An Analysis of Research Topic Areas of Medical School Researchers

의학대학 소속 연구자 발표 논문의 주제 분야에 대한 분석

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ABSTRACT

In this study, research topic areas in Korean and American medical schools were analyzed to detect each nation's major research areas. CLINICAL NEUROLOGY was identified as the Korean researchers' major subject area by the total number of journals and 'RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING' was the most major area by the total number of articles. On the other hand, American researchers' top major subject area was the one same area according to all analysis, BIOCHEMISTRY & MOLECULAR BIOLOGY. In addition, Korean researchers showed publishing tendency related to journal preference in several subject areas.

초 록

본 연구에서는 한국과 미국의 주요 의과대학 소속 연구자들이 발표한 연구논문 주제영역을 분석함으로써, 의학 주제영역의 학제적 성격에 대한 파악과 함께 국가별 연구 주제 영역의 특성과 경향을 비교하였다. 분석 결과 저널 수로 파악된 한국 의학 연구자들의 주요 연구 영역은 CLINICAL NEUROLOGY이며 논문수로 파악된 주요 연구영역 은 RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING로 나타났다. 반면, 미국 의학 연구자들의 주요 연구영역은 저널 및 논문 분석 결과 모두 동일하게 BIOCHEMISTRY & MOLECULAR BIOLOGY로 나타났다. 또한 한국 연구자들은 몇몇 주제분야에서 일부 저널에 논문을 다수 게재하는 출판경향이 있는 것으로 나타났다.

Keywords: medicine, school of medicine, research topic analysis, bibliometric analysis, SCIE, SSCI, CC-clinical medicine
의학, 의과대학, 연구주제분석, 계량분석, SCIE, SSCI, CC-clinical medicine

1. Introduction

As the boundaries of academic disciplines have blurred due to the increase of collaborative research involving several areas, it has become more difficult to determine which are the major research areas in any particular subject. This study aims to investigate research topic areas of medical school researchers in two countries, Korea and America, by analyzing academic papers published between 2006 and 2008. Typically, medical schools have conducted studies in numerous subject areas. The other purpose of this study is to suggest methods to identify research areas by statistical analysis. In order to do this, research areas were investigated according to frequency of journals and articles.

In this study, five top medical schools in both Korea and America were chosen and their major research areas analyzed. The SCOPUS database was used for collecting data by affiliation of research paper authors. In addition, the subject categories of science Citation Index Extended(SCIE), Social Science Citation Index(SSCI) and Current Contents-Clinical Medicine(CC-Clinical Medicine) were used to detect subject areas. The subject categories were automatically assigned to the collected data according to the categories of SCIE, SSCI, and CC Clinical Medicine. Social science categories were also considered as potential subject areas of medical research, because some subjects in social science seem to be closely related to medical research, such as psychiatry or psychology.

Throughout this statistical analysis, two nations'

major medical research areas and characteristics were identified. Details of medical subject areas and portions, produced by matching journals and articles to SCIE, SSCI, and CC-Clinical Medicine subject categories, were provided by tables, and this will help readers to understand the rank and subject areas.

2. Previous Research

Research to identify subject areas or research trends has been carried out dynamically in various fields, especially using bibliometrics or visualization methods. Bibliometirc research related to medical fields are as below.

DiMatteo (2004) calculated a meta-analysis of 569 studies that reported adherence to medical treatments prescribed by a nonpsychiatrist physician. The ultimate goal of this research is the retrieval, compilation, and averaging of adherence rates found in all published empirical studies in the medical treatment field over a 50-year period (1948 to 1998).

Robert et al. (2006) provided an overview of the sleep research literature in medicine and biology through bibliometric analysis of the distribution of journal articles per country, the average journal impact factor of each country, the journal subject category of each article, and the population and gross domestic product of the top-producing countries. The authors of the 2325 articles were from 66 countries. This study complements con-

tinuing subject reviews on sleep research and offers readers a better understanding of the literature size and research richness in this field.

McLean et al. (2007) undertook a bibliometirc analysis of Australian rural research trends and compared these with international rural health research output, and analyzed how Australian rural health research has been addressing the National Health Priority Areas (NHPAs). For this analysis, Medline listed publications from 1990 to 2005 relating to rural health or rural health services were downloaded using PubMed and written to a Microsoft Access database suing specially developed software. Analysis was performed to determine the country of origin of authors, frequency of journals, publication types and how publications addressed Australian NHPAs.

Ugolini et al. (2007) compared the scientific production in the field of cancer molecular epidemiology amon countries and to evaluate the publication trend between 1995 and 2004. A bibliometric study was carried out searching the PubMed database with a combined search strategy based on the key words listed in the medical subject headings and a free text search. A total of 3842 citations were selected for the analysis. According to the analysis, author found that cancer molecular epidemiology is an expanding area attracting an increasing interest.

Hendrix (2008) analyzed bibliometric data from ISI, National Institutes of Health (NIH) - funding data, and faculty size information for Association of American Medical Colleges (AAMC) member

schools during 1997 to 2007 to assess research productivity and impact. For this research, author gathered and synthesized 10 metrics for almost all AAMC medical schools: total number of published articles per medical school, total number of citations to published articles per medical school, average number of citations per article, institutional impact indices, institutional percentages of articles with zero citations, annual average number of faculty per medical school, total amount of NIH funding per medical school, average amount of NIH grant money awarded per faculty member, average number of articles per faculty member, and average number of citations per faculty member.

Payne and Turner (2008) evaluated the nature of research methodologies presented in published research within the broad remit of palliative care. A systematic search of the Medline database between 1997 and 2006, using key words 'palliative care' or 'end-of-life care' and 'research methodology', identified over 318 publications. A bibliometric analysis indicates an incremental increase in published outputs per year from 27 countries. There was a greater acknowledgement of the differing epistemological and theoretical frameworks used by researchers.

Brooke (2009) evaluated whether the methodologic quality of the most frequently cited surgical clinical evidence has improved since 1985. This bibliometric review identified the 50 most-cited general surgery clinical research studies published in general surgery and medicine journals during 4 consecutive time periods (1985-1989, 1990-1994,

1995-1999, 2000-2004).

3. Research Overview

In this study, the major research areas in Korean and American medical schools were analyzed by the frequencies of journals and articles that match subject categories used in the SCIE, SSCI and CC-Clinical Medicine database. Five medical schools for each country were chosen according to the articles of reliable daily newspapers, the New York Times (U.S.) and Chosun Ilbo (Korea) to select generally research-active institutions.

In Korea, the five universities were Seoul National University, Yonsei University, Korea University, Sung Kyun Kwan University and Catholic University. In America, the five schools were Harvard University, Johns Hopkins University, Washington University (St. Louis), the University of Pennsylvania, and California University.

Research articles and journals affiliated with these ten schools, from 2006 to 2008, comprised the preliminary data collection. Collected data were matched to journal lists in each subject category of SCIE, SSCI, and CC-Clinical Medicine. These categories cover comprehensive journals in each subject area and provide organized subject frames. For this reason, subject categories provided by Thompson Reuters were used for the analysis. All matched data among preliminary data were analyzed according to three areas: science (SCIE), social science (SSCI) and clinical medicine (CC-Clinical Medicine).

A subject category was assigned to each article and each journal. Twenty high-ranked subject categories (i.e. the twenty categories assigned most often to journals or articles) were selected and analyzed. To visualize subject areas' size and tendency, bubble maps were created using xlstats, a statistical software. The size of each bubble showed a subject's weight, with more assignments creating larger bubbles. The location of each bubble showed its research assignment. Through the analysis of visualization results, dominant research areas and publishing trends in the two countries were described.
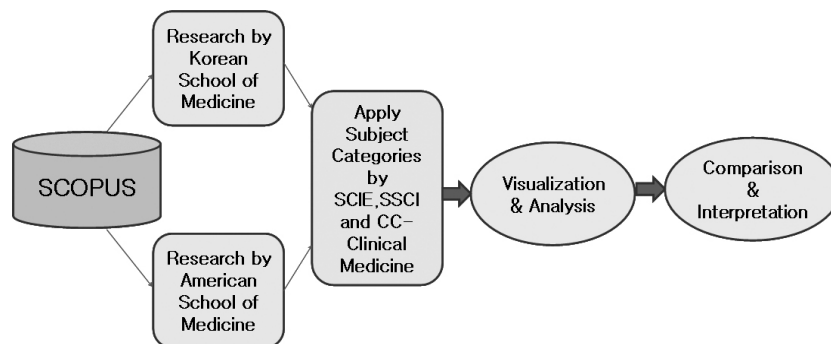
〈Figure 1〉 Research frame

3.1 Collected Data of Medicine School of Korean and America

Collected data from SCOPUS are divided by two criteria, the number of journals and the number of articles (Table 1). Data affiliated by researchers of Korean medical schools, from 2006 to 2008, were 6,300 articles in 1,237 journals excluding redundant journals. Data of American medical schools, from 2006 to 2008, were 22,821 articles in 2,714 journals.

3.2 Subject Categories

One hundred seventy-two subject categories are in SCIE. On average, 65.7 journals are assigned to each subject category and 1.53 categories are assigned to each journal. In SSCI, fifty-five subject categories are used to identify topic of source journals. On average, 43.1 journals of SSCI are assigned to each subject category and 1.36 categories are assigned to each journal. CC Clinical Medicine has twenty-six categories and each journal is assigned to one subject category, which prevented redundant subject assignments.

4. Analysis of research topics in Korean and American schools of medicine

To identify major research areas of medical school scholars and their publishing tendency in these areas, bibliometric analyses were carried out in three stages.

First, the topic of each journal in which the scholars published was determined by the subject categories of SCIE, SSCI, and CC Clinical Medicine, all of which categorize their source journals by subject. SCIE subject categories were used to examine science and general medicine-related subject areas of medical school researchers in both countries. SSCI was used for social science areas and CC Clinical Medicine was used for more specific medical areas such as clinical medicine. When the journals identified for this study were found in the lists of journals from particular subject categories, the titles of the categories became the subjects of the journals. Multiple subject titles could be assigned to one journal because SCIE and SSCI do so.

After the journals were assigned to subject categories, the subjects were arranged by the total frequency of journals per category and by the total

<Table 1> Retrieval results from SCOPUS

	Korea		America	
	no. of Articles	no. of Journals	no. of Articles	no. of Journals
2006	1716	618	7020	1569
2007	2066	733	7858	1684
2008	2518	818	7943	1737

number of articles published in those journals. The top 10-20 subjects were identified, sorted by the number of journals and the number of articles.

4.1 Analyses of Research Publications Associated with Korean Medical Schools

Among the 1,237 journals collected in SCOPUS, 1,055 were matched to journals in the subject categories of SCIE and SSCI. Twenty-seven journals (2.6%) appear both in science (SCIE) and social science (SSCI) areas only 4 journals belong to exclusively SSCI categories. A major portion of the journals corresponded exclusively to categories of scientific disciplines. This tendency was seen more distinctly in the article analysis results.

In order to understand the nature of subject distribution in this study, it is necessary to explain the cases of journals with multiple subjects. Because neither SCIE nor SSCI limit the number of categories that can be assigned to one journal, 3 journals appeared in 5 different subject categories and 28 journals had 4 subject categories. Three hundred thirty-one journals appeared in 2 subject categories and 115 journals belonged to 3 subject categories.

1) Subject analysis by SCIE categories

One hundred nine categories of SCIE were used to assign subjects to the journals in which Korean medical school researchers had published. The subject category with the highest number of journals that include articles by Korean scholars is CLINICAL NEUROLOGY. In turn, CLINICAL NEUROLOGY has 85 journals, the highest number, which indicates that this is the major subject area for Korean medical-school researchers. It is reasonable to assume that most scholars try to publish their papers in the journals of their research areas. Seven other important subject categories identified by journals are NEUROSCIENCES; ONCOLOGY; SURGERY; BIOCHEMISTRY & MOLECULAR; BIOLOGY CELL BIOLOGY; PHARMACOLOGY & PHARMACY; IMMUNOLOGY; and RADIOLOGY, NUCLEAR MEDICINE, & MEDICAL IMAGING. These subject categories all include more than 50 journals in which Korean researchers have published.

The ten major subject categories identified by the number of articles are RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING; ONCOLOGY; MEDICINE, GENERAL & INTERNAL; SURGERY; CLINICAL NEUROLOGY; BIOCHEMISTRY & MOLECULAR BIOLOGY; GASTRO-

〈Table 2〉 Journals and articles matched to SCIE & SSCI categories

Number of the Journals analyzed by SCIE & SSCI SUBJECT CATEGORIES		Number of the Articles analyzed by SCIE & SSCI SUBJECT CATEGORIES	
Journals in SCIE and SSCI categories	27(2.6%)	Articles in SCIE and SSCI categories	69(1.2%)
Journals only in SSCI categories	4(0.4%)	Articles only in SSCI categories	6(0.1%)
Journals only in SCIE categories	1,024(98%)	Articles only in SCIE categories	5,554(98.7%)
Total	1,055(100%)	Total	5,629(100%)

〈Table 3〉 Subject analysis by journals - Korean school of medicine

subject categories	range by the number of journals	number of subject categories
CLINICAL NEUROLOGY(85)	over 80	1
NEUROSCIENCES(75), ONCOLOGY(74),SURGERY(70)	70-79	3
BIOCHEMISTRY & MOLECULAR BIOLOGY(68), CELL BIOLOGY(65)	60-69	2
PHARMACOLOGY & PHARMACY(59), IMMUNOLOGY(53), RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING(51)	50-59	3
CARDIAC & CARDIOVASCULAR SYSTEMS(41), ENDOCRINOLOGY & METABOLISM(41), GENETICS & HEREDITY(40)	40-49	3
MEDICINE, RESEARCH & EXPERIMENTAL(39), BIOTECHNOLOGY & APPLIED MICROBIOLOGY(38), GASTROENTEROLOGY & HEPATOLOGY(38), PSYCHIATRY(36), HEMATOLOGY(34), INFECTIOUS DISEASES(31)	30-39	6
MICROBIOLOGY(29), PEDIATRICS(28), PATHOLOGY(25), PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH(25), UROLOGY & NEPHROLOGY(25), DERMATOLOGY(24), OPHTHALMOLOGY(24), OBSTETRICS & GYNECOLOGY(23), PERIPHERAL VASCULAR DISEASE(22), MEDICINE, GENERAL & INTERNAL(21), RESPIRATORY SYSTEM(20)	20-29	11
TRANSPLANTATION(19), DENTISTRY, ORAL SURGERY & MEDICINE(18), ENGINEERING, BIOMEDICAL(18), ORTHOPEDICS(17), BIOCHEMICAL RESEARCH METHODS(16), TOXICOLOGY(15), ANESTHESIOLOGY(14), VIROLOGY(14), BIOLOGY(13), HYSIOLOGY(13), BIOPHYSICS(12), GERIATRICS & GERONTOLOGY(12), MEDICAL LABORATORY TECHNOLOGY(12), CHEMISTRY, MEDICINAL(11), NUTRITION & DIETETICS(11), RHEUMATOLOGY(11), CHEMISTRY, MULTIDISCIPLINARY(10), HEALTH CARE SCIENCES & SERVICES(10)	10-19	18
CHEMISTRY, ANALYTICAL(9), NEUROIMAGING(9), PARASITOLOGY(9), PSYCHOLOGY(9), CRITICAL CARE MEDICINE(8), MATERIALS SCIENCE, MULTIDISCIPLINARY(8), ALLERGY(7), ANATOMY & MORPHOLOGY(7), FOOD SCIENCE & TECHNOLOGY(7), MEDICAL INFORMATICS(7), OTORHINOLARYNGOLOGY(7), PHYSICS, APPLIED(7), REPRODUCTIVE BIOLOGY(7), CHEMISTRY, ORGANIC(6), CHEMISTRY, PHYSICAL(6), COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS(6), ENVIRONMENTAL SCIENCES(6), MATERIALS SCIENCE, BIOMATERIALS(6), SPORT SCIENCES(6), INSTRUMENTS & INSTRUMENTATION(5), NUCLEAR SCIENCE & TECHNOLOGY(5), PHYSICS, CONDENSED MATTER(5) DEVELOPMENTAL BIOLOGY(4), EMERGENCY MEDICINE(4), MATHEMATICAL & COMPUTATIONAL BIOLOGY(4), MICROSCOPY(4), PLANT SCIENCES(4), REHABILITATION(4), TROPICAL MEDICINE(4), VETERINARY SCIENCES(4), ACOUSTICS(3), BEHAVIORAL SCIENCES(3), COMPUTER SCIENCE, INFORMATION SYSTEMS(3), ENGINEERING, ELECTRICAL & ELECTRONIC(3), MEDICINE, LEGAL(3), MULTIDISCIPLINARY SCIENCES(3), NANOSCIENCE & NANOTECHNOLOGY(3), NURSING(3), SUBSTANCE ABUSE(3), ANDROLOGY(2), CHEMISTRY, APPLIED(2), ELECTROCHEMISTRY(2), ENTOMOLOGY(2), MATERIALS SCIENCE, COATINGS & FILMS(2), MYCOLOGY(2), POLYMER SCIENCE(2), STATISTICS & PROBABILITY(2), ZOOLOGY(2), AGRICULTURE, MULTIDISCIPLINARY(1), CHEMISTRY, INORGANIC & NUCLEAR(1), COMPUTER SCIENCE, CYBERNETICS(1), COMPUTER SCIENCE, SOFTWARE ENGINEERING(1), COMPUTER SCIENCE, THEORY & METHODS(1), RYSTALLOGRAPHY(1), EDUCATION, SCIENTIFIC DISCIPLINES(1), ENGINEERING, ENVIRONMENTAL(1), INTEGRATIVE & COMPLEMENTARY MEDICINE(1), MECHANICS(1), OPTICS(1), PHYSICS, MATHEMATICAL(1), PHYSICS, MULTIDISCIPLINARY(1), SPECTROSCOPY(1)	1-9	62

ENTEROLOGY & HEPATOLOGY; NEURO-SCIENCES; and CARDIAC & CARDIOVAS-CULAR SYSTEMS. These subject categories have more than 200 articles written by Korean medical school researchers.
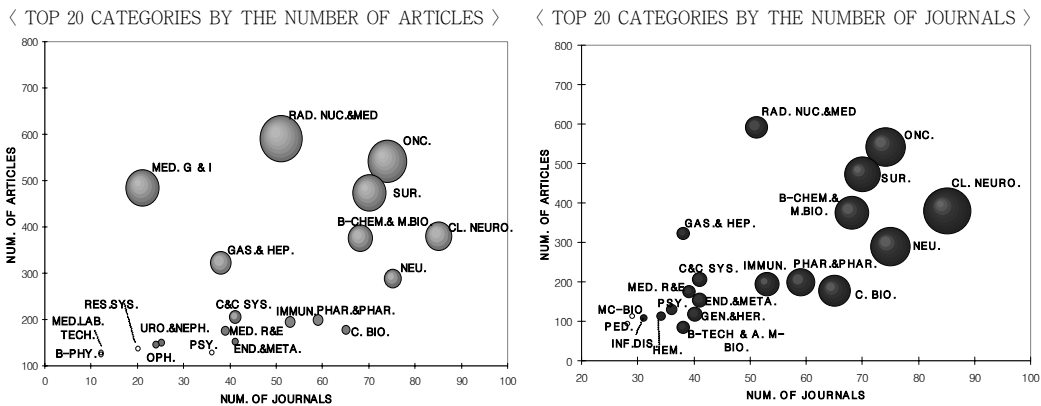
In comparison with the result of subject analysis by journals, analysis of the highest number of articles shows some notable changes in subject

categories. CLINICAL NEUROLOGY, which had the most journals, was ranked fifth among subject categories calculated by the number of articles.

However, RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING became the subject categories that had the most articles published by

〈Table 4〉 Subject analysis in science by articles - Korean school of medicine

subject categories	range by the number of articles	number of subject categories
RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING(592), ONCOLOGY(542)	over 500	2
MEDICINE, GENERAL & INTERNAL(485), SURGERY(474)	400~499	2
CLINICAL NEUROLOGY(381), BIOCHEMISTRY & MOLECULAR BIOLOGY(377), GASTROENTEROLOGY & HEPATOLOGY(323)	300~399	3
NEUROSCIENCES(290), CARDIAC & CARDIOVASCULAR SYSTEMS(206)	200~299	2
PHARMACOLOGY & PHARMACY(199), IMMUNOLOGY(196), CELL BIOLOGY(179), MEDICINE, RESEARCH & EXPERIMENTAL(176), ENDOCRINOLOGY & METABOLISM(154), UROLOGY & NEPHROLOGY(151), OPHTHALMOLOGY(147), RESPIRATORY SYSTEM(138), PSYCHIATRY(130), MEDICAL LABORATORY TECHNOLOGY(129), BIOPHYSICS(125), OBSTETRICS & GYNECOLOGY(118), GENETICS & HEREDITY(118), HEMATOLOGY(115), MICROBIOLOGY(114), PERIPHERAL VASCULAR DISEASE(111), INFECTIOUS DISEASES(110), TRANSPLANTATION(102)	100~199	18
DERMATOLOGY(97), PEDIATRICS(96), PATHOLOGY(87), BIOTECHNOLOGY & APPLIED MICROBIOLOGY(85), OTORHINOLARYNGOLOGY(80), ORTHOPEDICS(69), NEUROIMAGING(67), ANESTHESIOLOGY(58), DENTISTRY, ORAL SURGERY & MEDICINE(54)	50~99	9
PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH(47), RHEUMATOLOGY(42), BIOCHEMICAL RESEARCH METHODS(41), VIROLOGY(38), ENGINEERING, BIOMEDICAL(37), PARASITOLOGY(36), ACOUSTICS(35), GERIATRICS & GERONTOLOGY(34), TOXICOLOGY(30), SPORT SCIENCES(30), CHEMISTRY, MEDICINAL(29), MATERIALS SCIENCE, BIOMATERIALS(28), ALLERGY(28), PSYCHOLOGY(25), BIOLOGY(23), ANATOMY & MORPHOLOGY(22), NUTRITION & DIETETICS(20), REPRODUCTIVE BIOLOGY(18), PHYSIOLOGY(18), MULTIDISCIPLINARY SCIENCES(18), EMERGENCY MEDICINE(18), CHEMISTRY, MULTIDISCIPLINARY(18), MATERIALS SCIENCE, MULTIDISCIPLINARY(15), HEALTH CARE SCIENCES & SERVICES(15), CRITICAL CARE MEDICINE(14), REHABILITATION(13), PLANT SCIENCES(12), PHYSICS, APPLIED(12), MATHEMATICAL & COMPUTATIONAL BIOLOGY(12), CHEMISTRY, ANALYTICAL(11), VETERINARY SCIENCES(10), CHEMISTRY, ORGANIC(10)	10~49	32
FOOD SCIENCE & TECHNOLOGY(9), MEDICINE, LEGAL(8), MEDICAL INFORMATICS(8), TROPICAL MEDICINE(7), SUBSTANCE ABUSE(7), NUCLEAR SCIENCE & TECHNOLOGY(7), INSTRUMENTS & INSTRUMENTATION(7), ENVIRONMENTAL SCIENCES(7), COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS(7), MICROSCOPY(6), CHEMISTRY, PHYSICAL(6), ANDROLOGY(6), PHYSICS, CONDENSED MATTER(5), INTEGRATIVE & COMPLEMENTARY MEDICINE(5), DEVELOPMENTAL BIOLOGY(5), BEHAVIORAL SCIENCES(5), NANOSCIENCE & NANOTECHNOLOGY(4), MYCOLOGY(4), NURSING(3), ENGINEERING, ELECTRICAL & ELECTRONIC(3), ELECTROCHEMISTRY(3), COMPUTER SCIENCE, INFORMATION SYSTEMS(3), CHEMISTRY, APPLIED(3), ZOOLOGY(2), STATISTICS & PROBABILITY(2), POLYMER SCIENCE(2),MATERIALS SCIENCE, COATINGS & FILMS(2), ENTOMOLOGY(2), CRYSTALLOGRAPHY(2), AGRICULTURE, MULTIDISCIPLINARY(2), SPECTROSCOPY(1), PHYSICS, MULTIDISCIPLINARY(1), PHYSICS, MATHEMATICAL(1), OPTICS(1), MECHANICS(1), ENGINEERING, ENVIRONMENTAL(1), EDUCATION, SCIENTIFIC DISCIPLINES(1), COMPUTER SCIENCE, THEORY & METHODS(1), COMPUTER SCIENCE, SOFTWARE ENGINEERING(1), COMPUTER SCIENCE, CYBERNETICS(1), CHEMISTRY, INORGANIC & NUCLEAR(1)	1~9	41

〈 TOP 20 CATEGORIES BY THE NUMBER OF ARTICLES 〉   〈 TOP 20 CATEGORIES BY THE NUMBER OF JOURNALS 〉

ABBREATION USED IN FIGURE 1.

- BIOCHEMISTRY & MOLECULAR BIOLOGY : B-CHEM.& M.BIO.
- BIOPHYSICS:B-PHY.
- BIOTECHNOLOGY & APPLIED MICROBIOLOGY:B-TECH & A. M-BIO.
- CARDIAC & CARDIOVASCULAR SYSTEMS:C&C SYS.
- CELL BIOLOGY:C. BIO.
- CLINICAL NEUROLOGY:CL. NEURO.
- ENDOCRINOLOGY & METABOLISM:END.&META.
- GASTROENTEROLOGY & HEPATOLOGY:GAS.& HEP.
- GENETICS & HEREDITY:GEN.&HER.
- HEMATOLOGY:HEM.
- IMMUNOLOGY:IMMUN.
- INFECTIOUS DISEASES:INF.DIS.

- MEDICAL LABORATORY TECHNOLOGY:MED.LAB. TECH.
- MEDICINE, GENERAL & INTERNAL:MED. G & I
- MEDICINE, RESEARCH & EXPERIMENTAL:MED. R&E
- MICROBIOLOGY:MC-BIO
- NEUROSCIENCES:NEU.
- ONCOLOGY:ONC.
- OPHTHALMOLOGY:OPH.
- PEDIATRICS:PED.
- PHARMACOLOGY & PHARMACY:PHAR.&PHAR.
- PSYCHIATRY:PSY.
- RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING:RAD. NUC.&MED.
- RESPIRATORY SYSTEM:RES.SYS.
- SURGERY:SUR.
- UROLOGY & NEPHROLOGY:URO.&NEPH.

〈Figure 2〉 Top 20 SCIE categories by journals and by articles

Korean scholars for 3 years, even though they were ranked sixth among in subject categories calculated by the number of journals. The latter result seems to indicate that Korean scholars writing about CLINICAL NEUROLOGY published their articles in more various journals than Korean scholars writing about RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING. This result also shows that there are more dominant journals in RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING than in CLINICAL NEUROLOGY, because the former has less journals, but more articles. This tendency can be seen more clearly in the scatter-

gram (Figure 2) that compares changes in subject categories by both journal analysis and article analysis.

Figure 2 compares the top 20 subjects by the total number of journals and the total number of articles. What stands out most from the two scatter-grams is correlation between changes in bubble size and subject category. As explained above, the bubble sizes of CLINICAL NEUROLOGY and RADIOLOGY, NUCLEAR MEDICINE & MED-ICAL IMAGING show significant changes accord-ing to frequencies of journals and articles. NEU-ROSCIENCES and CELL BIOLOGY show a ten-

dency similar to CLINICAL NEUROLOGY, as the bubbles of both NEUROSCIENCES and CELL BIOLOGY appear larger in the journals scattergram than their bubbles in the articles scattergram. This means that NEUROSCIENCES and CELL BIOLOGY are major subject areas for Korean researchers, even though their articles appear in a smaller number of journals.

In the articles scattergram, MEDICINE, GENERAL & INTERNAL is the third major subject even though it isn't ranked in the top 20 journal categories. MEDICINE, GENERAL & INTERNAL shows a similar tendency as RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING in terms of the number of dominant journals in the subject area. In the area of MEDICINE, GENERAL & INTERNAL, compared to other subject areas in the top 20, Korean scholars published in a smaller number of journals.

In both scattergrams, neither the bubble sizes nor the coordinates of ONCOLOGY; MEDICINE,

GENERAL & INTERNAL; SURGERY; CLINICAL NEUROLOGY; and BIOCHEMISTRY & MOLECULAR BIOLOGY show significant changes. They are major subject areas in which Korean researchers consistently published many papers, but the articles did not appear in consistently preferred journals.

Taken from the top 20 categories, the top 10 categories in each scattergram are the same except MEDICINE, GENERAL & INTERNAL. In the bottom 10 categories, rank of subject categories changes more inconsistently.

2) Subject analysis by SSCI categories

Among the 1,237 journals collected from SCOPUS, only 30 journals matched to journals of SSCI subject categories. Korean researchers' subject areas mainly belong to science areas, including medicine. Among the social science subject categories matched by journals and articles, PSYCHIATRY and PSYCHOLOGY, CLINICAL are

⟨Table 5⟩ Subject analysis in social science by journals and articles – Korean school of medicine

SUBJECT CATEGORIES	the number of journals	SUBJECT CATEGORIES	the number of articles
PSYCHIATRY	18	PSYCHIATRY	57
PSYCHOLOGY, CLINICAL	5	PSYCHOLOGY, CLINICAL	17
GERONTOLOGY	4	GERONTOLOGY	6
NURSING, PSYCHOLOGY, MULTIDISCIPLINARY, PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	2	PSYCHOLOGY, MULTIDISCIPLINARY	4
		COMMUNICATION, PSYCHOLOGY, APPLIED	3
BUSINESS, COMMUNICATION, PSYCHOLOGY, APPLIED, PSYCHOLOGY, DEVELOPMENTAL, REHABILITATION, SOCIAL SCIENCES, BIOMEDICAL, SOCIAL SCIENCES, INTERDISCIPLINARY	1	NURSING, PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH, SOCIAL SCIENCES, BIOMEDICAL	2
		BUSINESS, PSYCHOLOGY, DEVELOPMENTAL, REHABILITATION, SOCIAL SCIENCES, INTERDISCIPLINARY	1

the two major areas in social science that Korean researchers write about. Including these categories, almost all of matched subject categories seem to be related to medical areas such as PSYCHOLOGY, REHABILITATION and SOCIAL SCIENCES, BIOMEDICAL.

3) Subject analysis by CC-Clinical Medicine categories

In 3 years, Korean researchers published 3,611 papers in 575 journals in clinical medicine areas. Of the 26 categories provided by CC-Clinical Medicine, 25 subject categories have journals that included Korean researchers' papers. The subject category with the highest number(53) of journals is CARDIOVASCULAR & RESPIRATORY SYSTEMS. This shows that CARDIOVASCULAR & RESPIRATORY SYSTEMS is a major research area for Korean medical school researchers. Other noticeable subject categories identified by journals are CARDIOVASCULAR & RESPIRATORY SYSTEMS; NEUROLOGY; ONCOLOGY; RADIOLOGY, NUCLEAR MEDICINE & IMAGING; SURGERY; GASTROENTEROLOGY & HEPATOLOGY; and RESEARCH/LABORATORY MEDICINE & MEDICAL TECHNOLOGY. These categories dominate the top 30 percent of journals.

By number of articles, the subject category with the highest publication rate is RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING, with 533 articles by Korean scholars. This subject category is ranked fourth, by the number of journals in which these articles appear. This pattern is almost the same pattern as the one seen in the science areas. MEDICINE, GENERAL & INTERNAL also appears very similarly to the way it did in the science area (see figures 2 and 3). Four other categories, ONCOLOGY; GASTROENTEROLOGY & HEPATOLOGY; CARDIOVASCULAR & RESPIRATORY SYSTEMS; and NEUROLOGY
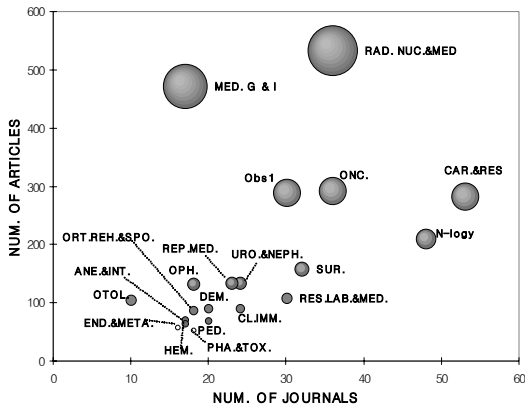
〈Table 6〉 Subject analysis in clinical medicine by journals - Korean school of medicine

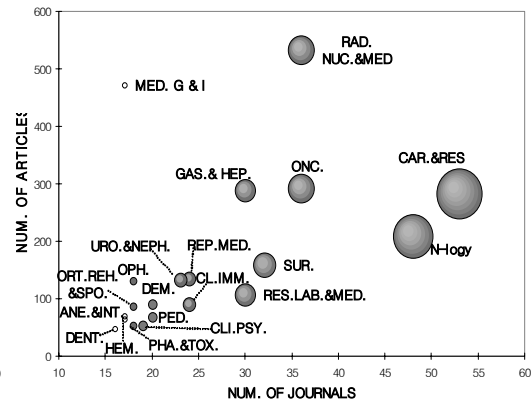| subject categories	range by the number of journals	number of subject categories
Cardiovascular & Respiratory Systems(53)	OVER 50	1
Neurology(48)	40-49	1
Oncology(36), Radiology, Nuclear Medicine & Imaging(36), Surgery(32), Gastroenterology & Hepatology(30), Research/Laboratory Medicine & Medical Technology(30)	30-39	5
Clinical Immunology & Infectious Disease(24), Reproductive Medicine(24), Urology & Nephrology(23), Dermatology(20), Pediatrics(20)	20-29	5
Clinical Psychology & Psychiatry(19), Ophthalmology(18), Orthopedics, Rehabilitation & Sports Medicine(18), Pharmacology/Toxicology(18), Anesthesia & Intensive Care(17), General & Internal Medicine(17), Hematology(17), Dentistry/Oral Surgery & Medicine(16), Endocrinology, Metabolism & Nutrition(16), Environmental Medicine & Public Health(14), Otolaryngology(10), Rheumatology(10)	10-19	12
Health Care Sciences & Services(9)	1-9	1

〈Table 7〉 Subject analysis in clinical medicine by articles - Korean school of medicine

subject categories	range by the number of articles	number of subject categories
Radiology, Nuclear Medicine & Imaging(533)	OVER 500	1
Medicine, General & Internal(473)	401-499	1
Oncology(292), Gastroenterology & Hepatology(289), Cardiovascular & Respiratory Systems(283), Neurology(210)	200-299	4
Surgery(159), Reproductive Medicine(135), Urology & Nephrology(134), Ophthalmology(132), Research/Laboratory Medicine & Medical Technology(108), Otolaryngology(105)	100-199	6
Clinical Immunology & Infectious Disease(90), Dermatology(90), Orthopedics, Rehabilitation & Sports Medicine(87), Anesthesia & Intensive Care(71), Pediatrics(69), Hematology(64), Endocrinology, Metabolism & Nutrition(58), Pharmacology/Toxicology(54),Clinical Psychology & Psychiatry(53)	50-99	9
Dentistry/Oral Surgery & Medicine(49), Rheumatology(32), Environmental Medicine & Public Health(28), Health Care Sciences & Services(13)	10-49	4

〈 TOP 20 CATEGORIES BY THE NUMBER OF ARTICLES 〉 〈 TOP 20 CATEGORIES BY THE NUMBER OF JOURNALS 〉

ABBREATION USED IN FIGURE 1.
• Anesthesia & Intensive Care : ANE.&INT.
• Cardiovascular & Respiratory System : CAR.&RES
• Clinical Immunology & Infectious Disease : CL.IMM.
• Clinical Psychology & Psychiatry : CLI.PSY.
• Dentistry/Oral Surgery & Medicine : DENT.
• Dermatology : DEM.
• Endocrinology, Metabolism & Nutrition : END.&META.
• Gastroenterology & Hepatology : GAS.& HEP.
• Hematology : HEM.
• MEDICINE, GENERAL & INTERNAL : MED. G & I
• Neurology : N-logy

• Oncology : ONC.
• Ophthalmology : OPH.
• Orthopedics, Rehabilitation & Sports Medicine : ORT.REH.&SPO.
• Otolaryngology : OTOL.
• Pediatrics : PED.
• Pharmacology/Toxicology : PHA.&TOX.
• Radiology, Nuclear Medicine & Imaging : RAD. NUC.&MED
• Reproductive Medicine : REP.MED.
• Research/Laboratory Medicine & Medical Technology : RES.LAB.&MED.
• Surgery : SUR.
• Urology & Nephrology : URO.&NEPH.

〈Figure 3〉 Top 20 CC Clinical Medicine Categories by journals and by articles

are identified as major subject areas of Korean researchers.

CARDIOVASCULAR & RESPIRATORY SYSTEMS and NEUROLOGY can be interpreted as subject areas where researchers had publishing tendency, by comparing them with the two scatter-grams in Figure 3. A higher number of journals but a lower number of articles appear in these areas. This means researchers published their papers in more various journals rather than in some particular journals

4.2 Analyses of Research Publications Associated with American Medical Schools

Researchers in American medical schools published 22,733 articles in 2,018 journals in the SCIE and SSCI categories from 2006 to 2008. Of these, 85% of all the journals and 93.2% of all the articles appear only in SCIE. 9% of the journals and 2.5% of the articles belonged only to SSCI categories. However, journals and articles both in SCIE and SSCI show reverse results of SSCI only case. Nine percent of the journals were listed in both SCIE and SSCI, a larger portion than the journals listed exclusively in SSCI. By contrast, articles are 2.5%,

so the portion became smaller than the one belong-ing exclusively SSCI. These results provide a plausible explanation for the publication rationale of researchers in American medical schools: they preferred journals in the social science areas that over-lapped with science areas, so several journals show a large number of articles in these areas.

The number of categories used in this analysis is 185. Of these, 141 were in SCIE and 44 in SSCI. Two journals included 6 subject categories and 10 journals included 5 subject categories. Sixty-one journals appeared in 4 subject categories and 233 journals in 3. Seven hundred six journals appeared in 2 subject categories.

1) Subject analysis by SCIE categories

The subject category with the highest num-ber(157) of journals BIOCHEMISTRY & MO-LECULAR BIOLOGY. Including BIOCHEMISTRY & MOLECULAR BIOLOGY, major subject areas identified by a high number of journals are NEUROSCIENCES; CLINICAL NEUROLOGY; CELL BIOLOGY; and PHARMACOLOGY & PHARMACY. These subject categories are the top 5 and appear in more than 100 journals in which American researchers published their papers.

The American subject category with the highest

〈Table 8〉 Journals and articles matched with SCIE & SSCI categories

Number of the Journals analyzed by SCIE & SSCI SUBJECT CATEGORIES		Number of the Articles analyzed by SCIE & SSCI SUBJECT CATEGORIES	
Journals in SCIE and SSCI categories	113(6%)	Articles in SCIE and SSCI categories	926(4.3%)
Journals only in SSCI categories	180(9%)	Articles only in SSCI categories	536(2.5%)
Journals only in SCIE categories	1,725(85%)	Articles only in SCIE categories	20,271(93.2%)
Total	2,018(100%	Total	21,733(100%)

〈Table 9〉 Subject analysis in science by journals - American school of medicine

subject categories	range by the number of journals	number of subject categories
BIOCHEMISTRY & MOLECULAR BIOLOGY(157), NEUROSCIENCES(138), CLINICAL NEUROLOGY(113), CELL BIOLOGY(102), PHARMACOLOGY & PHARMACY(101)	OVER 100	5
ONCOLOGY (98), SURGERY (94), GENETICS & HEREDITY(80), IMMUNOLOGY(72), PSYCHIATRY(72), RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING(72), PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH (66), ENDOCRINOLOGY & METABOLISM(65), CARDIAC & CARDIOVASCULAR SYSTEMS(59), MEDICINE, GENERAL & INTERNAL(57), PEDIATRICS(57), PSYCHOLOGY, CLINICAL(52), BIOTECHNOLOGY & APPLIED MICROBIOLOGY(51), MEDICINE, RESEARCH & EXPERIMENTAL(50), PSYCHIATRY(50)	50-99	15
PATHOLOGY(45), HEALTH CARE SCIENCES & SERVICES(42), MICROBIOLOGY(40), HEMATOLOGY(38), OPHTHALMOLOGY(38), INFECTIOUS DISEASES(38), BIOCHEMICAL RESEARCH METHODS(38), PSYCHOLOGY(38), OBSTETRICS & GYNECOLOGY(37), PERIPHERAL VASCULAR DISEASE(34), GASTROENTEROLOGY & HEPATOLOGY(34), UROLOGY & NEPHROLOGY(33), BIOPHYSICS(32), PHYSIOLOGY(30), ORTHOPEDICS(30), PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH(30)	30-49	16
RESPIRATORY SYSTEM(28), TOXICOLOGY(28), CHEMISTRY, MULTIDISCIPLINARY(27), PSYCHOLOGY, MULTIDISCIPLINARY(27), DEVELOPMENTAL BIOLOGY(26), NUTRITION & DIETETICS(26), BIOLOGY(26), SPORT SCIENCES(26), DERMATOLOGY(25), PSYCHOLOGY, EXPERIMENTAL(25), HEALTH POLICY & SERVICES(23), ENGINEERING, BIOMEDICAL(22), BEHAVIORAL SCIENCES(22), VETERINARY SCIENCES (21), PSYCHOLOGY, DEVELOPMENTAL(21), GERIATRICS & GERONTOLOGY(20), REHABILITATION(20), TRANSPLANTATION(19), NURSING(19), VIROLOGY(18), OTORHINOLARYNGOLOGY(18), MATHEMATICAL & COMPUTATIONAL BIOLOGY(18), ENGINEERING, ELECTRICAL & ELECTRONIC(18), STATISTICS & PROBABILITY(17), COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS(16), CHEMISTRY, ANALYTICAL(16), CHEMISTRY, PHYSICAL(16), REHABILITATION(15), REPRODUCTIVE BIOLOGY(15), DENTISTRY, ORAL SURGERY & MEDICINE(15), CHEMISTRY, MEDICINAL(14), EVOLUTIONARY BIOLOGY(14), PLANT SCIENCES(14), MEDICAL INFORMATICS(13), CRITICAL CARE MEDICINE(13), NANOSCIENCE & NANOTECHNOLOGY(13), ZOOLOGY (12), MATERIALS SCIENCE, MULTIDISCIPLINARY(12), SUBSTANCE ABUSE(12), FAMILY STUDIES(12), MULTIDISCIPLINARY SCIENCES(11), MEDICAL LABORATORY TECHNOLOGY(11), CHEMISTRY, ORGANIC(11), ECOLOGY(11), SOCIAL SCIENCES, BIOMEDICAL(11), ANATOMY & MORPHOLOGY(10), ANESTHESIOLOGY(10), RHEUMATOLOGY(10), ENVIRONMENTAL SCIENCES(10), GERONTOLOGY(10), EDUCATION & EDUCATIONAL RESEARCH(10)	10-29	51
EMERGENCY MEDICINE(9), ALLERGY(9), PARASITOLOGY(9), EDUCATION, SCIENTIFIC DISCIPLINES(9), COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE(9), PSYCHOLOGY, SOCIAL(9), NURSING(9), NEUROIMAGING(8), SUBSTANCE ABUSE(8), INTEGRATIVE & COMPLEMENTARY MEDICINE (8), TROPICAL MEDICINE(8), PSYCHOLOGY, PSYCHOANALYSIS(8), SPECTROSCOPY (7), MATERIALS SCIENCE, BIOMATERIALS(7), ACOUSTICS(7), FOOD SCIENCE & TECHNOLOGY(7), MEDICINE, LEGAL(7), PSYCHOLOGY, EDUCATIONAL(7), COMPUTER SCIENCE, INFORMATION SYSTEMS(6), PHYSICS, APPLIED (6), ANTHROPOLOGY(6), SOCIAL SCIENCES, INTERDISCIPLINARY(6), ECONOMICS(6), SOCIAL ISSUES(6), OPTICS(5), PHYSICS, ATOMIC, MOLECULAR & CHEMICAL(5), MYCOLOGY(5), NUCLEAR SCIENCE & TECHNOLOGY(5), MARINE & FRESHWATER BIOLOGY(5), MATHEMATICS, INTERDISCIPLINARY APPLICATIONS(5), AGRICULTURE, DAIRY & ANIMAL SCIENCE(5), PSYCHOLOGY, BIOLOGICAL(5), SOCIAL WORK(5), ERGONOMICS(5), LAW(5), APPLIED LINGUISTICS(5), PSYCHOLOGY, APPLIED(5), ANDROLOGY(4), CRYSTALLOGRAPHY(4), CHEMISTRY, APPLIED(4), MEDICAL ETHICS(4), PHYSICS, CONDENSED MATTER(4), MATHEMATICS, APPLIED(4), EDUCATION, SPECIAL(4), SOCIOLOGY(4), POLYMER SCIENCE(3), AUTOMATION & CONTROL SYSTEMS(3), FISHERIES(3), PHYSICS, MULTIDISCIPLINARY(3), CHEMISTRY, INORGANIC & NUCLEAR(3), ETHICS(3), ASTRONOMY & ASTROPHYSICS(2), ENGINEERING, MECHANICAL(2), GEOSCIENCES, MULTIDISCIPLINARY(2), ENGINEERING, ENVIRONMENTAL(2), PHYSICS, MATHEMATICAL(2), TELECOMMUNICATIONS(2), COMPUTER SCIENCE, CYBERNETICS(2), COMPUTER SCIENCE, THEORY & METHODS(2), ENGINEERING, INDUSTRIAL(2), GEOGRAPHY, PHYSICAL(2), MATHEMATICS(2), MICROSCOPY(2), PALEONTOLOGY(2),	1-9	98

TRANSPORTATION(2), PSYCHOLOGY, MATHEMATICAL(2), BUSINESS(2), DEMOGRAPHY(2), ENVIRONMENTAL STUDIES(2), IMAGING SCIENCE & PHOTOGRAPHIC TECHNOLOGY(1), ENGINEERING, AEROSPACE(1), ENGINEERING, MANUFACTURING(1), METEOROLOGY & ATMOSPHERIC SCIENCES(1), AGRICULTURE, MULTIDISCIPLINARY(1), ENGINEERING, MULTIDISCIPLINARY(1), AGRICULTURAL ENGINEERING(1), AGRONOMY(1), COMPUTER SCIENCE, SOFTWARE ENGINEERING(1), CONSTRUCTION & BUILDING TECHNOLOGY(1), ELECTROCHEMISTRY(1), ENERGY & FUELS(1), ENGINEERING, CIVIL(1), ENTOMOLOGY(1), HISTORY & PHILOSOPHY OF SCIENCE(1), INSTRUMENTS & INSTRUMENTATION(1), LIMNOLOGY(1), OCEANOGRAPHY (1), OPERATIONS RESEARCH & MANAGEMENT(1), ORNITHOLOGY(1), INFORMATION SCIENCE & LIBRARY SCIENCE(1), POLITICAL SCIENCE(1), COMMUNICATION(1), CRIMINOLOGY & PENOLOGY(1), ETHNIC STUDIES(1), MANAGEMENT(1), PUBLIC ADMINISTRATION(1), SOCIAL SCIENCES, MATHEMATICAL METHODS(1), URBAN STUDIES(1)		

number of journals and articles is the same as the Korean subject area: BIOCHEMISTRY & MOLECULAR BIOLOGY. Results of analysis by journals and by articles were also similar. Major subject categories identified by the number of articles ar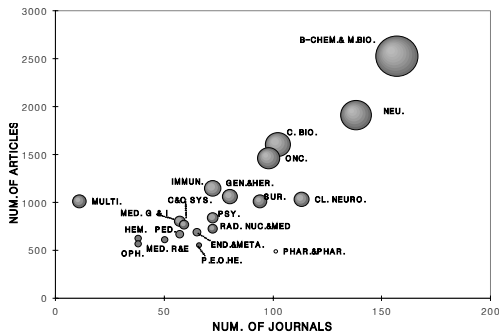e NEUROSCIENCES; CELL BIOLOGY; ONCOL-OGY; IMMUNOLOG;Y GENETICS & HEREDITY; CLINICAL NEUROLOGY; SURGERY; and MULTIDISCIPLINARY SCIENCES. More than 1000 articles were published by American researchers in these subject areas.

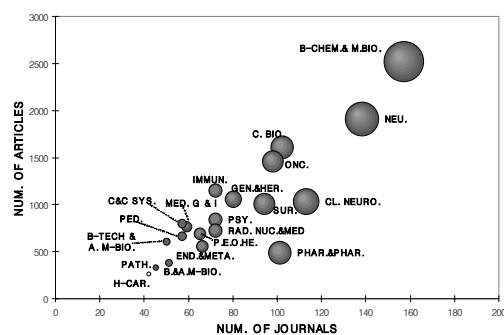⟨Table 10⟩ Subject analysis in science by articles – American school of medicine

subject categories	range by the number of articles	number of subject categories
BIOCHEMISTRY & MOLECULAR BIOLOGY(2525)	over 2000	1
NEUROSCIENCES(1911), CELL BIOLOGY(1609), ONCOLOGY (1462), IMMUNOLOGY(1150), GENETICS & HEREDITY(1064), CLINICAL NEUROLOGY(1038), SURGERY (1014), MULTIDISCIPLINARY SCIENCES(1012)	1000-1999	8
PSYCHIATRY(840), MEDICINE, GENERAL & INTERNAL(804), CARDIAC & CARDIOVASCULAR SYSTEMS(772), RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING(727), ENDOCRINOLOGY & METABOLISM(692), PEDIATRICS(668), HEMATOLOGY(631), MEDICINE, RESEARCH & EXPERIMENTAL(613), OPHTHALMOLOGY(574), PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH (557)	500-999	10
PHARMACOLOGY & PHARMACY(490), INFECTIOUS DISEASES(486), VIROLOGY(482), UROLOGY & NEPHROLOGY(458), MICROBIOLOGY(457), PHYSIOLOGY(422), PERIPHERAL VASCULAR DISEASE(403), BIOTECHNOLOGY & APPLIED MICROBIOLOGY(383), DEVELOPMENTAL BIOLOGY(378), RESPIRATORY SYSTEM(355), BIOCHEMICAL RESEARCH METHODS(351), PATHOLOGY(331), OBSTETRICS & GYNECOLOGY(329), GASTROENTEROLOGY & HEPATOLOGY(326), BIOPHYSICS(296), HEALTH CARE SCIENCES & SERVICES(264), OTORHINOLARYNGOLOGY(251), ORTHOPEDICS(214), DERMATOLOGY(190), PSYCHOLOGY(186), NUTRITION & DIETETICS(184), BIOLOGY(175), TRANSPLANTATION(169), MATHEMATICAL & COMPUTATIONAL BIOLOGY(153), SPORT SCIENCES(140), GERIATRICS & GERONTOLOGY(139), CHEMISTRY, MULTIDISCIPLINARY(135), NEUROIMAGING(134), ENGINEERING, BIOMEDICAL(128), SUBSTANCE ABUSE(124), BEHAVIORAL SCIENCES(118), EMERGENCY MEDICINE(115), MEDICAL INFORMATICS(112), CRITICAL CARE MEDICINE(110), ALLERGY(107), ANATOMY & MORPHOLOGY(100)	100-499	36
VETERINARY SCIENCES (91), REHABILITATION(83), COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS(81), ANESTHESIOLOGY(80), ZOOLOGY (78), PARASITOLOGY(76), TOXICOLOGY(74), CHEMISTRY, ANALYTICAL(73), CHEMISTRY, MEDICINAL(70), EDUCATION, SCIENTIFIC DISCIPLINES(69), STATISTICS & PROBABILITY(66), MEDICAL LABORATORY TECHNOLOGY(63), REPRODUCTIVE BIOLOGY(62), RHEUMATOLOGY(58), COMPUTER SCIENCE, INFORMATION SYSTEMS(50)	50-99	15

CHEMISTRY, ORGANIC(49), SPECTROSCOPY (43), EVOLUTIONARY BIOLOGY(41), ENGINEERING, ELECTRICAL & ELECTRONIC(39), MATERIALS SCIENCE, BIOMATERIALS(39), DENTISTRY, ORAL SURGERY & MEDICINE(37), CHEMISTRY, PHYSICAL(36), ENVIRONMENTAL SCIENCES(36), ACOUSTICS(33), INTEGRATIVE & COMPLEMENTARY MEDICINE (32), TROPICAL MEDICINE(32), ANDROLOGY(30), NURSING(25), PLANT SCIENCES(25), NANOSCIENCE & NANOTECHNOLOGY(23), OPTICS(21), MATERIALS SCIENCE, MULTIDISCIPLINARY(17), CRYSTALLOGRAPHY(14), IMAGING SCIENCE & PHOTOGRAPHIC TECHNOLOGY(14), POLYMER SCIENCE(14), PHYSICS, ATOMIC, MOLECULAR & CHEMICAL(13), COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE(12), ECOLOGY(12), FOOD SCIENCE & TECHNOLOGY(12), MEDICINE, LEGAL(12)	10-49	25
CHEMISTRY, APPLIED(8), MYCOLOGY(8), NUCLEAR SCIENCE & TECHNOLOGY(8), PHYSICS, APPLIED (8), MARINE & FRESHWATER BIOLOGY(7), MEDICAL ETHICS(7), PHYSICS, CONDENSED MATTER(7), ENGINEERING, AEROSPACE(6), MATHEMATICS, INTERDISCIPLINARY APPLICATIONS(6), AGRICULTURE, DAIRY & ANIMAL SCIENCE(5), AUTOMATION & CONTROL SYSTEMS(5), FISHERIES(5), PHYSICS, MULTIDISCIPLINARY(5), ASTRONOMY & ASTROPHYSICS(4), ENGINEERING, MECHANICAL(4), GEOSCIENCES, MULTIDISCIPLINARY(4), MATHEMATICS, APPLIED(4), CHEMISTRY, INORGANIC & NUCLEAR(3), ENGINEERING, ENVIRONMENTAL(3), ENGINEERING, MANUFACTURING(3), METEOROLOGY & ATMOSPHERIC SCIENCES(3), PHYSICS, MATHEMATICAL(3), TELECOMMUNICATIONS(3), AGRICULTURE, MULTIDISCIPLINARY(2), COMPUTER SCIENCE, CYBERNETICS(2), COMPUTER SCIENCE, THEORY & METHODS(2), ENGINEERING, INDUSTRIAL(2), ENGINEERING, MULTIDISCIPLINARY(2), GEOGRAPHY, PHYSICAL(2), MATHEMATICS(2), MICROSCOPY(2), PALEONTOLOGY(2), AGRICULTURAL ENGINEERING(1), AGRONOMY(1), COMPUTER SCIENCE, SOFTWARE ENGINEERING(1), CONSTRUCTION & BUILDING TECHNOLOGY(1), ELECTROCHEMISTRY(1), ENERGY & FUELS(1), ENGINEERING, CIVIL(1), ENTOMOLOGY(1), HISTORY & PHILOSOPHY OF SCIENCE(1), INSTRUMENTS & INSTRUMENTATION(1), LIMNOLOGY(1), OCEANOGRAPHY (1), OPERATIONS RESEARCH & MANAGEMENT(1), ORNITHOLOGY(1)	1-9	46

〈 TOP 20 CATEGORIES BY THE NUMBER OF ARTICLES 〉 〈 TOP 20 CATEGORIES BY THE NUMBER OF JOURNALS 〉

ABBREATION USED IN FIGURE 1.
- BIOCHEMISTRY & MOLECULAR BIOLOGY:B-CHEM.& M.BIO.
- NEUROSCIENCES:NEU.
- CLINICAL NEUROLOGYCL.:NEURO.
- CELL BIOLOGY:C. BIO.
- PHARMACOLOGY & PHARMACY:PHAR.&PHAR.
- ONCOLOGY:ONC.
- SURGERY:SUR.
- GENETICS & HEREDITY:GEN.&HER.
- IMMUNOLOGY:IMMUN.
- PSYCHIATRY:PSY.
- RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING:RAD. NUC.&MED
- PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH :P.E.O.HE.

- ENDOCRINOLOGY & METABOLISM:END.&META.
- CARDIAC & CARDIOVASCULAR SYSTEMS:C&C SYS.
- MEDICINE, GENERAL & INTERNAL:MED. G & I
- PEDIATRICS:PED.
- BIOTECHNOLOGY & APPLIED MICROBIOLOGY:B-TECH & A. M-BIO.
- MEDICINE, RESEARCH & EXPERIMENTAL:B-TECH & A. M-BIO.
- PATHOLOGY:PATH.
- HEALTH CARE SCIENCES & SERVICES:H-CAR.
- MULTIDISCIPLINARY SCIENCES:MULTI.
- HEMATOLOGY:HEM.
- MEDICINE, RESEARCH & EXPERIMENTAL:MED. R&E
- OPHTHALMOLOGY:OPH.

〈Figure 4〉 top 20 SCIE Medicine Categories by journals and by articles

The scattergrams in Figure 4 show that NEU-ROSCIENCES, CELL BIOLOGY and ONCO-LOGY had the same size bubbles as BIOCHE-MISTRY & MOLECULAR BIOLOGY. There are, however, some changes of subject categories, even though several dominant areas were consistent in both scattergrams. The bubbles of CLINICAL NEUROLOGY and PHARMACOLOGY & PHA-RMACY in the journals scattergram are larger than those in the articles scattergram. The size changed because the article ratios in these categories are lower than the top 10 categories sorted by journal. Evidently, researchers in American medical schools published their papers in these areas in sub-topic journals.

2) Subject analysis by SSCI categories

Three hundred twenty-five journals were matched to subject categories in SSCI. The main subject categories were PSYCHOLOGY, CLINICAL and PSYCHIATRY. Among subject categories, PSY-CHOLOGY-related keywords appeared most often. This shows that psychology areas are most closely related to medical research in social science fields.

Subject categories such as PUBLIC, ENVIRON-MENTAL & OCCUPATIONAL HEALTH; HEALTH POLICY & SERVICES and REHABILITATION were also prominent areas to which more than 20 journals were assigned.

Compared to the subject scope of Korean medical school researchers, the subject areas of American researchers were much more extensive.

〈Table 11〉 Subject analysis in social science by journals and articles – American school of medicine

SUBJECT CATEGORIES	the number of journals	SUBJECT CATEGORIES	the number of articles
PSYCHOLOGY, CLINICAL	52	PSYCHIATRY	443
PSYCHIATRY	50	PSYCHOLOGY, CLINICAL	310
PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	30	HEALTH POLICY & SERVICES	181
PSYCHOLOGY, MULTIDISCIPLINARY	27	PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	143
PSYCHOLOGY, EXPERIMENTAL	25	SUBSTANCE ABUSE	114
HEALTH POLICY & SERVICES	23	PSYCHOLOGY, DEVELOPMENTAL	108
PSYCHOLOGY, DEVELOPMENTAL	21	PSYCHOLOGY, EXPERIMENTAL	104
REHABILITATION	20	GERONTOLOGY	85
SUBSTANCE ABUSE, FAMILY STUDIES	12	PSYCHOLOGY, MULTIDISCIPLINARY	80
		REHABILITATION	48
SOCIAL SCIENCES, BIOMEDICAL	11	INFORMATION SCIENCE & LIBRARY SCIENCE	35
GERONTOLOGY, EDUCATION & EDUCATIONAL RESEARCH	10	PSYCHOLOGY, BIOLOGICAL, SOCIAL SCIENCES, BIOMEDICAL	34
PSYCHOLOGY, SOCIAL, NURSING	9	ANTHROPOLOGY, SOCIAL SCIENCES, INTERDISCIPLINARY	28
PSYCHOLOGY, PSYCHOANALYSIS	8	FAMILY STUDIES	27
PSYCHOLOGY, EDUCATIONAL	7	EDUCATION & EDUCATIONAL RESEARCH	24
ANTHROPOLOGY, SOCIAL SCIENCES, INTERDISCIPLINARY, ECONOMICS, SOCIAL ISSUES	6	PSYCHOLOGY, PSYCHOANALYSIS, PSYCHOLOGY, SOCIAL	16
		NURSING	14

PSYCHOLOGY, BIOLOGICAL, SOCIAL WORK, ERGONOMICS, LAW, APPLIED LINGUISTICS, PSYCHOLOGY, APPLIED	5	ECONOMICS, SOCIAL ISSUES	13
		SOCIAL WORK	12
		EDUCATION, SPECIAL	11
		ERGONOMICS, ETHICS, LAW, PSYCHOLOGY, EDUCATIONAL	10
EDUCATION, SPECIAL, SOCIOLOGY	4	APPLIED LINGUISTICS	8
ETHICS	3	TRANSPORTATION	7
TRANSPORTATION, PSYCHOLOGY, MATHEMATICAL, BUSINESS, DEMOGRAPHY, ENVIRONMENTAL STUDIES	1	POLITICAL SCIENCE, PSYCHOLOGY, APPLIED	5
		PSYCHOLOGY, MATHEMATICAL, SOCIOLOGY	4
INFORMATION SCIENCE & LIBRARY SCIENCE, POLITICAL SCIENCE, COMMUNICATION, CRIMINOLOGY & PENOLOGY, ETHNIC STUDIES, MANAGEMENT, PUBLIC ADMINISTRATION, SOCIAL SCIENCES, MATHEMATICAL METHODS, URBAN STUDIES	1	BUSINESS, COMMUNICATION, DEMOGRAPHY, ENVIRONMENTAL STUDIES	2
		CRIMINOLOGY & PENOLOGY, ETHNIC STUDIES, MANAGEMENT, PUBLIC ADMINISTRATION, SOCIAL SCIENCES, MATHEMATICAL METHODS, URBAN STUDIES	1

3) Subject analysis by CC-Clinical Medicine categories

From 2006 to 2008, 7,203 articles were published in 639 journals by American medical school researchers. The journals appeared in all 26 subject categories of CC-Clinical Medicine. As in the Korean analysis, the subject category with the highest number(65) of journals was CARDIOVASCULAR & RESPIRATORY SYSTEMS. Other prominent clinical medicine subject categories identified by journals were NEUROLOGY; ONCOLOGY; MEDICINE, GENERAL & INTERNAL; RADIOLOGY; NUCLEAR MEDICINE & IMAGING; RESEARCH/ LABORATORY MEDICINE & MEDICAL TECHNOLOGY; and CLINICAL PSYCHOLOGY & PSYCHIATRY.

Top three of clinical medicine subject categories identified by the number of articles were ONCOLOGY; CARDIOVASCULAR & RESPIRATORY SYSTEMS; and NEUROLOGY. ONCOLOGY was the most dominant subject area with the highest number of articles, but it ranked third in subject areas by journals. Its changes can bee seen in the scattergrams shown in Figure 5.
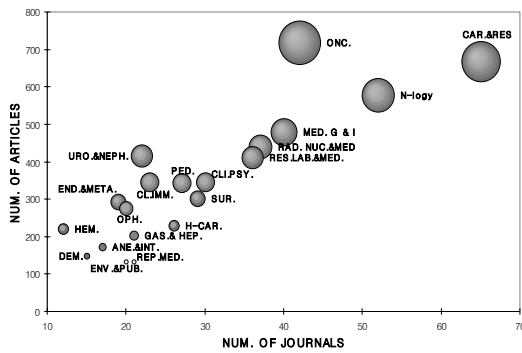
〈Table 12〉 Subject analysis in clinical medicine by journals – American school of medicine

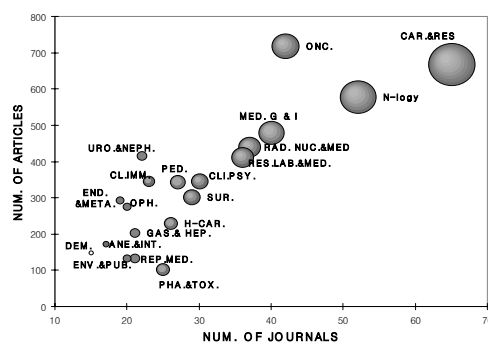| subject categories	range by the number of journals	number of subject categories
Cardiovascular & Respiratory Systems(65), Neurology(52)	OVER 50	2
Oncology (42), General & Internal Medicine (40)	40-49	2
Radiology, Nuclear Medicine & Imaging(37), Research/Laboratory Medicine & Medical Technology (36), Clinical Psychology & Psychiatry(30)	30-39	3
Surgery(29), Pediatrics(27), Health Care Sciences & Services(26), Pharmacology/Toxicology(25), Clinical Immunology & Infectious Disease(23), Urology & Nephrology(22), Gastroenterology & Hepatology(21), Reproductive Medicine (21), Environmental Medicine & Public Health(20), Ophthalmology(20)	20-29	10
Endocrinology, Metabolism & Nutrition(19), Anesthesia & Intensive Care(17), Dermatology (15), Orthopedics, Rehabilitation & Sports Medicine(13), Hematology(12)	10-19	5
Dentistry/Oral Surgery & Medicine(8), Otolaryngology(8), Rheumatology(6), Nursing(5)	1-9	4

⟨Table 13⟩ Subject analysis in clinical medicine by articles – American school of medicine

subject categories	range by the number of articles	number of subject categories
Oncology (720), Cardiovascular & Respiratory Systems(669), Neurology(578)	over 500	3
General & Internal Medicine (481), Radiology, Nuclear Medicine & Imaging(440), Urology & Nephrology(416), Research/Laboratory Medicine & Medical Technology (413)	400-499	4
Clinical Immunology & Infectious Disease(347), Clinical Psychology & Psychiatry(346), Pediatrics(345), Surgery(302)	300-399	4
Endocrinology, Metabolism & Nutrition(293),Ophthalmology(276), Health Care Sciences & Services(231), Hematology(221), Gastroenterology & Hepatology(203)	200-299	5
Anesthesia & Intensive Care(174), Dermatology(150), Environmental Medicine & Public Health(134), Reproductive Medicine (134), Pharmacology/Toxicology(102)	100-199	5
Orthopedics, Rehabilitation & Sports Medicine(83), Otolaryngology(77), Rheumatology(42), Dentistry/Oral Surgery & Medicine(20), Nursing(6)	1-100	5

⟨ TOP 20 CATEGORIES BY THE NUMBER OF ARTICLES ⟩   ⟨ TOP 20 CATEGORIES BY THE NUMBER OF JOURNALS ⟩

ABBREATION USED IN FIGURE 1.
- Anesthesia & Intensive Care：ANE.&INT.
- Cardiovascular & Respiratory System：CAR.&RES
- Clinical Immunology & Infectious Disease：CL.IMM.
- Clinical Psychology & Psychiatry：CLI.PSY.
- Dermatology：DEM.
- Endocrinology, Metabolism & Nutrition：END.&META.
- Environmental Medicine & Public Health：ENV.&PUB.
- Gastroenterology & Hepatology：GAS.& HEP.
- Health Care Sciences & Services：H-CAR.
- Hematology：HEM.

- MEDICINE, GENERAL & INTERNAL：MED. G & I
- Neurology：N-logy
- Oncology：ONC.
- Ophthalmology： OPH.
- Pharmacology/Toxicology：PHA.&TOX.
- Radiology, Nuclear Medicine & Imaging：RAD. NUC.&MED
- Reproductive Medicine： REP.MED.
- Research/Laboratory Medicine & Medical Technology： RES.LAB.&MED.
- Surgery： SUR.
- Urology & Nephrology： URO.&NEPH.

⟨Figure 5⟩ Top 20 CC Clinical Medicine Categories by journals and by articles

The scattergrams in Figure 5 shows that ONCOLOGY is the primary article-centered subject area while CARDIOVASCULAR & RESPIRATORY SYSTEMS is the primary journal-centered subject area. ONCOLOGY and CAR-DIOVASCULAR & RESPIRATORY SYSTEMS are the top 2 dominant subject categories according to both scattergrams. ONCOLOGY has more articles but fewer journals than CARDIOVASCULAR & RESPIRATORY SYSTEMS, so it can be consid-

ered article-centered. CARDIOVASCULAR & RESPIRATORY SYSTEMS shows the opposite result, so it is journal-centered. UROLOGY & NEPHROLOGY ENDOCRINOLOGYMETABOLISM & NUTRITION and OPHTHALMOLOGY show a tendency similar to ONCOLOGY.

5. Conclusion

This study identifies and ranks subject areas based on analyses of journal articles published by researchers in the top 5 medical schools of two countries, Korea and America, from 2006 to 2008. This bibliometric anaylsis were carried out by investigating the numbers of journals and articles in three subject areas: science, social science and clinical medicine.

In the analyses of Korean researchers' publications in the science area, CLINICAL NEUROLOGY is identified as primary in terms of journal quantity and RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING is primary in terms of article quantity. The most dominant subject area among American researchers is BIOCHEMISTRY & MOLECULAR BIOLOGY according to all analyses. Korean researchers' publications showed significant differences in their major subject areas according to whether the analysis was by number of journals or by number of articles. When subject areas are sorted by journal preference, it is apparent that Korean medical school researchers published their papers in several dominant journals, mainly in subject areas such as Medicine, General and Internal.

In the social science area, American medical school researchers published their papers in more subject areas than the Korean researchers did. American researchers presented their output in 44 subject areas while Korean researcher did in 14 areas. The difference between the numbers of journals in which researchers from both countries published is also significant, which provides statistical evidence that social science is not a subject area that attracts researchers in Korean medical schools.

For both countries, the most dominant subject area in clinical medicine differs both by the number of journals and the number of articles. For Korean researchers, CARDIOVASCULAR & RASIPRATORY SYSTEMS is the major subject identified by journals and RADIOLOGY, NUCLEAR MEDICINE & IMAGING is the major subject area identified by articles. For American researchers, CARDIOVASCULAR & RASIPRATORY SYSTEMS is also ranked first in the subject list by journals, but the most dominant subject area according to the number of articles is ONCOLOGY. In terms of journal preference, it seems that there are several major journals for Korean researchers in the MEDICINE, GENERAL & INTERNAL and RADIOLOGY, NUCLEAR MEDICINE & IMAGING subject areas. ONCOLOGY is the subject area that shows a similar tendency for American researchers.

In general terms, this study shows how research areas can be investigated by analyses of academic

publications. It can lay the foundation for future analyses of research trends in many areas. However, the data of this study is limited in 2006-2008 SCOPUS data matched to SCIE, SSCI, and CC-CM. Therefore extending time period or combining other databases such as Medline can be considered for further research to get more comprehensive results.

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