Korean Mainstream Medical Papers Published in the 1980s

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초 록

"국제적으로 영향력 있는 학술지"에 실린 한국 의학 논문들의 실태와 그 파급 효과에 관한 연구가 지금까지 별로 없었기 때문에, 그 실태를 정확히 파악 할 수 있는 연구의 필요성이 절실히 요구되어지고 있다. 따라서 본 논문에서는 국내에 있는 여러 의학 관련기관의 연구자들이, MEDLINE, EMBASE, SCI가 색인, 초록하고 있는 "영향력 있는 외국 학술지"에 1980년에서 1989년 사이에 발표한 의학 논문의 숫자와 그 증가상태를 측정해 보았다. 비교의 목적으로, SCI가 취급하는 학술지에 실린 화학논문에 대한 조사도 병행하였다.

ABSTRACT

A review of literature discussing the status and impact of mainstream Korean research revealed that there have been few studies carried out to investigate the status of Korean mainstream medical research and that we need to know exact status of Korean medical papers published in mainstream journals. Accordingly, a study is undertaken to measure mainstream medical publication output by authors at Korean institutions and its growth during the 1980s as recorded in MEDLINE, EMBASE and SCI. For comparison purpose, a measurement of mainstream publication output of chemistry, a scientific field which showed the best mainstream performance, is also made. The database searching is limited to SCI for chemistry records.

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1. Introduction

Any researcher who desires the broadest possible exposure and recognition of his work would much prefer to publish his findings in highly cited, international journals. Korean medical researchers have been criticized for not publishing much in those journals. Korean medical researchers are concerned also about the quality of their research because their papers do not seem to be used (i.e., cited) internationally or domestically. Since not much is known specifically about the performance of Korean medical research in world science, the discomfort among Koreans may be somewhat exaggerated. That is, it is obviously necessary to gather information to assess the degree of "mainstream" performance by Korean medical researchers.

Definition of "Mainstream" Science

Several studies[1] have been conducted to measure a nation's impact on world science by its publication output in "mainstream" journals, Though there are many arguments about how to interpret such measurements.[2] Frame, Narin and Carpenter used the Science Citation Index (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.[3] Thus, "mainstream" performance has been measured using the SCI database in those studies and "mainstream" journals have been defined as any journals indexed in SCI. These journals are selected on the basis of several criteria, including citation analysis, resulting in coverage of the most frequently cited publications in the scientific,

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1) For instance, a series of reports by T. Braun, W. Glänzel and A. Schubert, such as "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", which appear in *Scientometrics* 11 : 9-15, 127-40, 12 : 3-16, 13 : 181-88, 14 : 3-15, 14 : 365-82 are rather well known studies. Eugene Garfield, "Mapping Science in the Third World," *Science & Public policy* 10 (1983) : 112 · 7.

2) Thomas O. Eisemon and Charles H. Davis argue that if we look solely at Third World articles published in mainstream journals, we see only a tiny fraction of the work being carried out by scientists in developing countries · · · However, by restricting ourselves to mainstream papers, at least we have some assurance that this work meets some minimal international standards of quality. "Publication Strategies of Scientists in Four Peripheral Asian Scientific Communities : Some Issues in the Measurement and Interpretation of Non-mainstream Science," in *Scientific Development and Higher Education : the Case of Newly Industrializing Nations*, eds by Philip G. Altbach, et al. (New York : Praeger, 1989), p.28.

3) J. Davidson Frame, F. Narin and M. Carpenter, "The Distribution of World Science," *Social Studies of Science* 7 (1977) : 502.

technical and biomedical literature.[4] SCI database covers the top 10% of all scientific journals published worldwide.[5]

Mainstream Korean Medical Journals

There are no Korean medical journals covered in SCI.[6] Therefore, in terms of the restrictive definition given above, there are no mainstream Korean medical journals. However, other large databases exist that provide worldwide access to scientific (medical) literature. Although it is true that the inclusion of Korean medical journals in international databases of importance does not guarantee their use, such inclusion means they are findable and makes them more accessible to the world scientists. So, I will extend the definition of a mainstream journal as follows : a Korean medical journal will be defined as a mainstream journal if it is indexed by renowned international abstracting and indexing services in the area of medicine, for my purpose, MEDLINE and EMBASE (Excerpta Medica online database).[7]

Unfortunately there are still very few Korean journals covered by these two databases among the approximately 100 scholarly medical journals currently published in Korea. (125 journals are indexed in the *Korean Index Medicus : 1992.*) Seven titles are covered in MEDLINE. Two of them are dentistry journals and another two are nursing journals.[8] Therefore, there are three Korean medical journals indexed in MEDLINE. Until recently, only one Korean journal was indexed in *Index Medicus* : *Yonsei Medical journal* published by the College of Medicine at Yonsei University. The journal was indexed by the database from 1964. *The Journal of the Korean Medical Science* and the *Korean Journal of Ophthalmology* were picked up by the database immediately when the journals began publication in 1986 and in 1987. All these three journals are published in English from cover to cover.

15 medical journals were covered by the

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4) *DIALOG SCISEARCH Bluesheet* (Palo Alto, CA : DIALOG Information Services, Inc., revised April 1987), p.34-1.

5) David P. Hamilton, "Research Papers : Who's Uncited Now?" Science 251 (January 4, 1991) : 25.

6) By contrast, one Korean journal in the field of chemistry is included in SCI.

7) While other online abstracting and indexing services such as Biological Abstracts (BA) and Chemical Abstracts (CA) index a larger number of Korean medical journals than these two databases, providing some access to these journals, MEDLINE and EMBASE are the most central to the medical profession.

8) Dentistry and nursing will not be included in the scope of medical literature used for this study. For detailed explanation, see later section *Scope of Medical Literature*.

Excerpta Medica/EMBASE during the 1980s.[9] All original articles and significant contributions from four journals—the *Korean Journal of Pharmacology*, the *Korean Journal of Physiology, Tuberculosis and Respiratory Diseases*, and the *Yonsei Medical Journal*—are normally included in the database. But, articles of the other 11 journals are screened selectively for inclusion into the database.[10] None of the Korean medical journals were indicated as priority journals selected for rapid input of citations and abstracts. Since, this database includes almost a dozen Korean-language journals, Korean-language papers as well as English-language papers are abstracted. Contribution of Korean journals to the EMBASE during 1988 is 0.26% of the total input to the database (Rank 29 among 70 countries).[11]

Since Korean medical journals have not received recognition within the international databases in spite of the efforts of Korean medical journal publishers to be integrated into the international medical communication network,[12] the surest way for Korean medical researchers to disseminate their findings internationally is by publishing in non-Korean mainstream journals. This is possibly a major reason why Korean medical researchers are so much concerned about their rate of publication in international journals published by mainstream countries. But also, there is pressure on scientists working in peripheral countries[13] in general to publish their findings in international journals, which are seen to be more important—and more prestigious—than local journals.[14] There is a general feeling among Koreans that the best science is published in international journals, and that domestic journals are ignored by their

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9) There were five more titles covered in EMBASE during the 1980s that are not included in the Korean Index medicus. They are the *Archives of Pharmacal Research*, the *Korean Journal of Pharmacognosy*, the *Research Reports of the Forest Research Institute*, the *Research Reports of the Office of Rural Development*, and the *Yakhak Hoeji*.

10) The basis for the selection is originality of an article. "Introduction" *List of journals abstracted : 1990*, (Amsterdam : Excerpta Medica, c1989).

11) "Percentage Contribution of Journals by Country of Origin," *List of Journals Abstracted by Excerpta Medica : 1989*, (Amsterdam : Elsevier, 1989), p. 2.

12) For example, some articles are in English (sometimes with Korean abstracts accompanying the English text). English abstracts are almost always required to accompany Korean text articles. Bibliographic information for journal titles and for every article included in these journals is given both in Korean and English.

13) Eisemon and Davis assess the characterization of scientific output of South Korea, Taiwan, Singapore and Malaysia as peripheral, as being of little consequence to world science in "Publication Strategies of Scientists," p. 325.

14) Philip G. Altbach, "Higher Education and Scientific Development : the Promise of Newly Industrializing Countries," in *Scientific Development and Higher Education : the Case of Newly Industrializing Nations*, eds. Philip G. Altbach, et al. (New York : Praeger, 1989), p. 5.

colleagues. Therefore, they prefer to publish in mainstream non-Korean journals rather than in mainstream Korean journals if they have a choice.

Interestingly enough, the same attitude was also found among Japanese scientists, even though Japan is not a peripheral country in any sense.[15] For instance, Stankus, Rosseel and Littlefield[16] found that the researchers in nine highly visible Japanese institutions[17] export about 60% of their papers (35% in American journals and 25% in European journals), and that the best (i.e., the most highly cited) papers appear in American journals, then in European journals, then finally in Japanese journals.[18] Fundamental characteristics of the journals where the most highly cited Japanese papers are published is that these journals are the most cited in their subjects. Based on these experiments, they concluded that Japanese themselves place primary emphasis on appearing in highly cited American and European titles.

It is clear that most researchers would rather publish their best research results in highly cited mainstream journals. The desire of Korean medical researchers to publish in mainstream non-Korean journals is quite understandable, because Korean journals are rarely covered in international databases, and because it is very unlikely that even a mainstream Korean journal would have the power to attract foreign readers.

2. Korean Mainstream Medical Research

Growth of Korean Mainstream Papers

Korean researchers may not have published as much as they would wish in mainstream journals, but the number of Korean mainstream papers has increased a great deal over the last decade. Korean scientists contributed 0.08 percent of the papers in internationally recognized journals indexed in SCI (i.e., "mainstream" journals) from 1981 to 1985 according to Braun, Glänzel and Schubert's

15) It usually ranks third in the world's publication output (refer to Table 1).

16) Tony Stankus, Kevin Rosseel and William C. Littlefield, analyzed 3,634 papers in SCI 1983-1985, which were published by researchers in 9 Japanese institutions with highly visible mainstream activity identified by the *Corporate Index* of *SCI*. "Is the Best Japanese Science in Western Journals?" *The Serials Librarian* 14, nos. 1-2 (1988) : 95-107.

17) NEC, Hitachi and Fujitsu companies were chosen for high technology research, and Dainippon Pharmaceutical, Ajinomoto and Tanabe were chosen for biotechnology research. Three universities-Tokyo, Osaka and Nagoya-were selected for both disciplines.

18) Impact factors were determined for citations to 7,835 Japanese papers from 1982 to 1984 in 6 Japanese, 6 European and 6 American journals with each set matched for subject.

data.[19] That is quite an increase from only 0.03 percent during the period from 1978 to 1980[20] as summarized in Table 1. During 1978－1980, Korean mainstream scientific papers[21] were published at the rate of 118 articles per year. The rate has almost tripled to 312 articles per year during 1981－1985. As indicated in Figure 1, the increase in the proportion of research papers originating from Korean institutions (percentage share of world publication output) during 1980－1985 was very dramatic. Another study conducted by Eisemon and Davis[22] clearly shows that the growth of Korean mainstream authors, especially after 1980, has exceeded that of the other three peripheral Asian scientific communities studied (Figure 2). The absolute number of mainstream scientists has grown more than in the other peripheral countries as well (Figure 3).

Slow Growth of Korean Mainstream Medical Papers

It is demonstrated in the previous section that there is growth in Korean mainstream science in general. However, there are signs that medicine is showing a slower increase than other scientific fields in the production of research papers published in mainstream journals.

Braun, Glänzel and Schubert's data (Table 1 and Figure 4) indicate that during 1978－1980, the life sciences[23] 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 SCI. However, the ranking has changed

19) T. Braun, W. Glänzel and A. Schubert, "The Newest Version of the Facts and Figures on Publication Output and Relative Citation Impact of 100 Countries," *Scientometrics* 13, nos. 5－6 (1988) : 181－88.

20) T. Braun, W. Glänzel and A. Schubert, "One More Version of the Facts and Figures on Publication Output and Relative Citation Impact of 107 Countries : 1978－1980," *Scientometrics* 11, nos. 1－2 (1987) : 9－15.

21) Original articles, reviews, notes and letters published in mainstream journals are defined as mainstream papers. Only these four publication types deserve the name citable item and no other publication type is relevant in impact oriented evaluation. T. Braun, W. Glänzel and A. Schubert, "Some Data on the Distribution of Journal Publication Types in the Science Citation Index Database," *Scientometrics* 15, nos. 5－6 (1989) : 325－30.

22) Eisemon, "Publication Strategies of Scientists," p. 325.

23) In their series of "Facts and Figures of Publication Output and Relative Citation Impact," Braun, Glänzel and Schubert regrouped clinical medicine, biomedical research and biology into life sciences. However in the present study, only clinical medicine and biomedical research are included in the scope of medical literature to be examined. Detailed explanation of the classification and grouping of scientific subfields into fields appears in another section, *Scope of Medical Literature*.

TABLE 1

PUBLICATION OUTPUT AND RELATIVE CITATION IMPACT

Country	1978–1980				1981–1985			
	Rank	Output	% share	RCR	Rank	Output	% share	RCR
All science fields combined								
Korea	51	354	0.031	0.65	42	1,561	0.08	0.53
USA	1	407,726	36.34	1.03	1	751,635	36.67	1.05
Japan	4	70,794	6.31	0.93	4	139,645	6.81	0.90
Life sciences								
Korea	65	103	0.017	0.89	58	271	0.024	0.72
USA	1	250,941	40.34	1.01	1	460,861	40.33	1.04
Japan	5	31,557	5.07	0.90	3	64,663	5.66	0.86
Chemistry								
Korea	48	74	0.047	0.69	35	522	0.198	0.62
USA	1	32,302	20.7	1.04	1	59,596	22.57	1.07
Japan	3	16,084	10.31	0.97	3	29,348	11.12	0.98
Physics								
Korea	44	86	0.048	0.44	39	389	0.100	0.36
USA	1	58,742	32.55	1.10	1	134,937	34.71	1.09
Japan	3	13,542	7.50	0.90	3	26,761	6.88	0.88
Mathematics								
Korea	51	11	0.038	0.63	44	57	0.108	0.53
USA	1	11,895	41.06	1.06	1	21,423	40.60	1.08
Japan	7	1,229	7.50	0.88	6	2,630	4.98	0.85
Engineering								
Korea					36	434	0.199	0.65
USA					1	85,494	39.21	1.09
Japan					2	20,851	0.56	0.98

COMPILED FROM : T. Braun, W. Glänzel 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.

NOTE : RCR (Relative Citation Rate) is ratio of observed to expected citation rate.

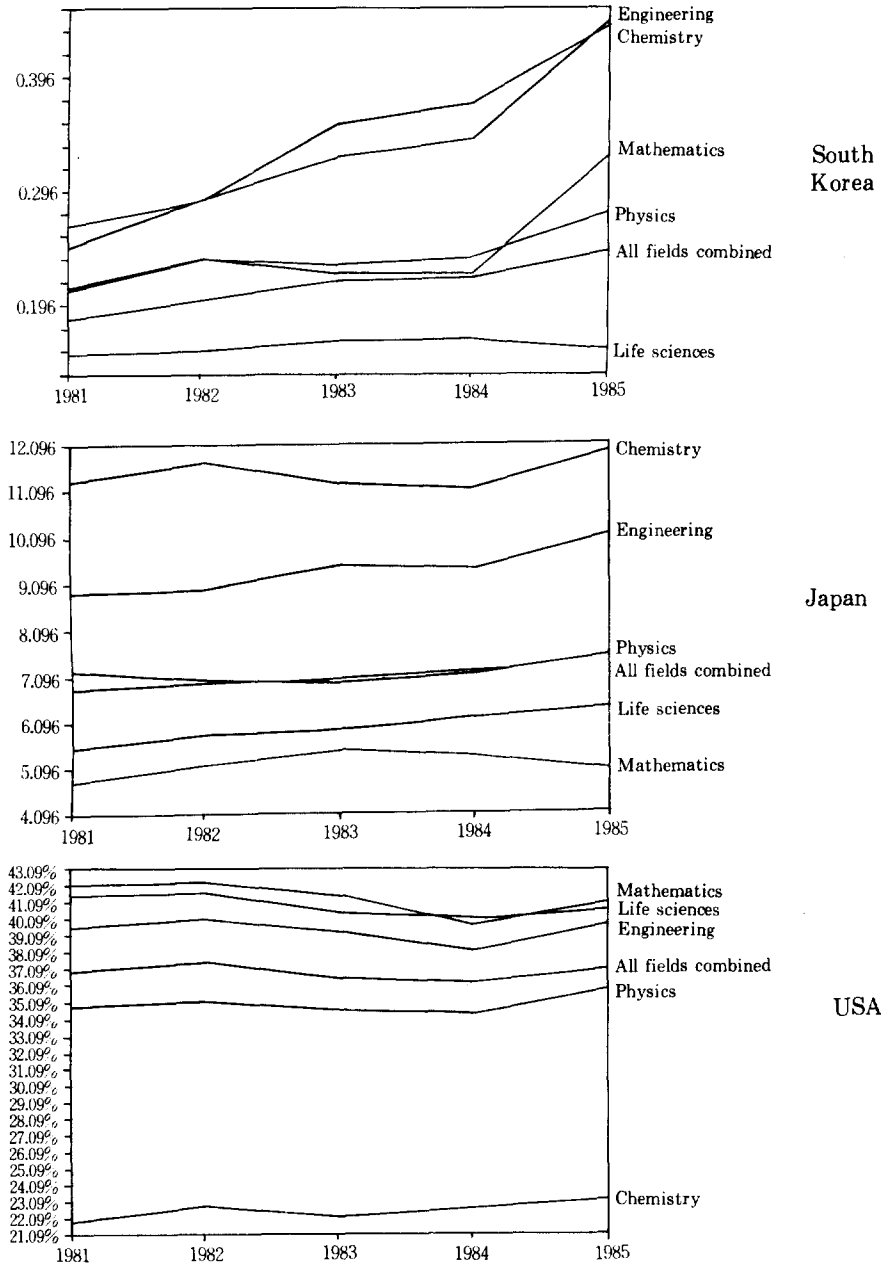

Fig. 1. World share in publications : year by year

SOURCE : A. Schubert, W. Glänzel and T. Braun, "Scientometric Datafiles : a Comprehensive Set of Indicators on 2,649 Journals and 96 Countries in All Major Science Fields and Subfields," Scientometrics 16, nos. 1−6(1989) : 431, 418, 438.

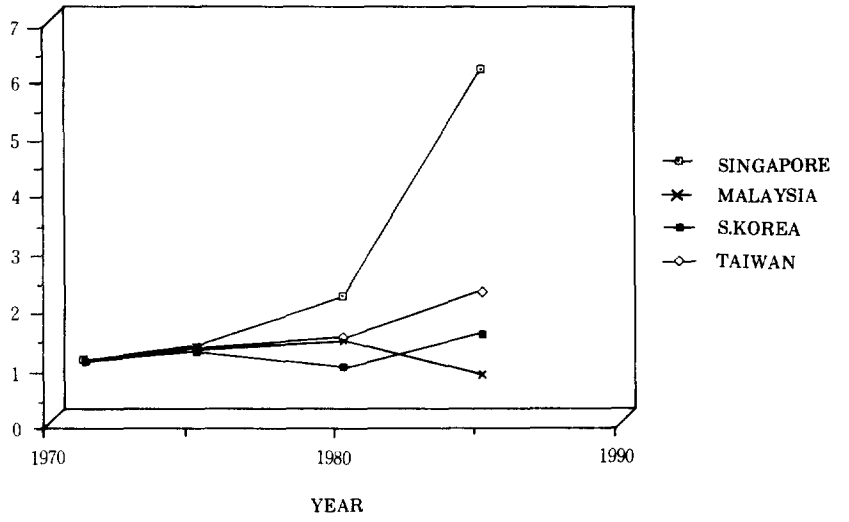

Fig. 2. Relative growth, four countries

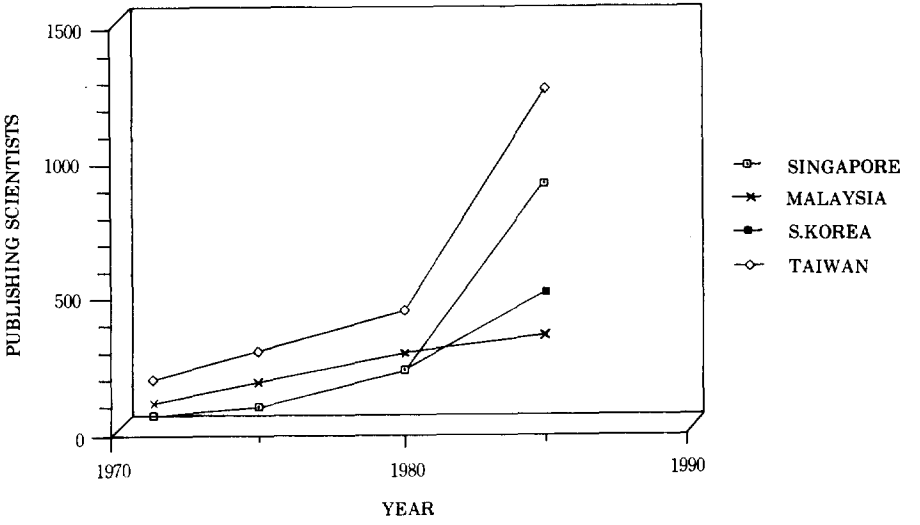

Fig. 3. Mainstream science in four countries

SOURCE : Thomas O. Eisemon and Charles H. Davis, "Publication Strategies of Scientists in Four Peripheral Asian Scientific Communities : Some Issues in the Measurement and Interpretation of Non-mainstream Science," in Scientific Development and Higher Education : the Case of Newly Industrializing Nations, eds. Philip G. Altbach, et al. (New York : Praeger, 1989), p. 369.

South Korea : 1981~1985

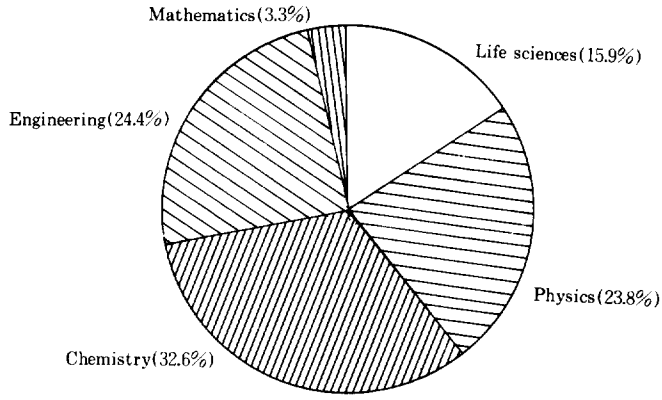

Fig. 4. Distribution of papers by major fields

SOURCE : A. Schubert, W. Glänzel and T. Braun, "Scientometric Datafiles : a Comprehensive Set of Indicators on 2,649 Journals and 96 Countries in All Major Science Fields and Subfields," Scientometrics 16, nos. 1-6 (1989) : 431

	1980 N	%	1985 N	%	% Change, 1980 to 1985
Korea					
Agriculture	9	5.9	5	0.6	-44.4
Behavioral Science	2	1.3	7	0.9	250.0
Biology	21	13.8	66	8.4	214.3
Chemistry	18	11.8	223	28.3	1138.9
Computers	3	2.0	13	1.6	333.3
Energy	2	1.3	0	0.0	-100.0
Engineering	20	13.2	119	15.1	495.0
Forestry	1	0.7	0	0.0	-100.0
Geosciences	2	1.3	18	2.3	800.0
Materials Science	2	1.3	24	3.0	1100.0
Mathematics	4	2.6	14	1.8	250.0
Medicine	26	17.1	108	13.7	315.4
Metallurgy	2	1.3	49	6.2	2350.0
Multidisciplinary	2	1.3	5	0.6	150.0
Physics	38	25.0	124	15.7	226.3
Unidentified	0	0.0	14	1.8	n/a
Total	152		789		419.1

Fig. 5. Mainstream scientific publications by field

SOURCE : Thomas O. Eisemon and Charles H. Davis, "Publication Strategies of Scientists in Four Peripheral Asian Scientific Communities : Some Issues in the Measurement and Interpretation of Non-mainstream Science," in Scientific Development and Higher Education : the Case of Newly Industrializing nations, eds. Philip G. Altbach, et al. (New York : Praeger, 1989), p. 355.

over the years, with chemistry produced the most publications, 33.4% (522/1,561), and the life sciences comprised 17.36% (271/1,561)[24] in the 1980−1985 period. Eisemon and Davis' data (Figure 5) also illustrates this point : where chemistry has increased 1138.9% over the years from 1981 to 1985, medicine increased by a more modest 315.4%, biology[25] increased by only 214.3%.

My speculation is that the Korean medical education and training system may have contributed to this relatively slow increase in mainstream medical publication output. Almost all the Korean physicians complete their entire education and medical training in Korea, and almost all the faculty members of medical colleges and of affiliated teaching hospitals hold degrees from Korean universities. More specifically, faculty members of a medical college are usually the graduates of the same medical college where they are currently employed (that is, the so-called inbreeding ratio[26] is very high among medical faculty members). Therefore, it is very unlikely that they are exposed to international communication networks while they are studying and being trained. Their chances for international contact are limited, and thus these scholars have few opportunities to move quickly into the international mainstream.

On the other hand, there are very large numbers of Korean scientists with foreign doctoral degrees in science and engineering, and the numbers are still increasing. While they were studying and doing research in more industrialized countries, they can and often do publish in mainstream journals. In that process, they might have learned effective strategies for publishing in mainstream journals. Some retain personal relationships and continue to exchange ideas, papers and visits with other researchers in "mainstream" countries even after they have returned to Korea.[27] A consequence of this trend is elo-

24) In theory, percentage of distribution by fields in Figure 4 should be the same as these numbers calculated from Table 1 since they are derived from the same dataset compiled by the same researchers. The reasons for slight discrepancies could not be identified from the information given in their papers.

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

26) The practice of filling faculty positions with its own graduates whose highest degrees are from the employing institution is defined as institutional inbreeding. Faculty members are identified as inbred if they held a terminal degree from the institution at which they are teaching. The inbreeding problem is discussed in depth in the author's unpublished paper "Inbreeding of Medical and Chemistry Faculty in Korean context."

27) As Eugene Garfield suggested, including a scientist from a developed country on the research team may be an effective strategy for increasing the impact of third world research. "Mapping Science in the Third World," p. 119.

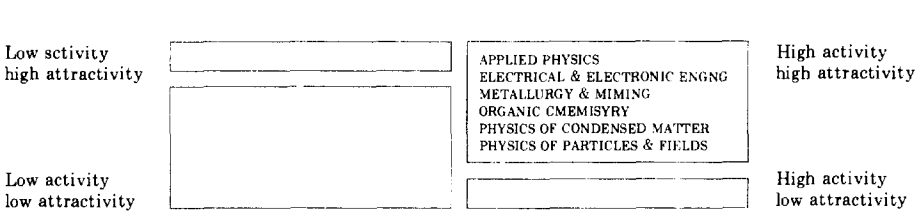

Fig. 6. Scientific subfields
of extreme activity and/or attractivity
(1981−1985 period)

SOURCE : A. Schubert, W. Glänzel and T. Braun, "Scientometric Datafiles : a Comprehensive Set of Indicators on 2,649 Journals and 96 Countries in All Major Science Fields and Subfields," Scientometrics 16, nos. 1−6 (1989) : 467.

quently demonstrated by a rapid growth of publication output by Korean scientists in mainstream journals, especially after 1980. The growth rate of Korean medical publications is comparably slower.

An explanation may be needed as to why 1980 seems to be a turning point for a relative decrease in the growth rate of medical papers. Until the late 1960's, most of the doctoral degree holders in Korea were medical doctors. More correctly, most of the doctoral degrees conferred in Korea were in medicine.[28] There were not many science and engineering Ph.D's, especially earned from universities in foreign countries. As Korea was industrialized,[29] the national emphasis was given to the development of science and technology, and related programs were expanded in universities, consequently producing many graduates to work in industry. In comparison, medical research manpower became relatively small.[30] In the meantime, many students majoring in science and engineering have taken up studies in foreign countries. Since the early 1970s[31] there has been a national effort to induce Korean scientists with reputations in foreign countries to come back to Korea to teach and to do strategic research. The number of foreign science and engineering degree holders

28) 85.6% (244/285) of doctoral degrees conferred in Korea during 1952−1963 was in medicine. *Moongyo Tonggye Yoram* [*Annual Survey of Education*] : 1963, p.326.

29) It is generally said industrialization of Korea began in 1961 with President Park's the Third Republic.

30) 20.02% (525/2,623) of doctoral degrees conferred in Korea was in medicine in 1989. *Moongyo Tonggye Yonbo* [*Statistical Yearbook of Education*] : *1989, p.684−685.*

31) Korea Advanced Institute for Science and Technology (KAIST) was found in 1971. It is supposed to be a driving force for Korean mainstream research in science and technology.

working in Korea has increased since then. The increase seemed very dramatic, especially after 1980.

Eisemon and Davis state that "chemistry, physics, engineering, and medicine dominate the South Korean profile of mainstream science. Most remarkable is the substantial expansion of chemical research and the development of capacity in two industrial specialties, materials science and metallurgy."[32] The inclusion of the *Bulletin of the Korean Chemical Society* in the SCI database since 1981 may have contributed to the rapid growth in the number of Korean chemistry papers in the international scene. The *Bulletin* is the only Korean journal indexed in SCI, therefore the only mainstream Korean journal in the strict sense noted above. This may be interpreted as an indication that chemistry is much more active, or at least more internationally visible, than other scientific fields. Schubert, Glänzel and Braun also identified organic chemistry is one of the scientific subfields showing high activity and high attractivity[33] in South Korea (Figure 6).

Methodology

The brief review of literature discussing the status and impact of mainstream Korean research revealed that there have been few studies carried out to investigate the status of Korean mainstream medical research and that we need to know exact status of Korean papers published in mainstream journals. Accordingly, it is appropriate to measure mainstream medical publication output by authors at Korean institutions and its growth during the last ten years (1980−1989) as recorded in MEDLINE, EMBASE and SCI. The identification of Korean papers will be limited to papers published in non-Korean mainstream journals. Papers in Korean journals indexed in these international medical databases, even though they certainly are international papers, do not fall into the immediate scope of the present study. For comparison purpose, a measurement of mainstream publication output of chemistry, a scientific field which showed the best mainstream performance, will also be made. The database searching will be limited to SCI for chemistry records.

Databases to be Searched

MEDLINE, produced by the U.S. National

32) Eisemon, "Publication Strategies of Scientists," p. 336.

33) High attractivity reflects the fact that the country's citation impact in the given scientific subfield is higher than world average. T. Braun, W. Glänzel and A. Schubert, "Scientometric Datafiles : a Comprehensive Set of Indicators on 2649 Journals and 96 Countries in All Major Science Fields and Subfields," *Scientometrics* 16, nos. 1−6(1989) : 13.

Library of Medicine (NLM), is the most important database in the medical field and the printed *Index Medicus* has been available without fee to Korean doctors from very early on.[34] It covers virtually every area in the broad field of biomedicine and indexes articles from 3,353 journals published in over 70 countries. Abstracts, which are taken directly from the published articles, are included for over 47% of the records added from 1975 forward.[35] Approximately 300,000 records are added each year, of which over 75% represent publications written in the English language. MEDLINE corresponds to three printed indexes : *Index Medicus, Index to Dental Literature*, and *International Nursing Index*. Additional materials not published in *Index Medicus* are included in the MEDLINE database in the area of communication disorders, and population and reproductive biology.[36]

EMBASE has long been recognized as an important, comprehensive index of the world's literature on human medicine and related disciplines. EMBASE provides access to periodical articles from more than 3,500 primary journals from over 100 countries. And additional 1,000 journals are selectively screened for relevant articles. Nearly every aspect of human medicine, including topics in the basic biological sciences with some relevance to human medicine, is covered. Nursing, dentistry, psychology, paramedical professions, podiatry, optometry, chiropractic, and homeopathy are covered selectively. An outstanding feature of EMBASE is its complete coverage of articles on drugs and potential drugs. About 300,000 records are added annually, over 60% of which contain abstracts. All journal articles are added to the database within 30 days after receipt of the journal, and all records appear online with complete indexing. Each record is classified and indexed in accordance with a highly developed classification schedule and controlled vocabulary. The EMBASE is used to produce 46 printed abstract bulletins and two printed drug literature bibliographies.[37]

SCI,[38] produced by the Institute for Scientific Information (ISI), is an international, multidisciplinary index to the literature of science, technology, biomedicine, and related

34) Probably from early 1960s.

35) Records added before 1975 do not contain abstracts ; records added from 1984 to the present have abstracts for about 59% of the records. Citations to chapters or articles from selected monographs were included from May 1976 through 1981.

36) *DIALOG MEDLINE Bluesheet* (Palo Alto, CA : DIALOG Information Services, Inc., revised February 1988), p. 152-1.

37) *DIALOG EMBASE Bluesheet* (Palo Alto, CA : DIALOG Information Services, Inc., revised July 1988), p. 72-1.

38) SCISEARCH is the correct name to refer to the SCI online database. However, SCI is used to mean both the database and the printed volumes.

disciplines. It contains all of the records published in *SCI* bimonthly issues, plus additional records from the *Current Contents* series of publications. Documents indexed for inclusion in the annual and five-year cumulative index volumes of the printed *SCI* are not entered in the SCI online database. *SCI* is distinguished by two important and unique characteristics. First, journals indexed 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. Second, in addition to the more conventional retrieval methods, *SCI* offers citation search for approximately 85% of the documents indexed.[39]

SCI has often been used in studies which aim to measure a nation's impact on world science. One of the merits of utilizing this database is the possibility that the results of the present study can be compared to other studies for the final analysis. Most importantly, SCI is the only database which provides an effective means to verify citations to and in mainstream Korean medical papers. The only limitation of using SCI is that none of the Korean medical journals are covered in the database, making it impossible to compare the characteristics and impact of medical papers in mainstream non-Korean journals to those in mainstream Korean journals. However, since the emphasis of the present study is on identification of Korean medical papers in non-Korean mainstream journals, the limitation is a minor handicap.

Search Strategy

The major task of the present study is to identify Korean medical papers in the three databases, SCI, EMBASE and MEDLINE. The identification of papers (search strategy) is very database dependent. (Search statements used to retrieve records of Korean papers published in non-Korean journals are summarized in Table 2.) It 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 whose addresses is in Korea. The decision of which scientific subfields in medicine to include is so complex and elaborate that it merits a detailed discussion in a later section, *Scope of the Medical Literature*. Briefly, a medical paper is defined as a paper in any of the scientific subfields listed under clinical medicine or under biomedical research for the tabulation of science literature indicators in *Science and Engineering Indicators* (*S&E Indicators*).[40] Two subfields, dentistry and

39) DIALOG SCISEARCH Bluesheet, p. 34-10.

40) National Science Board, *Science and Engineering Indicators* (Washington D.C. : U.S. GPO, 1973-). Hereafter cited as *S&E Indicators*.

TABLE 2

SEARCH STATEMENTS USED TO RETRIEVE RECORDS OF KOREAN PAPERS PUBLISHED IN NON-KOREAN JOURNALS

MEDLINE	EMBASE	SCI	
		Medicine	Chemistry
S1 CS=(KOREA? OR SEOUL)	S1 CS=KOREA	S1 SC=ALLERGY	S1 SC=CHEMISTRY
S2 CP=KOREA	S2 CP=KOREA	S2 SC=ANDROLOGY	S2 GL=SOUTH KOREA
S3 S1 NOT S2	S3 S1 NOT S2	·	S3 S1 AND S2
S4 JN=J KOREAN MED SCI		· 32 subject codes (SC)	S4 JN=BULL KOR CHEM SOC
S5 S3 NOT S4		· for medical specialties	S5 S3 NOT S4
		· of clinical medicine	
		·	
		S32 SC=UROLOGY & NEPHROLOGY	
		S33 SC=ANATOMY & MORPHOLOGY	
		·	
		· 15 subject codes for	
		· medical specialties of	
		· biomedical research	
		·	
		S47 SC=VIROLOGY	
		S48 S1-S23/OR	
		S49 S24-S47/OR	
		S50 S48 OR S49	
		S51 GL=SOUTH KOREA	
		S52 S50 AND S51	

NOTE : The following DIALOG files are serched for each database.

MEDLINE File 155 (1962-present)

EMBASE File 172 (1980-1984), File 72 (1985-present)

SCI File 433 (1980-1987), File 434 (1988-present)

veterinary medicine, will not be included in the study. Nursing does not constitute a subfield in *S&E Indicators*, so it is not included in the present study either.

SCI search. As a first step, all the Korean papers in the databases are to be identified. This is rather 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 to retrieve all the papers contributed from Korea. The next step is to identify all the medical papers, and this is a rather complicated process in SCI. The set of records of all the medical papers are union of all the medical specialties (i.e., Subject Category (SC) codes) listed in Table 3. Korean medical papers are identified by the intersection of the two sets : all the Korean papers and all the medical papers. All the Korean medical papers found in SCI are from non-Korean journals, so a search to separate papers into two groups (one from Korean journals and the other one from non-Korean journals) is not necessary. For retrieval purposes, the combined set of all the medical specialties is sorted by the Publication Year (PY), and the records in the sorted sets are downloaded from DIALOG SCI files.

EMBASE search. In EMBASE, the Corporate Source (CS) field is used to list the address of the authors. If authors from several institutions have collaborated in the preparation of the document, only the address of the first author is listed. The address includes country information and the names of countries are generated from a code and are therefore consistent.[41] Accordingly, there is no problem identifying papers contributed by authors in Korean institutions provided that they are the first ones listed. In the case of EMBASE, any Korean papers in the database are medical papers by definition. Veterinary medicine is not covered in this database, and nursing and dentistry are covered only selectively. Any records that turn out to belong to any of the three subfields will be deleted from downloaded files later. A search of CP=KOREA will retrieve all the papers from Korean journals in the database. By excluding all the papers in Korean journals from the set of records for all the Korean medical papers, all the mainstream Korean medical papers in non-Korean journals are identified. Then the records in two groups (one from Korean journals and the other one from non-Korean journals) are sorted by the Publication Year (PY) to obtain publication output in mainstream journals by Korean

41) *DIALOG EMBASE Bluesheet* (revised August 1980), p. 72-22.

TABLE 3

MEDICAL SPECIALTIES USED FOR THE STUDY

SCI's Subject Category	CHI's field/subfield
	Clinical medicine
1. Allergy	Allergy
2. Andrology[b]	–
3. Anesthesiology	Anesthesiology
4. Cardiovascular system	Cardiovascular system
– Dentistry & odontology[a]	Dentistry[a]
5. Dermatology & venereal diseases	Dermatology & venereal diseases
6. Endocrinology & metabolism	Endocrinology
7. Gastroenterology	Gastroenterology
8. Geriatrics & gerontology	Geriatrics & gerontology
9. Hematology	Hematology
10. Immunology	Immunology
11. Medicine, general & internal	General & internal medicine
12. Medicine, legal[b, c]	–
13. Medicine, miscellaneous[e]	Miscellaneous clinical medicine[e]
	Miscellaneous biomedicine[e]
14. Neurosciences	Neurology & Neurosurgery
15. Obstetrics & gynecology	Obstetrics & gynecology[d]
	Fertility[d]
16. Oncology	Cancer
17. Ophthalmology	Ophthalmology
18. Orthopedics	Orthopedics
19. Otorhinolaryngology	Otorhinolaryngology
20. Pathology	Pathology
21. Pediatrics	Pediatrics
22. Pharmacology & pharmacy	Pharmacology[d]
	Pharmacy[d]
23. Psychiatry	Psychiatry
24. Public health	Hygiene Public health
25. Radiology & nuclear medicine	Radiology & nuclear medicine
26. Respiratory system	Respiratory system
27. Rheumatology	Arthritis & Rheumatism
28. Substance abuse	Addictive disease
29. Surgery	Surgery
30. Toxicology[b]	–
31. Tropical medicine	Tropical medicine
32. Urology & nephrology	Urology[d]
	Nephrology[d]
– Veterinary medicine[a]	Veterinary medicine[a]

TABLE 3—continued

SCI's Subject Category	CHI's field/subfield
	Biomedical research
33. Anatomy & morphology	Anatomy & morphology
34. Biochemistry & molecular biology	Biochemistry & molecular biology
35. Biophysics	Biophysics
36. Biotechnology & applied microbiol[b]	—
37. Cytology & histology	Cell biology, cytology & histology
38. Developmental biology	Embryology
39. Engineering, biomedical	Engineering, biomedical
40. Genetics & heredity	Genetics & heredity
41. Medicine, research & experimental	General biomedical research
42. Microbiology	Microbiology
43. Microscopy	Microscopy
44. Nutrition & dietetics	Nutrition & dietetics
45. Parasitology	Parasitology
46. Physiology	Physiology
47. Virology	Virology

COMPILED FROM : "Source publications arranged by subject category", *SCI 1988 Annual : Guide and List of Source Publications.* In addition, SC codes were expanded on-line in June 1990 to update the list. Appendix Table 5—24 "U.S. and world scientific and technical publications by field and subfield : 1986," *S&E Indicators—1989.*

NOTE : Nursing is not in either list.

[a]The subject category (SC) code is not included in the present study.

[b]The SC code is used in SCI, but not a subfield in *S&E indicators.*

[c]This SC code was not used in SCI until 1986 (Dialog File 433).

[d]This is one SC code in SCI, but two separate subfilds in CHI.

[e]SCI integrates miscellaneous clinical medicine and miscellaneous biomedine into one SC, "medicine, miscellaneous". Here, it is classified under clinical medicine.

medical researchers for each year.

MEDLINE search. Corporate Source (CS) field will be used for the identification of Korean papers in MEDLINE. However, several difficulties are encountered in searching for Korean papers. The first problem is caused by the fact that the database producer of MEDLINE, unlike the other two (EMBASE and SCI), does not make an effort to supply address (country) information if it is not provided in the article. "The Corporate Source field includes the affiliation for the first named author · · · . The information is taken directly from the source in the journal article and is included for approximately one-half of the journals indexed."[42] One can assume that when a Korean author publishes in international journals, he will be conscientious enough to identify his country as part of the address, so the chances for missing these Korean papers will be very small. Also, if Korea appears as part of the institutional name, as in Korea Advanced Institute of Science and Technology (KAIST),[43] it is not a problem even if country information is not supplied, because the search CS=KOREA will still pick up the record.

Almost none of the papers in the three Korean journals indexed in MEDLINE supply country information as part of the address. However, almost all of the authors in these journals are Koreans. Therefore Journal Name (JN) or Country of Publication (CP) search is preferable for those papers. The CP field is searchable for journal articles from 1966 forward using the MeSH geographic codes from the Z category in the MeSH Annotated Alphabetic List or the MeSH Tree Structures. The code for Korea is Z1.252.474.538.[44]

The second and more significant problem using MEDLINE is that the search of Korean papers using CS can not be completed for all the years to be covered in the present study. The CS field is reportedly searchable in MEDLINE only for records added from 1987 to the present.[45] One way to compensate for the problem is to use free text searching for words such as "Korea", "Korean" and "Seoul". The dilemma is that the search will obviously generate false hits such as papers on diseases found in Korea written by authors working in different countries,[46] not to mention the fact

42) *DIALOG MEDLINE Bluesheet* (revised March 1983), p. 154-28.

43) Please note KAIST is quite often used in place of Korea Advanced Institute of Science and Technology, causing a search problem.

44) It is better to use the country code because country names can not be searched using the CP field for the years 1975-1981. *DIALOG MEDLINE Bluesheet* (revised March 1983), p. 154-27.

45) *DIALOG MEDLINE Bluesheet* (revised February 1991), p. 152-3.

46) For example, "Nephropathia epidemica and Korean hemorrhagic fever : the veil lifted?" written by K. M. Johnson and appeared in *Journal of Infectious Diseases* 141, no. 2 (February 1980), p. 135.

hat it can not be an exhaustive search either.[47] Therefore, it is decided to limit the search of the Korean papers by one search statement : CS=(KOREA? OR SEOUL),[48] and not to make an attempt to search the Korean papers for the years 1980 and 1981.[49]

Korean medical papers are located by excluding nursing, dentistry and veterinary medicine from all the Korea papers. Two SubFiles (SF), nursing and dentistry, are searched in order to exclude records from these two fields. The records from veterinary medicine will be manually excluded from downloaded files after the search is completed and the relevant records are retrieved, since a separate subfile for veterinary medicine does not exist. A search of CP=Z1.252.474.538 will retrieve all the papers from Korean journals in MEDLINE. By excluding all the papers in Korean journals from the set of records for all the Korean medical papers, all the mainstream Korean medical papers in non-Korean journals are identified. Then the records in two groups (one from Korean journals and the other one from non-Korean journals) are sorted by the Publication Year (PY).

Locating Korean chemistry papers. The identification of chemistry papers will be performed using SCI, 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.[50] Therefore, one search statement SC=CHEMISTRY. is sufficient to retrieve all the chemistry records in the database. The set of records for Korean chemistry papers is the intersection of SC=CHEMISTRY and GL=SOUTH KOREA. Since there is one Korean chemistry journal covered in the database, it is necessary to differentiate records from that journal from records from non-Korean journals. This can be easily done by performing a search JN=*BULLETIN OF THE KOREAN CHEMICAL SOCIETY* (i.e., all the records in the Korean journal), and excluding the records retrieved from the total Korean chemistry records found, leaving the records of papers in non-Korean journals.

Scope of Medical Literature

The compilation of 47 medical specialties (Table 3) used for the present study is primarily based on "source publications arranged by subject category," which appears in *SCI*

47) It is not possible (nor economical) to list all the city names in Korea.

48) "?" is a truncation symbol used in DIALOG.

49) In fact, a free text search of *(KOREA? OR SEOUL)* in MEDLINE for the years 1980 and 1981 resulted in zero records.

50) All the relevant chemistry subfields as found in SC code list are : chemistry; chemistry, analytical; chemistry, applied; chemistry, inorganic & nuclear; chemistry, organic; and chemistry, physical. Polymer science is not included in the study even though it is a subfield of chemistry in *S&E Indicators*.

1988 Annual : Guide and List of Source Publications. In addition, SC codes were expanded on-line in June 1990 to update the list. Then this SC list was compared to the subfield listing developedby the Computer Horizons, Inc. (CHI).[51] When a different term is used by CHI, a SCI term is chosen g. developmental biology rather than embryology, neur- oscience instead of neurology & neurosurgery). Pharmacology and pharmacy are two separate subfields in CHI, but one subject category in SCI ; therefore it is one medical specialty in this study.

The classification of a subfield (i.e., subject category) into clinical medicine or into biomedical research is based on the CHI system[52] as it appears in Appendix Table 5-4 "U.S. and world scientific and technical publications by field and subfield : 1986," in *S&E Indicators : 1989*. The only exception is "medicine, miscellaneous". The CHI uses both miscellaneous clinical medicine and miscellaneous biomedicine, whereas SCI integrates them imnto one subject category "medicine, miscellaneous". Here it is classified under clinical medicine.

In most Korean universities, dentistry, veterinary medicine and nursing are usually taught in separate colleges, apart from human medicine.[53] Quite often, veterinary medicine is a department in a college of agriculture. It is decided not to include either dentistry or veterinary medicine into the study, even though they are subfields of clinical medicine in *S&E Indicators*. They are covered in SCI and in MEDLINE. EMBASE covers dentistry selectively. However, EMBASE does not cover veterinary medicine because it deals for the most part with aspects of human medicine.[54]

Nursing does not compose a part in the present study, because it is neither a subject category in SCI nor a subfield used in *S&E Indicators*, EMBASE covers nursing selectively, but MEDLINE covers nursing literature in its database.

Chinese medicine (sometimes called herb medicine or oriental medicine) is still an im-

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51) The CHI system was developed for the National Science Foundation (NSF) by Pinski and Narin, and used for science literature indicator tabulation in *S&E Indicators*. Each subfield (e.g., Allergy) corresponds to the subject category (SC) assigned to a specialty by SCI, probably because CHI tabulations are derived from a fixed journal set of over 3,200 journals carried on the 1981 SCI tapes created by the Institute for Scientific Information (ISI). As a matter of fact, some minor discrepancies exist between SCI's SC codes and CHI's subfield listings.

52) It divides science into 8 fields : clinical medicine, biomedical research, biology, chemistry, physics, earth/space sciences, engineering/technology and mathematics. *S&E Indicators : 1989*, Appendix Tables 5-23, 5-24, 5-25, 5-27, 5-30, 5-32, 5-33 and 5-34.

53) For a university's medicine related programs, see Table 4.

54) *DIALOG EMBASE Bluesheet* (revised July 1988), p. 72-1.

portant part of medical practice in Korea, and a few years ago a national policy decreed that medical insurance plans would cover costs incurred in Chinese medicine clinic just as they would for western medicine.[55] However, the foundation for scientifically studying Chinese medicine has not yet been strongly established and it is very unlikely that scientific research reports on Chinese medicine will be published in the international journals covered by any of the three databases used for this study.[56] There are 8 colleges and universities with Chinese medicine program (Table 4) as of March 1990. None of them are national universities--a probable indication that it is not nationally supported as an academic discipline. Only three universities have both Chinese and western medicine programs. The cooperative research efforts between two medicines with different traditions are not yet widespread.

In many cases, pharmacology and pharmacy comprise a college separate from medicine. Even so, there are also departments of pharmacology and pharmacy in colleges of medicine within the same universities. By the same token, there are usually departments of biochemistry, molecular biology, microbiology, parasitology, etc. both in colleges of science and colleges of medicine at particular universities. This is merely an illustration of how interdisciplinary the medicine field is and how hard it can be to decide which subfields to include and which subfields to exclude in defining the scope of the medical literature.

In summary, all the medical specialties except nursing, dentistry, veterinary medicine are included in the present study of Korean medical literature published in mainstream non-Korean journals.

One thing to be noted is that papers are classified into scientific subfields according to the subfield of the journal in which they are published. Quite often, two or three subject category codes are assigned to a journal. For example, *American Journal of Neuroradiology* has radiology & nuclear medicine, and neuroscience assigned as subject categories by SCI.

4. Analysis of Data

Korean Mainstream Papers

Publication output. As a first step to identify Korean medical and chemistry papers through SCI searching, total number of

55) So called Hanbang-Uiryo-Bohum (Chinese medicine medical insurance) is in effect as of February 1, 1987. *Bogun Sahoebu Gosi* [*Official Announcements of the Ministry of Health and Welfare*] (January 27, 1987), Article 87-5.

56) And there are only five Korean journals in the area of Chinese medicine currently listed in the *Union Catalogue of Bio-Medical Journals*, 7th ed. (Seoul : Korean Medical Library Association, 1985, supplemented in 1988).

TABLE 4

KOREAN UNIVERSITIES WITH MEDICAL COLLEGES
(As of March 1990)

Name	Location	Year began	No. of Faculty[d]	Ph.D Program	Related programs: Pharmacology	Nursing	Dentistry	Vet med	Chinese med
1. Kyungpook	Daegue	1923	102 (17)	Yes	No	Yes	Yes	Yes	No
2. Kyungsang	Changwon	1981	82 (13)	Yes[e]	No	Yes	Yes	Yes	No
3. Pusan	Pusan	1955	94 (18)	Yes	Yes	Yes	Yes	No	No
4. Seoul	Seoul	1946	240 (34)	Yes	Yes	Yes	Yes	Yes	No
5. Cheonnam	Kwangju	1944	108 (16)	Yes	Yes	Yes	Yes	Yes	No
6. Cheonbuk	Cheonju	1971	85 (16)	Yes	No	Yes	Yes	Yes	No
7. Chungnam	Daejeon	1967	85 (20)	Yes	Yes	Yes	No	Yes	No
8. Chungbuk[a]	Chungju	1987	32 (15)	No	Yes	No	No	No	No
		Total	828 (149)	7	5	7	6	6	0
9. Catholic	Seoul	1954	443 (−)	Yes	No	Yes	No	No	No
10. Gunguk[a]	Chungju[b]	1986	56 (5)	No	No	No	No	Yes	No
11. Kyunghee	Seoul	1965	109 (12)	Yes	Yes	Yes	Yes	No	Yes
12. Kyemyong	Daegue	1979	107 (6)	Yes[e]	Yes	Yes	Yes	No	No
13. Korea	Seoul	1937	181 (16)	Yes	No	Yes	No	No	No
14. Koshin	Pusan	1981	79 (3)	Yes[e]	No	Yes	No	No	No
15. Danguk[a]	Cheonan[b]	1988	4 (11)	No	No	No	Yes	No	No
16. Dongguk[a]	Kyungju[b]	1986	28 (10)	No	No	No	No	No	Yes
17. Donga[a]	Pusan	1985	59 (9)	No	No	No	No	No	No
18. Suncheonhyang	Onyang	1978	173 (5)	Yes[e]	Yes	No	Yes	No	No
19. Ajou[a]	Suwon	1988	5 (6)	No	No	No	No	No	No
20. Yonsei	Seoul, Wonju[c]	1885	404 (19)	Yes	No	Yes	Yes	No	No

21. Youngnam	Daegue	1980	90	(9)	Yes[e]	Yes	No	Yes	No	No
22. Woolsan[a]	Woolsan	1988	98	(11)	No	No	No	No	No	No
23. Wonkwang	Iri	1981	69	(7)	Yes[e]	Yes	No	Yes	No	Yes
24. Ewha Women's	Seoul	1945	74	(9)	Yes	Yes	Yes	Yes	No	No
25. Inje	Pusan	1979	187	(8)	Yes[e]	No	No	Yes	No	No
26. Inha[a]	Incheon	1985	46	(11)	No	No	No	No	No	No
27. Chosun	Kwangju	1966	80	(7)	Yes	Yes	Yes	Yes	No	No
28. Jungang	Seoul	1971	116	(6)	Yes	Yes	Yes	No	No	No
29. Hallym	Chuncheon	1982	233	(6)	Yes[e]	No	No	No	No	No
30. Hanyang	Seoul	1968	133	(20)	Yes	Yes	Yes	Yes	No	No
		Total	2,774	(144)	16	9	10	11	1	3
		Grand Total	3,602	(293)	23	14	17	17	7	3
	No. of depts. nationwide		30	78	23	20	17	17	10	8

COMPILED FROM : Hanguk Taehak Kyoyouk Hyopuihoe. *1990 Haknyondo Taehak(kyo) Kyowon Myongbu.* [Korean Council for University Education. *Faculty List of Colleges and Universities for the Academic Year 1990*] [Vol. 1] : Kukgongrip [National and Public] ; [Vol. 2] : Sarip [Private]. (Seoul : Korean Council for University Education, 1990.) Information on beginning year of medical program and the existence of medicine Ph.D program in a university is taken from *1990－1991 Haknyundo Uikwa-Daehak-Gyoyouk-Hyunwhang* [*Yearbook of Medical College Education for the Academic Year 1990－1991*].

NOTE : Dentistry, nursing, veterinary medicine, Chinese medicine departments belong to medical colleges depending on universities. They are not included in the tabulation of the number of faculty members in a medical college.

[a]These schools are relatively new. (No graduates yet, thus no Ph.D program so far.)

[b]The main campus is in Seoul, but medical college is in these cities.

[c]Two medical colleges exist. Medical program at Wonju campus began in 1977.

[d]Number in ( ) is the combined number of faculty members of chemistry departments both in science college and in teachers' college within one university.

[e]Ph.Ds. in medicine has not yet produced. (SOURCE : *Statistical Yearbook of Education : 1989, p. 685.*)

Korean papers indexed in SCI database was verified (Table 5). The total number of Korean papers found in SCI for the ten-year period starting in 1980 and ending in 1989 is 7,059. 23.0% (1,623/7,059) of Korean SCI papers are published in chemistry journals. 55.8% (906/1,623) of chemistry papers, or 12.8% (906/7,059) of all Korean SCI papers, were published in the one and only Korean SCI journal, the *Bulletin of the Korean Chemical Society*. The number of papers published in that Korean journal has increased 5.7 times from 32 to 181 in nine years since the journal entered the SCI in 1981. If 906 papers in the Korean chemistry journal is excluded, 6,168 papers are published in SCI non-Korean journals in ten years.

The numbers in Table 5 are bigger than those in Table 1. For instance, 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 1 that 1,561 Korean papers were verifiable for all sciences combined for the 1981−1985 period. The major source of discrepancies seemed to be that the number of meeting abstracts are not excluded from Table 5. For instance, 70 out of 109 urology & nephrology papers retrieved from SCI were identified as meeting abstracts. The number of meeting abstracts included in the SCI varies a great deal from a specialty to another, from a field to another and from a year to another. The difference between the data collected in this study and the Braun's data is smaller for chemistry, 546 and 522 respectively.

Growth. The number of Korean mainstream papers published in each year has grown very rapidly during the 1980s. It has increased by 9.04 times (1,384/153) in ten years. The number of chemistry papers has grown 11.2 times from 13 to 146 in those years, and that of medical papers has grown 6.9 times from 47 to 323. The growth rate is higher than the overall growth rate of Korean science papers in chemistry and it is much lower in medicine.

Medicine is a discipline of vast scope. Also, compared to chemistry, it has a much larger size of manpower engaged in various medical specialties. For example, the number of medical faulty employed in Korean universities in the academic year of 1990 was 3,620, whereas the number of chemistry faculty was 494.[57] Thus, it is very disappointing to find out that the absolute number of mainstream medical papers produced by Korean researchers is not much bigger than that of chemistry papers. It

57) Hanguk Taehak Kyoyouk Hyopuihoe. *1990 Haknyondo Taehak(kyo) Kyowon Myongbu.* [Korean Council for University Education. *Faculty List of Colleges and Universities for the Academic Year 1990.]* [Vol. 1] : Kukgongrip [National and Public] ; [Vol. 2] : Sarip [Private]. (Seoul : Korean Council for University Education, 1990.)

TABLE 5

NUMBER OF KOREAN PAPERS FOUND IN SCI

	All Science fields			Chemistry			Medicine[c]
	GL=South Korea (a)	in non-K journals (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	1,277	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

NOTE : DIALOG SCI file 434 (1974–present) are searched.

[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).

Descrepancies 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, see TABLE 7, NUMBERS OF KOREAN MEDICAL PAPERS FOUND IN SCI.

is especially so, because the number of Korean medical journals newly started, and the number of medical papers published in non-mainstream Korean journals have exploded during the 1980s.[58] Of 125 scholarly medical journals currently published in Korea, 49 journals (40%) began publication during the 1980s. The total number of medical papers published in these journals as indexed by the *Korean Index Medicus* for the period 1982-1989 is 42,669.[59] In comparison, altogether 1,634 chemistry papers are published between 1980 and 1989 in three journals published by the Korean Chemical Society-*Taehan Whahak Hoeji* (the *Journal of the Korean Chemical Society*), the *Bulletin of the Korean Chemical Society*, and *Whahak Kyoyouk* (the *Chemical Education*).[60] The fact that there are 738 mainstream vs. 1,634 non-mainstream (to be exact, 1,620 mainstream vs. 697 non-mainstream, because the *Bulletin* is a mainstream journal) chemistry papers indicate that a major portion of chemistry papers are in mainstream. On the contrary, in medicine, there are 1,236 mainstream papers and about 50,000 non-mainstream papers.

Korean Mainstream Medical Papers

Publication output. The numbers of Korean medical papers published in mainstream journals during the 1980s as retrieved from the three databases-MEDLINE, EMBASE, and SCI-are presented in Table 6. Due to the limitation of MEDLINE database for searching the corporate source field for records entered the database before 1987, zero record was retrieved for the period 1980-1984. And, altogether three records were retrieved for two years, 1985 and 1986.

The number of medical records retrieved from each databases is quite different. MEDLINE and EMBASE include some Korean journals. The differences in number of papers from Korean journals between the two databases is simply a reflection of differences in the number of journals covered by these databases. The most numbers of records for papers published in non-Korean journals are retrieved from SCI for every year searched, and the least numbers of records are retrieved from MEDLINE. Because of the inconsistencies in MEDLINE for supplying information for

58) Choon Shil Lee. "Development of Medical Journal Publication in Korea," *Bulletin of the Korean Medical Library Association* 20, no. 1 (June 1993). In press.

59) The first volume covering two years of 1982 and 1983 was published in 1986, and the latest volume covered 1989. *Korean Index Medicus* (Seoul : Korean Medical Library Association, 1986-).

60) *Hoamsang Susang Huboja Chuchunsoe, Kwahak Kisul Bumun : Taehan Whahakhoe* [*The Report to Recommend the Korean Chemical Society as a Candidate of Hoam Award for Science and Technology*] (Seoul : the Recommendation Team, 1990), pp. 63-67.

TABLE 6

NUMBER OF KOREAN MEDICAL PAPERS FOUND IN INTERNATIONAL DATABASES

	MEDLINE			EMBASE		SCI
	in non-K journals[a]		in Korean journals	in non-K journals	in Korean journals	in non-K js. only[b]
1980	0	(0)	19	31	200	47
1981	0	(0)	58	30	231	56
1982	0	(0)	71	47	188	68
1983	0	(0)	18	44	130	65
1984	0	(0)	15	81	186	105
1985	1	(0)	24	89	179	95
1986	2	(3)	52	62	125	108
1987	42	(42)	109	94	171	184
1988	111	(111)	164	140	297	190
1989	152	(149)	138	190	292	323
Total	308	(305)	668	808	1,999	1,236

NOTE : The following DIALOG files are searched for each database.

MEDLINE : File 155 (1962-presnt)
EMBASE : File 73 (1974-present)
SCI : File 434 (1974-present)

Numbers of records of SCI do not include dentistry, nursing or veterinary medicine records, but those of MEDLINE and of EMBASE may have one or two such records for each year.

[a]The corporate source field is searchable "beginning in Feburary 1987" and "not available in Files 152 and 153." *DIALOG MEDLINE Bluesheet* (Revised February 1991), p.152-3. Numbers in ( ) are numbers of records found from CD-ROM version of MEDLINE. MEDLINE CD-ROMs are available from 1966, but records created before 1988 do not contain Address of Authors field.
[b]None of the Korean medical journals is indexed in SCI. The only Korean journal indexed in SCI is *the Bulletin of the Korean Chemical Society*, a chemistry journal.

TABLE 7

NUMBER OF KOREAN MEDICAL PAPERS INDEXED IN SCI DURING 1980S (BY SPECIALTIES)

Specialty[a]	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total[d]
Clinical Medicine											
1. Allergy (18)	0	1	0	0	2	6	1	0	1	5	16
2. Andrology (4)	1	0	0	0	0	0	0	0	0	0	1
3. Anesthesiology (16)	1	0	0	0	0	0	0	0	0	0	1
4. Cardiovascular system (59)	2	2	2	0	1	1	2	2	0	10	22
5. Dermatology & venereal diseases (28)	2	5	5	4	7	5	7	10	12	16	73
6. Endocrinology & metabolism (52)	0	2	0	0	1	1	1	2	4	4	15
7. Gastroenterology (31)	3	0	3	2	1	3	4	4	8	7	35
8. Geriatrics & gerontology (13)	0	0	0	0	0	0	0	0	0	0	0
9. Hematology (35)	0	1	1	0	0	0	2	2	1	8	15
10. Immunology (80)	0	3	3	1	3	3	4	9	2	8	36
11. Medicine, general & internal (121)	3	4	3	1	4	1	0	0	3	0	19
12. Medicine, legalb (5)	—	—	—	—	—	—	—	0	0	0	0
13. Medicine, miscellaneous (38)	0	0	0	1	1	1	2	3	1	1	10
14. Neurosciences (135)	3	2	1	3	2	1	3	5	9	10	39
15. Obstetrics & gynecology (42)	2	1	2	4	2	2	2	3	3	6	27
16. Oncology (68)	0	0	0	0	0	2	5	14	11	11	43
17. Ophthalmology (35)	0	0	1	0	0	0	1	0	2	2	6
18. Orthopedics (31)	4	1	1	1	3	0	1	3	5	2	21
19. Otorhinolaryngology (19)	0	0	0	0	1	1	0	1	4	0	7
20. Pathology (45)	1	1	2	2	4	0	0	7	6	7	30
21. Pediatrics (47)	0	2	1	0	0	1	1	4	3	7	19
22. Pharmacology & pharmacy (139)	4	11	8	9	29	14	8	21	20	29	153
23. Psychiatry (34)	0	0	0	1	2	0	2	0	2	2	9
24. Public health (42)	0	0	0	1	0	0	0	5	5	2	13
25. Radiology & nuclear medicine (63)	2	1	3	0	8	11	12	24	22	28	112
26. Respiratory system (22)	1	1	0	2	0	0	1	1	3	1	10
27. Rheumatology (16)	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
29. Surgery (83)	4	1	1	3	6	2	4	10	15	17	63
30. Toxicology (37)	1	0	2	5	4	0	2	4	4	4	26
31. Tropical medicine (17)	0	3	1	2	0	1	0	1	0	3	11
32. Urology & nephrology (33)	0	0	1	0	2	3	5	7	6	67	91

Biomedical Research											
33. Anatomy & morphology (15)	0	1	1	1	1	1	0	0	5	1	11
34. Biochemistry & molecular biology (151)	5	2	2	13	5	10	11	21	22	44	135
35. Biophysics (36)	1	0	1	4	0	2	2	6	8	16	40
36. Biotechnology & applied microbiology(30)	6	8	11	7	12	14	16	18	15	24	131
37. Cytology & histology (63)	0	1	3	0	2	2	2	1	3	7	21
38. Developmental biology (11)	1	1	2	1	0	3	3	1	0	0	12
39. Engineering, biomedical (28)	2	1	8	1	4	5	3	6	3	9	42
40. Genetics & heredity (61)	2	3	3	1	3	6	7	9	3	9	46
41. Medicine, research & experimental (50)	0	0	0	1	5	4	6	4	5	5	30
42. Microbiology (69)	2	1	2	5	4	4	4	1	3	14	40
43. Microscopy (11)	0	0	0	1	0	0	1	0	0	0	2
44. Nutrition & dietetics (37)	1	1	0	2	0	1	0	2	0	2	9
45. Parasitology (19)	0	1	0	0	0	0	0	0	2	2	5
46. Physiology (51)	0	1	1	3	0	1	3	7	2	7	25
47. Virology (18)	0	0	1	1	0	0	0	4	4	3	13
Total[c]	47	56	68	65	105	95	108	184	190	323	1,236

NOTE : DIALOG SCI databases (File 433, and 434) were searched on January 30, 1991. The compilation of medical specialties listing is primarily based on "Source publications arragned 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.*

[a]For each specialty, the number of journal titles covered by SCI in 1988 is provided in ( ).

[b]This SC code was not used in SCI during the period 1980-1986 (DIALOG File 433).

[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.

countries of origin of a paper, the statements used for MEDLINE searching was not as effective as EMBASE or SCI search statements. Still, the differences in the number of records retrieved for papers from non-Korean journals between EMBASE and SCI require some explanation. For example, records for which the first author's address is not in Korea is not retrievable from EMBASE, but retrievable from SCI. EMBASE does not index meeting abstracts, but SCI indexes meeting abstracts. Examination of overlap among medical records retrieved from three databases, and investigation of reasons for not retrieving certain records from a database are interesting problems to look at, but it is not dealt with in this paper.[61)]

Growth. Table 6 shows that there has been obvious growth in the production of mainstream papers by Korean medical researchers (even though it is not comparable to chemistry). There was a much larger increase in representation of medical papers in non-Korean journals than in Korean journals. The numbers of medical papers from Korean journals found in MEDLINE and EMBASE fluctuate, rather than increase constantly over the early years of the 1980s. However, in the later part of the 1980s, it is in steady increase. It is because the number of Korean medical journals indexed in MEDLINE increased from only one in 1980 to three in 1987, and several new English-language journals which began in the late 1980s were picked up by EMBASE.

Publication output by medical specialty. The frequency counts of Korean mainstream medical papers in 47 specialties by publication year are presented in Table 7. They are, in essence, the number of postings returned by the DIALOG system after each search statements was entered for SCI database searching. Altogether, 923 papers are published in 32 medical specialties of clinical medicine and 562 papers are published in 15 medical specialties of biomedical research. A column total for each year is always less than the sum of individual rows for a column (e.g., 1,236<

61) The overlap among medical databases are discussed in detail in the author's unpublished paper "Overlap of Records for Korean Medical Papers Published in Non-Korean Journals among MEDLINE, EMBASE, and SCI Databases." Some of the possible reasons why a record of a Korean medical paper is not retrieved from a databases are listed in the following :

- ○ papers are published in a journal not covered by a database
- ○ papers are published in a journal not classified under the subject category searched
- ○ first author's address is not in Korea
- ○ no address field is in the record
- ○ papers are not indexed because a paper is from a journal screened selectively
- ○ papers are not indexed because it is meeting abstracts.

923+562) because some records are coded more than once in different subjects. On the other hand, a row total is an exact sum of individual years for each specialty. There are four medical specialties in which not a single paper was published by Korean medical doctors in ten years searched. Zero paper was published by authors working in Korean institutions in number of years in about two thirds of specialties. Nonetheless, Table 7 displays that there has been a growth in almost every specialty area of Korean medical research. Especially, pharmacology & pharmacy, radiology & nuclear medicine, biochemistry & molecular biology, and biotechnology & applied microbiology are medical specialties where Korean medical researchers have published more than 100 papers in ten years. These are the specialties to which much of Korean medical papers were contributed constantly and increasingly over the years.

Mainstream performance by medical specialty. It is not adequate simply to compare one specialty area to another by the publication outputs in order to measure a specialty's mainstream performance. Publication practices differ from one specialty area to another. The difference may be complicated by a difference in the size of researchers. One specialty area may be more productive in publishing research reports than the others, not only in Korea but also worldwide. The number of journals covered by SCI varies a great deal depending on specialties. For instance, in the year of 1988, SCI indexes only four journals for andrology, but indexes 151 journals for biochemistry & molecular biology.[62]

A careful analysis design that reveals the traits which exist only in Korean medical papers is required to determine the degree of mainstream performance of a medical specialty. Therefore, the relative size of Korean mainstream papers among all the mainstream papers of a specialty is calculated (Table 8). For example, 17 papers were produced by Korean researchers who specialized in allergy from 1980 to 1990.[63] This is 0.092% (17/18,460) of total allergy papers published in SCI journals by scientists in the world during the same period (i.e., percentage contribution from Korea to the SCI "allergy" database). The 17 papers are 0.93% (17/1,842) of total mainstream papers produced by Korean medical researchers during the same period. The 18,460 SCI allergy papers are 0.52% (18,460/3,57,737) of total mainstream papers produced by World's scientists in those 47 medical specialties.

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62) The number of journal titles indexed by SCI in 1988 is given in ( ) after each specialty in Table 7.

63) The database search was made to include one extra year, 1990.

TABLE 8

TOTAL NUMBER OF MEDICAL PAPERS IN SCI FROM 1980 TO 1990 (BY SPECIALTIES)

	Korea[a]		Total SCI[b]		Ratio[c]	% contribution from Korea
Clinical Medicine						
1. Allergy	17	(0.93%)	18,460	(0.52%)	1.80	0.092%
2. Andrology	2	(0.11%)	4,194	(0.12%)	0.93	0.048%
3. Anesthesiology	1	(0.06%)	30,614	(0.86%)	0.06	0.003%
4. Cardiovascular system	28	(1.54%)	158,588	(4.44%)	0.34	0.018%
5. Dermatology & venereal diseases	83	(4.55%)	53,926	(1.51%)	3.02	0.154%
6. Endocrinology & metabolism	20	(1.10%)	90,469	(2.53%)	0.43	0.022%
7. Gastroenterology	43	(2.36%)	83,745	(2.34%)	1.01	0.051%
8. Geriatrics & gerontology	0	(0.00%)	11,201	(0.31%)	0.00	0.000%
9. Hematology	18	(0.99%)	85.007	(2.38%)	0.41	0.021%
10. Immunology	41	(2.25%)	135,590	(3.79%)	0.59	0.030%
11. Medicine, general & internal	21	(1.15%)	323,121	(9.04%)	0.13	0.006%
12. Medicine, legal	0	(0.00%)	672	(0.02%)	0.00	0.000%
13. Medicine, miscellaneous	13	(0.71%)	43,141	(1.21%)	0.59	0.030%
14. Neurosciences	56	(3.07%)	218,687	(6.12%)	0.50	0.026%
15. Obstetrics & gynecology	30	(1.64%)	57,643	(1.61%)	1.02	0.052%
16. Oncology	53	(2.91%)	83,835	(2.35%)	1.24	0.063%
17. Ophthalmology	6	(0.33%)	45,798	(1.28%)	0.26	0.013%
18. Orthopedics	26	(1.43%)	29,389	(0.82%)	1.73	0.088%
19. Otorhinolaryngology	11	(0.60%)	24,442	(0.68%)	0.88	0.045%
20. Pathology	37	(2.03%)	72,053	(2.02%)	1.01	0.051%
21. Pediatrics	23	(1.26%)	89,489	(2.50%)	0.50	0.026%
22. Pharmacology & pharmacy	179	(9.81%)	238,195	(6.67%)	1.47	0.075%
23. Psychiatry	16	(0.88%)	53,414	(1.50%)	0.59	0.030%
24. Public health	16	(0.88%)	36,101	(1.01%)	0.87	0.044%
25. Radiology & nuclear medicine	129	(7.07%)	110,417	(3.09%)	2.29	0.117%
26. Respiratory system	11	(0.60%)	51,856	(1.45%)	0.42	0.021%
27. Rheumatology	0	(0.00%)	20,780	(0.58%)	0.00	0.000%
28. Substance abuse	0	(0.00%)	6,444	(0.18%)	0.00	0.000%
29. Surgery	74	(4.06%)	140,696	(3.94%)	1.03	0.053%
30. Toxicology	41	(2.25%)	34,551	(0.97%)	2.32	0.119%
31. Tropical medicine	12	(0.66%)	14,571	(0.41%)	1.61	0.082%
32. Urology & nephrology	109	(5.98%)	61,260	(1.71%)	3.49	0.178%

33. Anatomy & morphology	11	(0.60%)	25,760	(0.72%)	0.84	0.043%
34. Biochemistry & molecular biology	178	(9.76%)	330,368	(9.24%)	1.06	0.054%
35. Biophysics	62	(3.40%)	97,807	(2.74%)	1.24	0.063%
36. Biotechnology & applied microbiology	163	(8.94%)	20.213	(0.57%)	15.63	0.806%
37. Cytology & histology	27	(1.48%)	103,610	(2.90%)	0.51	0.026%
38. Developmental biology	14	(0.77%)	17,601	(0.49%)	1.56	0.080%
39. Engineering, biomedical	48	(2.63%)	25,048	(0.70%)	3.75	0.191%
40. Genetics & heredity	51	(2.80%)	82,865	(2.32%)	1.21	0.062%
41. Medicine, research & experimental	37	(2.03%)	145,067	(4.06%)	0.50	0.026%
42. Microbiology	55	(3.02%)	107,424	(3.00%)	1.01	0.051%
43. Microscopy	4	(0.22%)	16,036	(0.45%)	0.49	0.025%
44. Nutrition & dietetics	11	(0.60%)	36,014	(1.01%)	0.60	0.030%
45. Parasitology	6	(0.33%)	21,521	(0.60%)	0.55	0.028%
46. Physiology	31	(1.70%)	107,385	(3.00%)	0.56	0.029%
47. Virology	13	(0.71%)	30,676	(0.86%)	0.83	0.042%
Total	1,824	(100.00%)	3,573,737	(100.00%)		0.051%

[a]Percentage share of a specialty out of the total number of papers published by Korean researchers is provided in ( ).

[b]Percentage share of a specialty out of the total number of papers published by world's researchers is provided in ( ).

[c]Ratio is the percentage share of Korea divided by the percentage share of total SCI.

Thus, the Korean scientists in this specialty produced 1.8 times (0.93%/0.52%) of the number of papers that they were expected to produce, if they were to publish papers in the same proportion as the world's allergy specialists did out of total mainstream medical papers.

As a matter of fact, percentage share of a specialty, out of the total number of papers published by Korean researchers from 1980 to 1990, is high in the above-mentioned four medical specialties. However, if the ratio of the percentage share of Korean scientists in relation to that of world's scientists is computed, one specialty, biotechnology & applied microbiology, shows an extremely outstanding mainstream performance. Korean scientists in this specialty produced 15.7 times of the percentage share achieved by world's scientists. Biomedical engineering was next with the ratio of 3.75, and dermatology & venereal diseases was the third with 3.02.

The ratio larger than one implies that Korean researchers in the specialty area has performed better in mainstream (i.e., produced more mainstream papers) than expected. There are 20 medical specialties with the ratio larger than one. Pharmacology & pharmacy, and biochemistry & molecular microbiology have ratios slightly larger than 1. That is, their mainstream performances are not so much impressive as they are indicated by the absolute number of mainstream papers published.

Korean Mainstream Chemistry Papers

Similarly, crosstabulation of mainstream chemistry papers by six subfields of chemistry[64] and by publication years are shown in Table 9. The Korean journal, *Bulletin of the Korean Chemical Society* is coded under the subject category "chemistry" in SCI database. Thus, the number of papers found in "chemistry" subfield is sorted into two groups : one group from the Korean journal and the other from non-Korean journals. Organic chemistry has been the biggest contributor of Korean mainstream chemistry papers during the 1980s. Also mainstream publication output by physical chemistry has been superior to other chemistry subfields. The ratio of the percentage share of Korean chemists in relation to that of world's chemists is bigger than one for these two chemistry subfields (Table 10). The ratio is 2.03 for organic chemistry and 1.45 for physical chemistry respectively. Thus, it can be concluded that

64) 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 arranged by subject category," *SCI 1988 Annual : Guide and List of Source Publications.*

TABLE 9

NUMBER OF KOREAN CHEMISTRY PAPERS FOUND IN SCI (BY SUBFIELDS)

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

NOTE : DIALOG SCI Files 433 (1980−1986) and 434 (1987−1989) were searched on January 30, 1991.

[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 10

TOTAL NUMBER OF CHEMISTRY PAPERS IN SCI FROM 1980 TO 1990 (BY SUBFIELDS)

	Korea[a]		Total SCI[b]		Ratio[c]	% contribution from Korea
1. Chemistry	1,271		248,502			0.511%
(in the Korean journal)	1,048		1.048			(0.422%)
(in non-K. journals only)	236	(25.35%)	247,454	(38.51%)	0.66	(0.095%)
2. Chemistry, analytical	75	(8.06%)	96,404	(15.00%)	0.53	0.078%
3. Chemistry, applied	19	(2.04%)	24,699	(3.84%)	0.53	0.077%
4. Chemistry, inorganic & nuclear	89	(9.56%)	77,864	(12.12%)	0.78	0.114%
5. Chemistry, organic	348	(37.38%)	118,219	(18.40%)	2.03	0.294%
6. Chemistry, physical	223	(23.95%)	106,235	(16.53%)	1.45	0.210%
−. Polymer science	−		−		−	−
Total[a]	1,963		643,598			0.305%
(in the Korean journal)	1,048		1,048			(0.163%)
(in non-K. journals only)	931	(100.00%)	642,550	(100.00%)		(0.145%)

[a]Percentage share of a subfield out of the total number of papers published by Korean researchers is provided in ( ).

[b]Percentage share of a subfield out of the total number of papers published by world's researchers is provided in ( ).

[c]Ratio is the percentage share of Korea divided by the percentage share of total SCI.

the mainstream performance of Korean chemical research heavily relies on the research done in organic and physical chemistry.

5. Summary and conclusions

The major task of the present study has been the identification of Korean medical papers as recorded in three databases, SCI, EMBASE and MEDLINE. The identification of papers (search strategy) was very database dependent. A Korean paper was defined as a paper written by researchers, at least one of whose addresses is in Korea. A medical paper was defined as a paper in any of the scientific subfields listed under clinical medicine or under biomedical research in *Science and Engineering* (*S&E Indicators*).

The database searching, prepared and conducted as described in the search strategy section, has identified 308 and 808 mainstream papers each from MEDLINE and EMBASE. 236 medical papers published in non-Korean journals of SCI has also been identified. There exist differences in the number of records retrieved from three databases, because different numbers of journals and different types of documents are indexed in each database, and because the characteristics of search keys used in each database are different. The SCI search resulted in the most number of records for every years studied. Especially in the later part of the 1980s, a larger number of Korean papers are indexed in SCI.

The analysis of retrieved data has shown that mainstream publication output of Korean chemistry during the 1980s (1,620papers) is bigger than that of Korean medicine (1,236papers) Percentage contribution from Korea of SCI medical papers is merely 0.051% (Table 8). On the contrary, the percentage contribution of Korean chemistry to SCI "chemistry" database is 0.305% (Table 10). In other words, Korean chemists have contributed six times more to mainstream world chemistry than Korean medical researchers have contributed to mainstream medicine.

The growth rate of mainstream papers published by Korean scientists in the 1980s is also higher in chemistry (11.2 times) than in medicine (6.9 times). The growth rate of chemistry was higher than that of all sciences combined (9.04 times), and the rate of medicine was much lower.

Among 47 medical specialties examined in this study, pharmacology & pharmacy, radiology & nuclear medicine, biochemistry & molecular biology, and biotechnology & applied microbiology have produced the most numbers of mainstream papers. When the percentage share achieved by Korean researchers in each specialty is compared to that by world's scientists in the same specialty, the biotechnology & applied microbiology has shown an extremely high ratio. The specialty

is a very small area of medicine. 20,213 papers have been published from 1980 to 1990 worldwide, making up 0.57% of all the medical literature covered by SCI in the period. 8% (163/20,213) of these papers are published by researchers located in Korean institutions. (Usually, less than 0.01% of mainstream papers are produced by Korean researchers in other specialties.) Another specialty with a relatively high ratio is biomedical engineering.

It is speculative whether the increase in the production of mainstream medical papers is due, to a certain degree, to the research papers originating in specialties of biomedical research than those in clinical medicine. As medicine becomes more multidisciplinary in nature, the number of medical faculties with non-medical training is increasing. It is also speculative whether they are more prolific authors of mainstream medical papers than faculty members with regular medical training. In another context, it may prove to be true that mainstream medical papers are published more by Ph.D's in science and engineering[65] than by Ph.D's in medicine or by professional degree (MD) holders. Then, foreign education and training received by Korean researchers may be a major contributing factor to the variation mainstream performance of Korean sciences. For example, the better performance of Korean chemistry in mainstream might have been supported by a larger base of chemists trained abroad.

6. Suggestions for Further Research

As an extension of the observations made in the present study, an in-depth approach to understanding characteristics of mainstream authors, papers, and journals where the papers are published are needed to be done. First, we need to know the characteristics of mainstream papers and journals in which Korean medical research papers appear, and of authors contributing to the mainstream journals, because this information will provide possible insights into the increase in their internationally recognized research output. Secondly, whether there has been any change in the characteristics of mainstream papers and authors over the time is an important issue. Thirdly, it would be very useful to know whether Korean medical papers in mainstream non-Korean journals are cited more than those in mainstream Korean medical journals. Fourthly, it would be also useful to know whether Korean mainstream authors have the same literature use pattern as international authors. The present paper is a preliminary report to provide factual, and insightful, information which will be helpful to conduct a

65) Almost all of them are expected to hold foreign Ph.Ds.

series of studies suggested.

References

Altbach, Philip G. 1989. "Higher Education and Scientific Development : the Promise of Newly Industrializing Countries." In *Scientific Development and Higher Education : the Case of Newly Industrializing Nations*, pp. 3-29. Edited by Philip G. Altbach, et al. New York : Praeger.

Braun, T. : Glänzel, W. : and Schubert, A. 1987. "One More Version of the Facts and Figures on Publication Output and Relative Citation Impact of 107 countries : 1978-1980." *Scientometrics* 11 (1-2) : 9-15.

_____. 1987. "One More Version of the Facts and Figures on Publication Output and Relative Citation Impact in the Life Sciences and Chemistry : 1978-1980." *Scientometrics* 11(3-4) : 127-40.

_____. 1987. "One More Version of the Facts and Figures on Publication Output and Relative Citation Impact in Physics and Mathematics : 1978-1980." *Scientometrics* 12(1-2) : 3-16.

_____. 1988. "The Newest Version of the Facts and Figures on Publication Output and Relative Citation Impact in the Life Sciences and Chemistry : 1981-1985." *Scientomtrics 14(1-2) : 3-15.*

_____. 1988. "The Newest Version of the Facts and Figures on Publication Output and Relative Citation Impact of 100 Countries." *Scientometrics* 13 (5-6) : 181-88.

_____. 1988. "The Newest Version of the Facts and Figures on Publication Output and Relative Citation Impact in Physics, Engineering and Mathematics : 1981-1985." *Scientometrics* 14 (5-6) : 365-82.

_____. 1989. "Scientometric Datafiles : a Comprehensive Set of Indicators on 2649 Journals and 96 Countries in All Major Science Fields and Subfields." *Scientometrics* 16(1-6) : 3-478.

_____. 1989. "Some Data on the Distribution of Journal Publication Types in the Science Citation Index Database." *Scientometrics* 15(5-6) : 325-30.

DIALOG EMBASE Bluesheet. Revised July 1988. Palo Alto, CA : DIALOG Information Services, Inc.

DIALOG MEDLINE Bluesheet. Revised March 1983. Palo Alto, CA : DIALOG Information Services, Inc.

DIALOG MEDLINE Bluesheet. Revised February 1988. Palo Alto, CA : DIALOG Information Services, Inc.

DIALOG MEDLINE Bluesheet. Revised February 1991. Palo Alto, CA : DIALOG Information Services, Inc.

DIALOG SCISEARCH Bluesheet. Revised April 1987. Palo Alto, CA : DIALOG Infor-

mation Services, Inc.

Eisemon, Thomas O., and Davis, Charles H. 1989. "Publication Strategies of Scientists in Four Peripheral Asian Scientific Communities : Some Issues in the Measurement and Interpretation of Non-mainstream Science." In *Scientific Development and Higher Education : the Case of Newly Industrializing Nations*. Pp. 325-75. Edited by Philip G. Altbach, et al. New York : Praeger.

Frame, J. Davidson ; Narin, Francis ; and Carpenter, M. 1977. "The Distribution of World Science," *Social Studies of Science* 7 : 501-7.

Garfield, Eugene. 1983. "Mapping Science in the Third World." *Science & Public policy* 10 : 112-27.

Hamilton, David P. 1991. "Research Papers : Who's Uncited Now?" *Science* 251 (January 4) : 25.

Hanguk Taehak Kyoyouk Hyopuihoe. 1990. *1990 Haknyondo Taehak(kyo) Kyowon Myongbu* [Korean Council for University Education. Faculty List of Colleges and Universities for the Academic Year 1990.] [Vol. 1] : Kukgongrip [National and Public] ; [Vol. 2] : Sarip [Private]. Seoul : Korean Council for University Education.

Hankguk Uikwa Daehkajang Hyopuihoe [Korean Association for Deans of Medical colleges]. 1991. *1990-1991 Haknyundo Uikwa-Daehak-Gyoyouk-Hyunwhang* [*Yearbook of Medical College Education for the Academic Year 1990-1991*. Seoul : Korean Association for Deans of Medical colleges.

Hoamsang Susang Huboja Chuchunsoe, Kwahak Kisul Bumun : Taehan Whahakhoe [The Report to Recommend the Korean Chemical Society as a Candidate of Hoam Award for Science and Technology]. 1990. Seoul : the Recommendation Team.

"Introduction." 1989. In *List of journals abstracted : 1990*. Amsterdam : Excerpta Medica.

Lee, Choon Shil. 1993. "Development of Medical Journal Publication in Korea." *Bulletin of the Korean Medical Library Association* 20 (1). To be published.

_____. Unpublished. "Inbreeding of Medical and Chemistry Faculty in Korean context."

_____. Unpublished. "Overlap of records for Korean medical papers published in non-Korean journals among MEDLINE, EMBASE, and SCI databases."

Korean Index Medicus 1986- . Seoul : Korean Medical Library ssociation.

Ministry of Education of Korea. 1963-1964. *Moongyo Tonggye Yoram*. [Annual Survey of Education]. Seoul : Ministry of Education of Korea.

Ministry of Education of Korea. 1965-present. *Moongyo Tonggye Yonbo* [*Statistical Yearbook of Education*]. Seoul : Ministry

of Education of Korea.

Ministry of Health and Welfare of Korea. 1987. *Bogun Sahoebu Gosi*[*Official Announcements of the Ministry of Health and Welfare*]. Article 87-5. Seoul : Ministry of Health and Welfare of Korea. January 27.

National Science Board. 1973-present. *Science & Engineering Indicators*. Washington, C. : U.S. GPO.

"Percentage Contribution of Journals by Country of Origin." 1989. In *List of Journals Abstracted by Excerpta Medica : 1989*, p. 2.

"Source publications arranged by subject category." 1988. In *SCI 1988 Annual : Guide and List of Source Publications*. Philadelphia : ISI.

Stankus, TonyRosseel, Kevin;and Littlefield, William C. 1988. "Is the Best Japanese Science in Western Journals?" *The Serials Librarian* 14(1-2) : 95-07.

Union Catalogue of Bio-Medical Journals. 7th ed. Seoul : Korean Medical Library Association. Supplemented in 1988.