that we need to include every papers in which Korean research institutions are involved at one degree or another. For instance, an examination of internationally collaborated papers is of interest to us(although not discussed in the present paper).

Another source of discrepancies is the fact that Braun et al. treated only four types of publications -articles[4], reviews, notes and letters- as original research contributions, and included only these document types in their study. Tables 3, 4 and 5 include the number of meeting abstracts as well as other types of documents included in the SCI database such as editorials, corrections, discussions, bibliographical items, and chronologies. Inclusion of these other document type records for the analysis of mainstream publication activity would make certain fields look unnecessarily active in contributing original research to the international communication network. However, they are still included in the present study, since one of the purposes of this study is, again, to identify as many Korean records indexed in SCI as possible.

"Meeting abstracts" comprise the second largest group of documents in SCI records. For Example, 17.7 % (109, 019/614, 210) of the source items indexed in SCI in 1988 were meeting abstracts (ISI, 1989a). Other groups of a particular

[4] Clinical case reports are treated as original articles in the SCI.

Table 3. Number of Korean Medical Papers Indexed in the SCI During the 1980s (by Specialty)

Specialty[a]	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Totald
Clinical Medicine											
1. Allergy [18]	0	1	0	0	2	6 (4)	1	0	1	5	16 (4)
2. Andrology [4]	1	0	0	0	0	0	0	0	0	0	1 (0)
3. Anesthesiology [16]	1	0	0	0	0	0	0	0	0	0	1 (0)
4. Cardiovascul sys [59]	2	2 (1)	2	0	1	1	2 (1)	2 (1)	0	10 (4)	22 (7)
5. Dermato & ven dis [28]	2	5	5	4	7	5	7 (1)	10 (2)	12 (1)	16 (4)	73 (8)
6. Endocrin & metab [52]	0	2 (1)	0	0	1	1	1 (1)	2	4	4	15 (2)
7. Gastroenterology [31]	3 (3)	0	3 (3)	2 (2)	1	3 (1)	4 (3)	4 (2)	8 (5)	7 (2)	35 (21)
8. Geriat & gerontol [13]	0	0	0	0	0	0	0	0	0	0	0 (0)
9. Hematology [35]	0	1 (1)	1	0	0	0	2 (1)	2 (1)	1	8 (4)	15 (7)
10. Immunology [80]	0	3	3	1 (1)	3	3 (1)	4	9 (1)	2 (1)	8	36 (4)
11. Med, gen & int [121]	3	4 (2)	3	1	4	1	0	0	3	0	19 (2)
12. Medicine, legal[b] [5]	–	–	–	–	–	–	–	0	0	0	0 (0)
13. Med, miscell [38]	0	0	0	1	1	1	2	3	1	1	10 (0)
14. Neurosciences [135]	3	2	1	3 (1)	2	1	3	5 (1)	9	10	39 (2)
15. Obstet & gynecol [42]	2	1	2 (1)	4	2	2	2	3	3	6	27 (1)
16. Oncology [68]	0	0	0	0	0	2	5 (3)	14 (1)	11 (2)	11	43 (6)
17. Ophthalmology [35]	0	0	1	0	0	0	1	0	2	2	6 (0)
18. Orthopedics [31]	4	1	1	1	3	0	1	3	5	2	21 (0)
19. Otorhinolaryngol [19]	0	0	0	0	1	1	0	1	4	0	7 (0)
20. Pathology [45]	1	1 (1)	2	2	4 (1)	0	0	7 (1)	6 (1)	7	30 (4)
21. Pediatrics [47]	0	2 (1)	1	0	0	1	1	4 (2)	3	7	19 (3)
22. Pharm & pharm [139]	4 (1)	11 (1)	8 (3)	9	29 (2)	14	8	21 (3)	20 (1)	29	153 (11)
23. Psychiatry [34]	0	0	0	1	2	0	2	0	2	2 (1)	9 (1)
24. Public health [42]	0	0	0	1	0	0	0	5	5	2	13 (0)
25. Radiol & nucl med [63]	2 (1)	1	3 (1)	0	8 (3)	11 (1)	12	24 (2)	22 (1)	28	112 (9)
26. Respiratory sys [22]	1	1	0	2	0	0	1	1	3	1	10 (0)
27. Rheumatology [16]	0	0	0	0	0	0	0	0	0	0	0 (0)
28. Substance abuse [8]	0	0	0	0	0	0	0	0	0	0	0 (0)
29. Surgery [83]	4	1	1	3	6	2	4	10	15 (1)	17	63 (1)
30. Toxicology [37]	1 (1)	0	2 (2)	5	4 (1)	0	2	4	4	4	26 (4)
31. Tropical med [17]	0	3	1	2	0	1	0	1	0	3	11 (0)
32. Urol & nephrol [33]	0	0	1	0	2 (2)	3 (2)	5 (2)	7 (2)	6 (2)	67 (58)	91 (68)

Table 3. Number of Korean Medical Papers Indexed in the SCI During the 1980s (by Specialty)

						Biomedical Research						
33.	Anatomy & morph [15]	0	1	1	1	1 (1)	1	0	0	5 (1)	1	11 (2)
34.	Bioche & mol bio [151]	5	2 (1)	2	13 (1)	5	10	11 (1)	21 (1)	22	44 (1)	135 (5)
35.	Biophysics [36]	1	0	1	4	0	2	2	6	8	16	40 (0)
36.	Biot & appl micro [30]	6	8	11	7	12	14	16	18	15	24	131 (0)
37.	Cytol & histol [63]	0	1	3 (1)	0	2	2	2	1	3	7	21 (1)
38.	Develop biol [11]	1	1	2	1	0	3 (2)	3 (3)	1	0	0	12 (5)
39.	Engin, biomed [28]	2 (2)	1 (1)	8 (4)	1	4	5	3	6 (1)	3	9	42 (8)
40.	Genet & heredity [61]	2 (2)	3 (2)	3 (1)	1	3	6 (1)	7 (1)	9	3 (1)	9	46 (8)
41.	Med, res & experi [50]	0	0	0	1 (1)	5 (2)	4 (2)	6 (4)	4 (1)	5 (1)	5 (5)	30 (16)
42.	Microbiology [69]	2	1	2	5	4	4	4	1	3 (1)	14	40 (1)
43.	Microscopy [11]	0	0	0	1	0	0	1	0	0	0	2 (0)
44.	Nutri & dietet [37]	1	1	0	2	0	1	0	2 (1)	0	2	9 (1)
45.	Parasitology [19]	0	1	0	0	0	0	0	0	2 (1)	2	5 (1)
46.	Physiology [51]	0	1 (1)	1	3	0	1	3	7 (1)	2	7 (2)	25 (4)
47.	Virology [18]	0	0	1	1	0	0	0	4 (1)	4 (2)	3	13 (3)
	Total[c]	47	56	68	65	105	95	108	184	190	323	1,236
	(Meeting abstracts)	(10)	(12)	(14)	(5)	(11)	(14)	(20)	(23)	(19)	(77)	(205)

NOTE: For each specialty, the numbers of journal titles covered by SCI in 1988 are provided in [ ]. The numbers of meeting abstracts are indicated in ( ). In addition to these meeting abstracts, one editorial is contributed to a dermatology & venereal diseases journal in 1986 from a Korean institution.

[a]The compilation of medical specialties listing is primarily based on "Source publications arranged by subject category", which appears in SCI 1988 Annual: Guide and List of Source Publications. It is basically the same system used in S&E Indicators developed by CHI for NSF. The classification of a subfield (i.e. subject category) into clinical medicine or into biomedical research follows the system used in S&E Indicators.

[b]This SC code was not used in SCI until 1986.

[c]A column total for each year is always less than the sum of individual rows for a column because some records are coded more than once in different subjects.

[d]A row total is a sum of individual years.

Table 4. Number of Korean Chemistry Papers Found in the SCI During the 1980s (by Subfield)

Subfield[a]	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total[b]
1. Chemistry (76)	3 (2)	41 (4)	47 (4)	73 (7)	91 (11)	126 (5)	172 (8)	176 (8)	161 (10)	203 (6)	1,093 (65)
(in the Korean j.)	N/A	32	37	62	68	105	144	145	132	181	906
(in non-K. j. only)	3 (2)	9 (4)	10 (4)	12 (7)	24 (11)	21 (5)	27 (8)	35 (8)	30 (10)	28 (6)	199 (65)
2. Chem, analytical (41)	4	2	2	0	4	5	7	9	13	13	55
3. Chem, applied (14)	0	0	3	2	2 (1)	3	3 (1)	2	0	1	16 (2)
4. Chem, inorgaic & nucl (28)	0	3	3	7	5	7	5	11	15	17	73
5. Chem, organic (34)	5	5	12	19	16 (1)	26	31	36	51	59	260 (1)
6. Chem, physical (51)	1	7 (1)	4	13	11 (1)	10	18	27	35	42	168 (2)
-. Polymer science (42)	4	5	13	11	16	9	15	30	34	54	191
Total[c]	13 (2)	58 (5)	71 (4)	113 (7)	128 (14)	176 (5)	232 (9)	255 (8)	262 (10)	321 (6)	1,629 (70)
(in non-K. js. only)	13 (2)	26 (5)	34 (4)	52 (7)	61 (14)	71 (5)	90 (9)	114 (8)	131 (10)	146 (6)	738 (70)

NOTE: For each specialty, the numbers of journal titles covered by SCI in 1988 are provided in [ ]. The numbers of meeting abstracts are indicated in ( ). In addition to these meeting abstracts, one editorial is contributed to a physical chemistry journal in 1988 from a Korean institution.

[a]The classification of a subfield into chemistry follows the system used in S&E Indicators. However, polymer science is not included. The wording of a subfield is in the form of a subject category as it appeared in "Source publications arragned by subject category", SCI 1988 Annual: Guide and List of Source Publications.

[b]A row total is a sum of individual years.

[c]A column total for each year is always less than the sum of individual rows for a column because some records are coded more than once in different subjects.

Table 5. Number of Korean Papers Found in the SCI

	All Science fields			Chemistry			Medicine[c]
	GL = South Korea (a)	in non-K journals (b)[b]	in Korean[a] journals (c)	GL = S.Kor AND SC = chem. (d)	in non-K journals (e)[b]	in Korean[a] journals (f)	in non-K journals only (j)
1980	153	153	–	13	13	–	47
1981	272	240	32	58	26	32	56
1982	329	292	37	71	34	37	68
1983	457	396	62	113	52	62	65
1984	542	475	68	128	61	68	105
1985	687	582	105	176	71	105	95
1986	790	648	144	232	90	144	108
1987	1,043	902	145	255	114	145	184
1988	1,227	1,096	132	262	131	132	190
1989	1,559	1,384	181	321	146	181	323
Total	7,059	6,168	906	1,629	738	906	1,236

[a]There is only one Korean journal indexed in SCI, *the Bulletin of the Korean Chemical Society*. Therefore, (c) = (f). The journal entered the SCI in 1981.

[b](b) > = (a) − (c) and (e) > = (d) − (f).

Discrepancies exist--(b) is not always (a) − (c), or (e) is not always (d) − (f)--because some of the entries from *the Bulletin of the Korean Chemical Society* are by foreign nationals not affiliated with Korean institutions. Therefore, they are not classified as GL (Geographic Location) = South Korea.

[c]For numbers of Korean articles in each medical specialty and chemistry subfield, see Tables 3 and 4.

document type not considered as original research contribution, are of negligible size. Similarly, 16.6% (205/1,236) of Korean medical records indexed in SCI between 1980 and 1989 are meeting abstracts (The number of Korean medical meeting abstracts are indicated in Table 3). There happened to be one editorial contributed from Korea in the decade, and there were no records of corrections, discussions, or chronologies. A few records for bibliographical items were found, but all of them are also classified as reviews (i.e., as original research contributions).

The number of meeting abstracts originated from Korea varies a great deal from one specialty to another and from one year to another. For example, 68 out of 91 (74.7%) Korean urology & nephrology records retrieved from SCI were identified as meeting abstracts, and 58 of these meeting abstracts were from one year, 1989[5]. On the other hand, none of the 131 biotechnology & applied microbiology records, and only one of the 63 surgery records identified for the ten-year period was a meeting abstract. In general, the proportion of meeting abstracts among mainstream Korean medical papers was quite high in the earlier years of the 1980s, and has gradually decreased during the 1980s from more than 20 % to 10%. There were even a few medical fields in which mainstream publication activity (as captured by the SCI database) merely presented papers at international conferences, in the earlier years of the 1980s. For instance, all of the eight gastroenterology records indexed in the SCI until 1983 were meeting abstracts. In chemistry, a very small number of meeting abstracts is found in every chemistry field, and throughout the decade. For example, one meeting abstract each from organic and physical chemistry were indexed by SCI in ten years.

Literature growth during the 1980s

Figure 1 shows the growth in the number of Korean medical papers published in SCI journals during the 1980s. The number of medical papers in the subfields of clinical medicine and those of biomedical research are separately plotted to show the differences in the growth rate. The addition of two points in each year, indicated for clinical medicine and for biomedical research in the graph, exceeds the total number of SCI Korean medical papers, because some papers are coded more than once, as explained earlier. Fig. 2 shows the trend of publication output for medicine and chemistry. Two lines are shown for chemistry: one for the total number of SCI Korean chemistry papers and the other for the number of SCI Korean chemistry papers published in non-Korean journals only (excluding the BKCS papers).

DISCUSSION

Publication output by medical specialty

A total of 1, 236 papers contributed from Korean research institutions were identified from the SCI for the ten-year study period (Table 3). 923 papers were published in 32 clinical medicine specialties, and 562 papers were published in 15 biomedical research specialties in ten years. Because some interdisciplinary journals are classified into more than one subject category in the SCI, the sum of papers contributed from each medical field in ten years (1, 485) is greater than the actual number of Korean medical papers found in SCI (1, 236).

The overall publication output of each specialty is very low, the average being 31.6 (1, 485/47) papers per specialty, or 3.16 papers each year per specialty (The true one-year average per specialty should be 2.68 (1, 236/47/10) papers). The average publication output is better in biomedical research than in clinical medicine. The ten-year average for a specialty of clinical medicine is 28.8 (923/32) papers and the average for

[5] It turned out that the abstracts section of the *Kidney International: Official Journal of the International Society of Nephrology*, vol. 36, no. 6 (December 1989) has featured 55 meeting abstracts from the 8th Annual Scientific Meeting of the Korean Society of Nephrology held in Seoul on June 10-11, 1988. In the same issue, meeting abstracts from the Australasian Society of Nephrology are also featured.

Table 6. Number of Medical Fields by Number of Papers Contributed to the SCI During the 1980s

No.of SCI Korean papers in ten years	No.of medical fields
0	4
1 - 10	10
11 - 20	10
21 - 30	8
31 - 40	5
41 - 50	3
51 - 100	3
more than 100	4
Total	47

biomedical research is 37.4 (562/15) papers.

The largest number of papers, 153 papers, was contributed by pharmacology & pharmacy in the decade of the 1980s. Only four specialties contributed more than 100 papers in ten years (Table 6): radiology & nuclear medicine, biochemistry & molecular biology, and biotechnology & applied microbiology, in addition to pharmacology & pharmacy. Three medical fields produced less than 100 SCI papers, but more than 50 papers: dermatology & venereal diseases, surgery, and urology & nephrology. About one half of the specialties (24/47) contributed less than 20 SCI papers in ten years. Not a single SCI paper was published by Korean medical doctors in that decade in the following four medical specialties: geriatrics & gerontology, legal medicine, rheumatology, and substance abuse.

In about three fourths (33 fields) of medical fields, not one paper was contributed to the SCI for a number of years. There are ten fields which produced at least one paper every year during the ten years of the 1980s, five of them being the specialties which produced more than 50 SCI papers.

Growth of medical literature

As examined above, the overall mainstream publication activity of Korean medicine in the 1980s was insignificant. However, if we examine the publication output year by year, then we find optimistic signs that publication activity has improved over the years. First, the numbers of papers contributed to the SCI have increased every year in almost every specialty area of Korean medical research. Table 7 summarizes the number of fields by the number of papers contributed to the SCI from a field. At the most, six papers were published from one medical field in 1980. However, the number of fields which produced a larger quantity of papers has increased over the years. In the middle of the 1980s, there were several medical fields which have produced ten to twenty papers a year. In 1989, not only has the number of medical fields with ten to twenty papers increased to almost a dozen, but also the maximum number of papers from a field has expanded to over 60. Secondly, the number of the fields which produced no SCI papers has gradually decreased over the years. In 1980, one half of the 47 medical specialties examined (23), contributed not a single paper to the SCI. Yet in 1985, the number of such medical specialties decreased to 16, and in 1989, to ten.

Fig. 1 demonstrates the growth of medical literature over the years. There is not much difference in the growth rates between clinical medicine and biomedical research. Clinical medicine papers have increased by 756% in ten years, and biomedical research papers by 715% (The hypothesis test that the growth pattern of the two groups is not different (c2) is not rejected at the significance level $p < 0.05$). The growth of medical literature was rather slow in the earlier part of the 1980s. However, the growth rate showed a rapid increase after 1986, coinciding with the sudden increase in the number of English-language Korean medical journals being published around that time. Of the 14 English-language medical journals currently published in Korea (Table 8), six journals began publication after 1985, and four journals were transformed into English-language journals from Korean-language journals after 1984. Awareness of the need to internationalize Korean medical papers at that time motivated ambitious authors to pursue publication in international journals, and am-

Table 7. Number of Medical fields by Number of Korean Papers Contriubted to the SCI in Each Year

No.of Papers	No. of medical specialties									
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	23	18	17	17	19	16	14	13	11	10
1	8	16	12	13	6	11	7	6	3	3
2	7	5	7	5	6	5	8	4	5	6
3	3	3	6	3	3	4	4	3	8	2
4	3	1		3	5	2	4	5	4	2
5	1	1	1	2	2	2	2	2	4	2
6	1				1	2	1	2	2	1
7				1	1		2	3		5
8		1	2		1		1		2	2
9				1				2	1	2
10						1		2		2
11		1	1			1	1		1	1
12					1		1		1	
13				1						
14						2		1		1
15									2	
16							1			2
17										1
18								1		
19										
20									1	
21								2		
22									2	
24								1		1
28										1
29					1					1
44										1
67										1
—[a]	1	1	1	1	1	1	1			

[a]of the total 47 medical specialties, of one field, legal medicine, was not used in the SCI until 1987.

bitious medical societies to turn Korean journals into international journals: as a first step, into English-language journals.

Comparison with chemistry

Mainstream publication activity

The total number of Korean papers found in the SCI for the ten-year period starting in 1980 and ending in 1989 is 7, 059 (Table 5). 17.5% (1,236/7, 059) of SCI Korean papers are published in medical journals, and 23.1% (1,629/7,059) are published in chemistry journals (Fig. 3). If the BKCS papers are excluded, then 10.5% (738 /7,059) of SCI Korean papers are published in non-Korean chemistry journals. Papers publish-

Table 8. English-Language Medical Journals Currently Published in Korea

Journal	Freq	Year pub. began	Indexed[b] by
Annals of Dermatology	A	1989	EM
Bulletin of the Clinical Research Institute	A	1973	
Chonnam Journal of Medical Science[a]	SA	1964 / 1988	
Journal of the Korean Cancer Research Association[a]	SA	1968 / 1984	CA, EM
Journal of Korean Medical Science	Q	1986	BA, EM, MED
Journal of the Korean Orthopaedic Association (Eng ed.)	A	1986	
Korean Journal of Biochemistry[a]	SA	1964 / 1975	BA, CA, EM
Korean Journal of Internal Medicine (Eng ed.)	SA	1986	BA, MED
Korean Journal of Ophthalmology	SA	1987	MED
Korean Journal of Pharmacology[a]	SA	1965 / 1985	BA, CA, EM
Korean Journal of Toxicology	A	1985	CA
Seoul Journal of Medicine[a]	Q	1960 / 1985	BA, CA, EM
Yonsei Medical Journal	Q	1960	BA, CA, EM, MED
Yonsei Reports on Tropical Medicine	A	1970	BA, CA, EM

[a]Started as a Korean-language journal, but changed into an English-language journal in the year indicated as the second date following the year the journal began publication.

[b]BA: BIOSIS (Biological Abstracts) CA: CAS (Chemical abstracts)
EM: EMBASE (Excerpta Medica) MED: MEDLINE (Index Medicus)

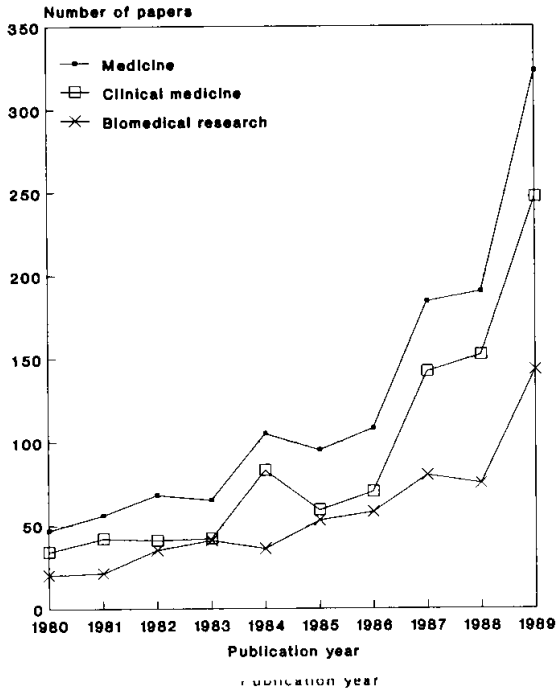

Fig. 1. Growth of Korean medical papers published in SCI journals during the 1980s. The addition of two points in each year, indicated for clinical medicine and x for biomedical research in the graph, exceeds, the total number of SCI Korean medical papers, because papers published in interdisciplinary journals are classified into more than one subject categories in the SCI database

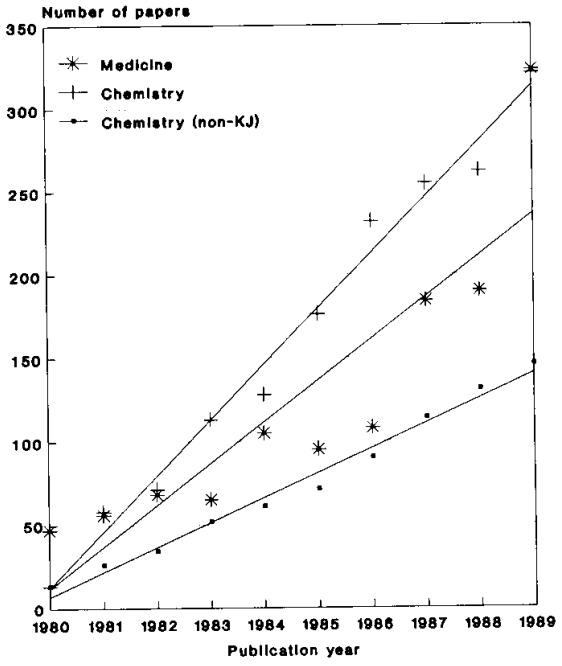

Fig. 2. Growth of Korean medical and chemistry papers published in SCI journals during the 1980s

ed in the one and only Korean SCI journal of the 1980s comprise 12.6% (891/7,059)[6] of all SCI Korean papers, or 54.7% (891/1,629) of SCI Korean chemistry papers. It is to be noted that the inclusion of a Korean journal into the SCI database more than doubled the mainstream output of Korean chemistry and increased the total mainstream output of Korean sciences at least by 10%.

Medicine is a discipline of vast scope. For instance, 47 subject categories are used in this study to define medicine whereas six are enough to define chemistry. Also, compared with chemistry, it has many more personnel engaged in various medical specialties. For example, the number of medical faculty employed in Korean universities in the academic year of 1990 was 3, 620, whereas the number of chemistry faculty was 494 (KCUE, 1990). Thus, the absolute numb-

[6] A discrepancy exists between the number in Table 3 (906 papers) and the number used here (891 papers), because some of the entries from the *BKCS* are by foreign nationals not affiliated with Korean institutions. The search statement JN = Bulletin of the Korean Chemical Society retrieves every paper published in the journal including papers contributed from other countries.

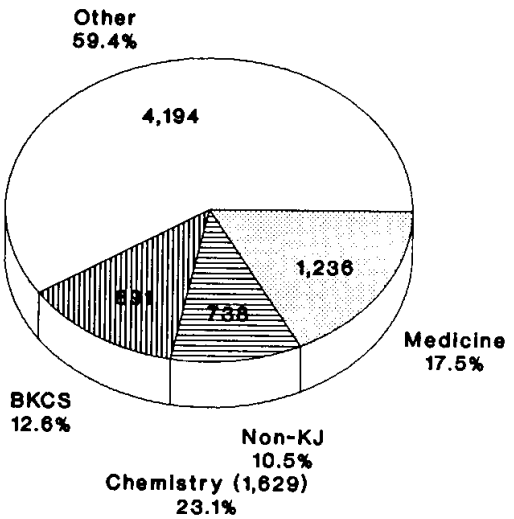

Fig. 3. Mainstream publication output: medicine vs chemistry (Total 7,059 papers). A discrepancy exists between the number of BKCS papers used here (891 papers) and the number in Table 5 (906 papers), because some of the entries from the Korean journal are by foreign nationals not affiliated with Korean institutions. The search statement JN = Bulletin of the Korean Chemical Society retrieves every paper published in the journal including papers contributed from other countries

er of SCI medical papers produced by Korean researchers is very disappointing, compared to that of chemistry (1,236 vs 1,629). The mainstream paper production rate per faculty member is at least five times higher in chemistry than in medicine. An average of 1.49 (738/494) papers (or 3.30 (1,629/494) if the BKCS papers are included) were produced by a Korean chemistry faculty member in ten years, whereas an average of 0.34 (1,236/3,620) papers were produced by a Korean medical faculty member.

If we compare the proportion of mainstream medical papers among all Korean medical papers produced during the 1980s to that of chemistry, we come up with even more disappointing results for medicine. It was mentioned earlier that approximately 50,000 medical papers were published in Korean journals in the same period. Thus, 1,236 Korean medical papers published in SCI (non-Korean) medical journals comprise 2.4 % (1,236/51,236) of all (i.e., mainstream and non-mainstream) Korean medical papers produced in ten years of the 1980s. In the case of chemistry, altogether 1,741 chemistry papers were published between 1980 and 1989 in three journals published by the Korean Chemical Society[7]. Of these, 835 papers were published in two non-SCI chemistry journals, and the rest in the BKCS. That is, the total number of Korean chemistry papers published in the 1980s is 2, 464: 835 non-SCI and 1,629 SCI papers. Thus, 66.1 % (1,629/2,464) of Korean chemistry papers are mainstream papers. To be more strict (i.e., if the SCI Korean chemistry journal papers are excluded), 30.0 % (738/2,464) of total Korean chemistry papers produced in the 1980s are published in mainstream non-Korean journals. The proportion of mainstream papers among all papers published by Korean researchers in chemistry is higher than that in medicine by a magnitude of at least ten (30.0 % vs 2.4 % or 66. 1 % vs 2.4 %).

Literature growth

Fig. 2 shows the growth pattern of SCI Korean

[7] The Korean Chemical Society is a centralized organization with approximately 2,000 members, and plays a key role in chemistry journal publication in Korea. It published four major journals during the 1980s. Except for one journal, *Chemworld*, which is the society's official newsletter, they are scholarly journals. It is no exaggeration to say that almost all of the scholarly chemical literature published in Korea is published in these three journals, even though there are a dozen chemistry related journals published by other associations and societies, e.g., *Journal of the Korean Institute of Chemical Engineers (Hwahak-Konghak)*.

medicine and chemistry papers during the 1980s. Chemistry papers published in SCI journals have continuously increased over the years at a constant rate. The growth pattern is linear whether the BKCS papers are included or not. Pearson Correlation Coefficient (g) to measure the strength of linear association between number of papers and the publication years is 0.9927 ($p < 0.001$), or 0.9920 ($p < 0.001$) if BKCS papers are excluded. The growth pattern of medical literature is also linear ($g = 0.8818$, $p < 0.001$). Nonetheless, as explained earlier, a big change in the growth rate around 1986 is noteworthy: growth was more rapid in the second half of the 1980s.

The growth rate of mainstream papers published by Korean scientists in the 1980s is much higher in chemistry than in medicine. The hypothesis test that the growth of medicine is not different from that of chemistry (c2) is rejected at the significance level $p < 0.01$, whether the BKCS papers are included or not. The medical literature increased by 687% in ten years. The chemistry literature has increased by 2,469%. If limited to non-Korean chemistry journal papers, it has increased by 1,123%. That is, the growth of SCI Korean chemistry literature was at least twice rapid than that of medicine.

During the 1980s, the growth rate of Korean chemistry literature was not only higher than that of medicine, but also higher than that of all sciences combined. The total SCI Korean literature has increased by 1,018% in ten years. Again, if limited to non-Korean journal papers (i.e., if BKCS papers are excluded), it has increased by 905%. On the other hand, the rate of medicine was much lower than that of all sciences combined.

In summary, the overall mainstream publication activity of Korean medicine during the 1980s was not satisfactory, especially compared to that of Korean chemistry. A larger number of chemistry papers than medical papers were published during the ten-year study period in the SCI journals by scientists whose addresses are in Korea, owing to the SCI Korean chemistry journal which is responsible for more than 50% of the SCI Korean chemistry papers. A rather striking difference in mainstream performance between medicine and chemistry is the ratio of mainstream and non-mainstream literature in each discipline. An extremely large number (about 50,000) of medical papers are published in Korean journals (i.e., non-SCI journals) during the 1980s. Thus, 1, 236 mainstream Korean medical papers published in the SCI journals make up for only 2.4% of all Korean medical papers published during the 1980s. On the other hand, 738 papers published in SCI non-Korean chemistry journals comprise 30.0% of all Korean chemistry papers (about 2,500) published during the same period. If the BKCS papers are included, 66.1% of Korean chemistry papers are mainstream papers. Both medical and chemistry papers have grown in numbers over the years. However, the growth rate was twice as high in chemistry (11.2 times, the BKCS papers are excluded) as in medicine (6.9 times). In fact, the growth rate of chemistry was higher than that of all sciences combined (9.0 times), and the growth rate of medicine was lower than that of all sciences combined.

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