# A Bibliometric Analysis of Biomedical Research in Australia

## Final Report

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# 1 Introduction

## 1.1 Background

This study was commissioned by the Association of Australian Medical Research Institutes (AAMRI) and has been carried out by the Research Evaluation and Policy Project (REPP) in the Research School of Social Sciences at the Australian National University.

It provides a bibliometric analysis of biomedical research in Australia, which will cover both a descriptive and comparative analysis of the output from the member institutes of AAMRI, universities, hospitals and government agencies. The focus of the study is to map the research publication production and their impact in the biomedical sciences in Australia. A large number of health and medical research conducted in Australia has been supported by the National Health and Medical Research Council (NHMRC). The forthcoming REPP study entitled 'NHMRC-Supported Research: The Impact of Journal Publication Output 2002-2006' (Butler and Henadeera 2009), which was commissioned by NHMRC, provides an evaluation of NHMRC-supported research in Australia. Complimenting this report, the current study examines the impact of biomedical research publications by the member institutes of AAMRI compared to universities, hospitals and government agencies.

As this study is primarily designed to provide data to assist AAMRI in assessing the scientific performance of its member institutes and comparator sectors, in conjunction with many other indicators, the commentary given on the various figures and tables will be limited. It will be restricted primarily to explanatory notes to assist in an accurate interpretation of the data presented.

## 1.2 Using Bibliometrics

In this study no assumption is made that judgements about 'quality' can be based solely on citation analysis. We prefer instead to talk about the visibility and impact of the research. More importantly, bibliometric data answer no single evaluative question in their own right. This information must be seen alongside other measures of esteem, performance, visibility and the testimony of expert peers in the activity which is being analysed. It is best used in conjunction with a peer evaluation process. The phrase we have coined for the correct interaction between bibliometric analysis and peer review is that bibliometric data should provide 'a trigger to the recognition of anomaly'. Where the two approaches do not result in consistent views, the differences should be recognised and it should be determined whether they result from problems with the numbers or whether they may highlight information unknown to peers in the field.

## 1.3 The Research Evaluation and Policy Project Database

The study draws on the REPP database which was created from Web of Science (WoS) data files purchased from Thomson Reuters, and contains all Australian publications indexed in the three major WoS Indices: the Science Citation Index (SCI), the Social Sciences Citation Index (SSCI), and the Arts and Humanities Citation Index (A&HCI). The database is updated annually, and currently contains details of nearly 440,000 publications covering the period between 1981 and 2007.

The focus of the database is the departmental and the institutional address(es) given for each publication rather than the names of authors. REPP 'cleans' the addresses in the database to enable analysis to be done at different levels of aggregation. 'Cleaning' means ensuring that all variations of the same address are identified and that all publications with variants of that address are allocated the one 'standardised address'. The standardised addresses for all Australian universities and other major research institutions are set up in a hierarchical format, from the institution down through faculties or schools to the department, enabling tabulations at these different levels of aggregation to be produced.

## 1.4 Identification of Sector Publications

Publication output and performance of the following sectors are analysed in this study:

- **AAMRI Institutes**
  It covers all relevant publications (i.e. research and review articles for the relevant period) from the following 38 AAMRI member institutions:

  ANZAC Research Institute (NSW)
  Baker IDI Heart and Diabetes Institute (VIC)
  Bernard O'Brien Institute of Microsurgery (VIC)
  Bionic Ear Institute (VIC)
  Brain Research Institute (VIC)
  Burnet Institute (VIC)
  Centenary Institute of Cancer Medicine and Cell Biology (NSW)
  Centre for Eye Research Australia (VIC)
  Children's Cancer Institute Australia for Medical Research (NSW)
  Children's Medical Research Institute (NSW)
  Florey Neurosciences Institute (VIC)
  Garvan Institute of Medical Research (NSW)
  The George Institute for International Health (NSW)
  Hanson Institute (SA)
  Heart Research Institute (NSW)
  Institute for Eye Research (NSW)
  Kolling Institute of Medical Research (NSW)
  Lions Eye Institute (WA)
  Ludwig Institute for Cancer Research Ltd (VIC)
  Mater Medical Research Institute (QLD)
  Mental Health Research Institute of Victoria (VIC)
  Menzies Research Institute (TAS)
  Menzies School of Health Research (NT)
  Murdoch Childrens Research Institute (VIC)
  National Ageing Research Institute (VIC)
  Peter MacCallum Cancer Institute (VIC)
  Prince Henry's Institute of Medical Research (VIC)
  Prince of Wales Medical Research Institute (NSW)
  Queensland Institute of Medical Research (QLD)
  St Vincent's Institute of Medical Research (VIC)
  Telethon Institute for Child Health Research (WA)
  Victor Chang Cardiac Research Institute (NSW)

The Walter and Eliza Hall Institute of Medical Research (VIC)
The Wesley Research Institute (QLD)
Western Australian Institute for Medical Research (WA)
Westmead Millennium Institute (NSW)
Women's & Children's Health Research Institute Inc (SA)
Woolcock Institute of Medical Research (NSW)

- **Government** departments and agencies
  The sector covers all relevant publications (i.e. research and review articles for the relevant period) from federal and state government departments and agencies.

- **Hospitals**
  The sector covers all relevant publications (i.e. research and review articles for the relevant period) from hospitals, both public and private institutions.

- **Universities**
  The sector covers all relevant publications (i.e. research and review articles for the relevant period) from all universities.

- **Medical research institutes** (only in Figures 2)
  This sector is included in the analysis in Figure 2, and covers all publications (i.e. research and review articles for 1981-2007 period). It comprises all Australian medical research institutes including the non AAMRI member institutes.

## 1.5 Sector Overlap

Given the collaborative nature of most research, with multi-authored papers the norm, it is inevitable that there will be some *double-counting*. Therefore the methods used to identify the relevant publications for each of the sectors resulted in some overlap between sectors. Where authors from more than one sector collaborate on a publication, it is fully counted for each sector involved.

## 1.6 Differences in Analysis Compared to the NHMRC study

The recent NHMRC study (Butler and Henadeera 2009) provides an analysis of the publication output and performance of university, hospital, government and medical research institutes sectors. The present study also analyses the publication output and performance of these sectors for the same 2002-06 period. However, it is important to stress that the methodologies used to create sectors in two studies are different.

The NHMRC study aimed at creating sectors with quite distinct characteristics and as little overlap as possible. In order to achieve this, some of the sectors created do not bear a strong resemblance to their commonly perceived definition. In particular, the Other University, Other Government and Other Hospital sectors created as comparators are not comprehensive, covering only those publications not supported, at least in part, by NHMRC funding schemes. In this respect, each sector output, as presented in the NHMRC study, is not a true reflection of the total output, but is more accurately a reflection of the output funded principally through sources other than NHMRC.

Other Research Institutes sector in the NHMRC study comprises publications from AAMRI member institutes at the time of the study **and** those from Division of Health Sciences and Nutrition of CSIRO. In contrast, the publication coverage of the 'AAMRI Institutes' sector in this study is limited to 38 current member institutes of AAMRI[1].

As a result of these methodological differences the publication and citation figures of individual sectors presented in two studies are different.

## 1.7 Classification of Biomedical Research

Web of Science has its own descriptive classification system involving about 200 subject categories and the REPP translated these as closely as possible into the fields and subfields[2] of the Research Fields, Courses, and Disciplines (RFCD) classification scheme (ABS 1998). The RFCD was prepared by the Australian Bureau of Statistics for use in the measurement and analysis of research and experimental development undertaken in Australia. REPP currently uses the 1998 edition of the RFCD scheme.

Biomedical publications used in this analysis include all Web of Science indexed journal publications in the following RFCD fields:

Biochemistry and cell biology
Genetics
Microbiology
Biotechnology
Immunology
Clinical chemistry
Pharmacology and pharmaceutical science
Medical physiology
Neurosciences
Clinical sciences
Public health and health services
Human movement and sports science
Medicine general
Multidisciplinary science

The translation of Web of Science subject categories into the science fields and subfields of the RFCD is given in the *Appendix*.

[1] The membership information is based on http://www.aamri.org/aamri_members/ as of July 2009.
[2] 'Fields' and 'subfields' in our terminology equate to Divisions and Disciplines respectively in the RFCD.

## 1.8 The Bibliometric Measures

A general description of the bibliometric measures used is given in this section. The analyses contained in this study are presented in the form of figures and tables, using the measures outlined below. Notes relevant to particular points of discussion are included throughout the study as required.

### 1.8.1 Publication Output

Total number of publications produced by the sector for a given period.

### 1.8.2 Citations Per Publication (CPP)

Publications that appeared in relevant periods were counted and the citations these publications received during the same periods were aggregated. A simple citation per publication (CPP) average was then calculated.

### 1.8.3 Relative Citation Impact (RCI)

Relative citation impact (RCI) compares the citation rate of sector output with the relevant world average. It is calculated by dividing the average number of citations per sector publication in a given field/subfield by the average number of citations for all publications in that field/subfield (i.e. the world citation rate for that field/subfield).

Thus, a relative citation impact of more than 1.0 indicates a higher/better position than the world average, while a relative citation impact of less than 1.0 would indicate a relatively low performance.

### 1.8.4 Centile Distribution

Thomson Reuters provides details of the performance of each Australian article relative to all other articles in the world in the same category. For this analysis, we have profiled the publications of individual sectors, showing the number and proportion of total output in each category that are classified into 6 bands: those amongst the 1% most highly cited in the world; those in the 2% to 5% band; those in the 6% to 10% range; 11% to 20%; 21% to 50%; and those in the bottom half of cited publications.

If a publication mirrored that of the world average, the distribution you would expect to see across the 6 bands would be: 1% -- 4% -- 5% -- 10% -- 30% -- 50%. A higher proportion in the top 2 or 3 bands is an indicator of strong citation performance.

# 2 Analysis

## 2.1 Biomedical Research Publications – Sector Analysis

This section presents a comparative analysis of all the journal publication output for the 2002-06 period in biomedical research fields produced by the following four sectors:

- AAMRI member institutes
- Universities
- Hospitals
- All government departments and agencies

The analysis explores the publication output and the citation performance of each sector. Also provided in this section are aggregated figures of the biomedical publication output for Australia and world for comparison and benchmarking purposes.

Table 1 shows total biomedical publications produced by each sector, the number of citations received by those publications. The CPP figure indicates the citation performance for each sector and can be benchmarked against the Australian and world averages. Figure 1 below illustrates the CPP data from Table 1.

**Table 1. Number of publications, citations and citations per publication by sector, 2002-06**

| | All Biomedical Publications | | |
|---|---|---|---|
| **Sector** | **Pubs** | **Citations** | **CPP** |
| **AAMRI Institutes** | **9078** | **96545** | **10.64** |
| Government | 3365 | 19250 | 5.72 |
| Hospitals | 13998 | 96229 | 6.87 |
| Universities | 35941 | 243209 | 6.77 |
| **Australia** | **47799** | **348523** | **7.29** |
| **World** | **1622169** | **11209532** | **6.91** |

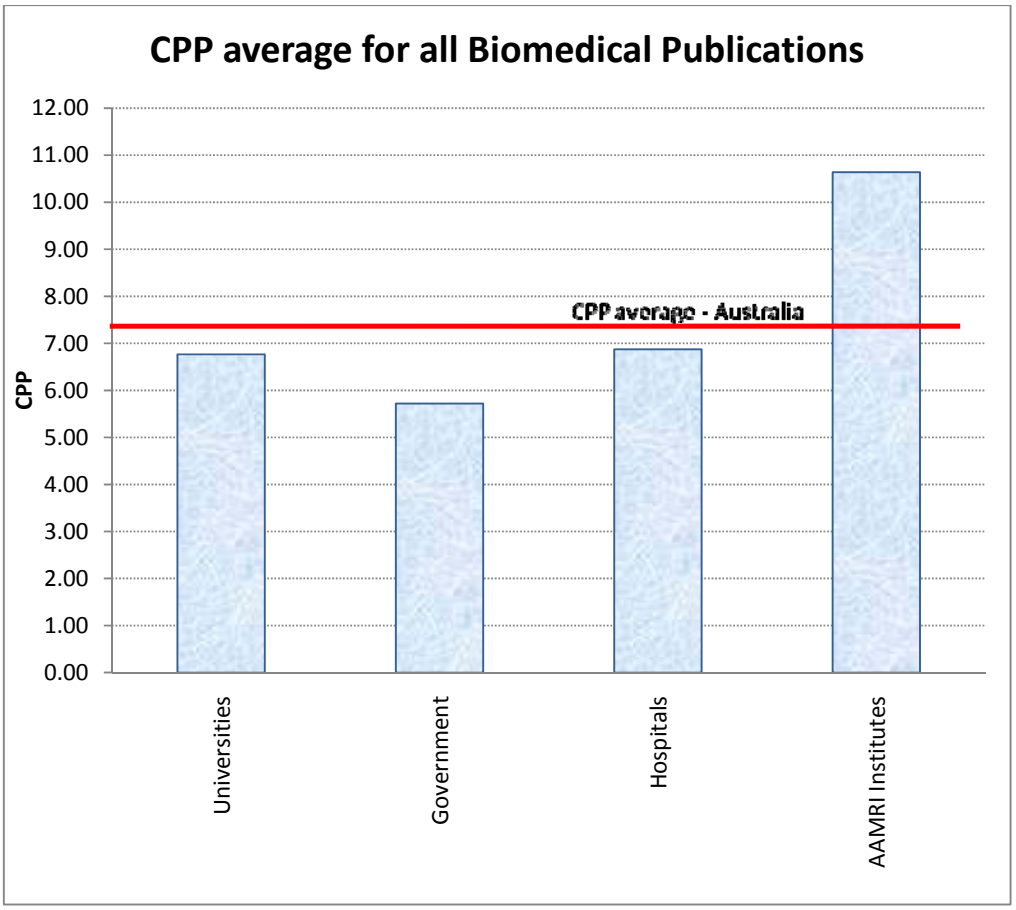


*Figure 1: Citations per publication by sector, 2002-06*

The table 2 represents the number of publications in each percentile. Centile distribution of publications from different sectors illustrate where the high impact research is to be found. Again the individual figures and proportion of publications within each band can be compared to the Australian average. For instance, 2.6% of biomedical publications from AAMRI member institutes reached the top 1% threshold of most highly cited publications, compared to the Australian average of 2.1%.

**Table 2: Centile distribution of publications, 2002-06, by sector**

| Sector | Top 1% | | Top 2-5% | | Top 6-10% | | Top 11-20% | | Top 21-50% | | Bottom 50% | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AAMRI Institutes** | **237** | ***2.6%*** | **743** | ***8.2%*** | **869** | ***9.6%*** | **1351** | ***14.9%*** | **2894** | ***31.9%*** | **2984** | ***32.9%*** | **9078** |
| Government | 69 | *2.1%* | 177 | *5.3%* | 221 | *6.6%* | 386 | *11.5%* | 1036 | *30.8%* | 1476 | *43.9%* | 3365 |
| Hospitals | 259 | *1.9%* | 746 | *5.3%* | 920 | *6.6%* | 1591 | *11.4%* | 4259 | *30.4%* | 6223 | *44.5%* | 13998 |
| Universities | 661 | *1.8%* | 2155 | *6.0%* | 2584 | *7.2%* | 4574 | *12.7%* | 11440 | *31.8%* | 14526 | *40.4%* | 35940 |
| **Australia** | **993** | ***2.1%*** | **2961** | ***6.2%*** | **3428** | ***7.2%*** | **5890** | ***12.3%*** | **14852** | ***31.1%*** | **19674** | ***41.2%*** | **47798** |

Relative citation impact of biomedical publications by sector is presented in Figure 2. The publication coverage is from 1981 to 2007 and the data are calculated in 5 year windows. In this measure, described in detail in section 1.8.3, citation performance for publications of each sector for a given time period is compared against that of the world average. The relative citation impact of 1.0 indicates the world average. Therefore, a citation impact higher than 1.0 denotes that publications are attracting citations at a greater rate than the world average for the field.

It is to be noted that Medical Research Institutes sector in this figure includes all medical research institutes in Australia. Since early 1990s the combined publication output of all medical research institutes have a relative citation rate over 1.5 times the world average.

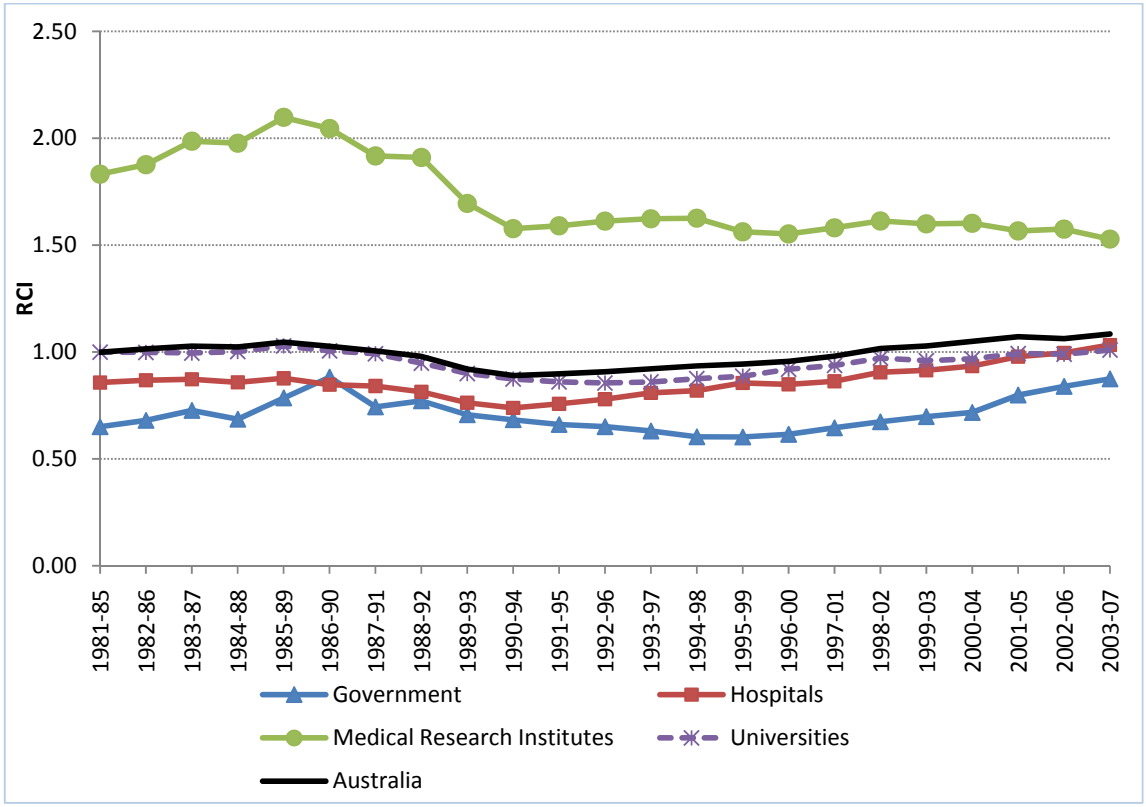


*Figure 2: Relative citation impact of biomedical research publications by sector*

## 2.2 Publication output and citation performance of AAMRI member institutes

**Table 3: Number of publications, citations and CPP, 2002-06**

| AAMRI member institutes | Publications | Citations | CPP |
|---|---|---|---|
| ANZAC Research Institute (NSW) | 142 | 1079 | 7.60 |
| Baker IDI Heart and Diabetes Institute (VIC) | 566 | 5235 | 9.25 |
| Bernard O'Brien Institute of Microsurgery (VIC) | 40 | | |
| Bionic Ear Institute (VIC) | 62 | | |
| Brain Research Institute (VIC) | 88 | | |
| Burnet Institute (VIC) | 206 | 990 | 4.81 |
| Centenary Institute of Cancer Medicine and Cell Biology (NSW) | 161 | 2080 | 12.92 |
| Centre for Eye Research Australia (VIC) | 185 | 1115 | 6.03 |
| Children's Cancer Institute Australia for Medical Research (NSW) | 95 | | |
| Children's Medical Research Institute (NSW) | 109 | 1512 | 13.87 |
| Florey Neurosciences Institute (VIC) | 501 | 4325 | 8.63 |
| Garvan Institute of Medical Research (NSW) | 520 | 7379 | 14.19 |
| The George Institute for International Health (NSW) | 81 | | |
| Hanson Institute (SA) | 230 | 2004 | 8.71 |
| Heart Research Institute (NSW) | 191 | 2235 | 11.70 |
| Kolling Institute of Medical Research (NSW) | 168 | 1672 | 9.95 |
| Lions Eye Institute (WA) | 118 | 773 | 6.55 |
| Ludwig Institute for Cancer Research Ltd (VIC) | 290 | 4519 | 15.58 |
| Mater Medical Research Institute (QLD) | 59 | | |
| Mental Health Research Institute of Victoria (VIC) | 263 | 2729 | 10.38 |
| Menzies Research Institute (TAS) | 139 | 972 | 6.99 |
| Menzies School of Health Research (NT) | 334 | 1627 | 4.87 |
| Murdoch Childrens Research Institute (VIC) | 748 | 5757 | 7.70 |
| National Ageing Research Institute (VIC) | 59 | | |
| Peter MacCallum Cancer Institute (VIC) | 765 | 10495 | 13.72 |
| Prince Henry's Institute of Medical Research (VIC) | 342 | 3013 | 8.81 |
| Prince of Wales Medical Research Institute (NSW) | 393 | 2815 | 7.16 |
| Queensland Institute of Medical Research (QLD) | 1033 | 10350 | 10.02 |
| St Vincent's Institute of Medical Research (VIC) | 272 | 3077 | 11.31 |
| Telethon Institute for Child Health Research (WA) | 329 | 2695 | 8.19 |
| Victor Chang Cardiac Research Institute (NSW) | 138 | 1833 | 13.28 |
| The Walter and Eliza Hall Institute of Medical Research (VIC) | 927 | 18746 | 20.22 |
| The Wesley Research Institute (QLD) | 24 | | |
| Western Australian Institute for Medical Research (WA) | 385 | 3593 | 9.33 |
| Westmead Millennium Institute (NSW) | 407 | 4242 | 10.42 |
| Women's & Children's Health Research Institute Inc (SA) | 108 | 414 | 3.83 |
| Woolcock Institute of Medical Research (NSW) | 100 | 746 | 7.46 |
| **AAMRI INSTITUTES** | **9078** | **96545** | **10.64** |

A special note of caution is required in relation to interpreting citations per publication rates for some institutions with the small numbers of publications. The very nature of citation practice means that averages can be disproportionately affected by a single highly cited publication. The smaller the number of publications being analysed, the greater the effect such an item will have on the average. Citation information based on any unit with less than 100 publications is too unreliable and has been omitted in this analysis. Our experience also suggests that extra caution should be used for citation figures based on units with between 100 and 200 publications.

The Institute for Eye Research (NSW) has a very small number of publications and therefore is not included in the table above.

## Bibliography

ABS [Australian Bureau of Statistics]. 1998. *Australian Standard Research Classification*. Catalogue no. 1927.0, Canberra.

Butler, L. and Henadeera, K. 2009. *NHMRC – Supported Research: The Impact of Journal Publication Output 2002-2006.* Research Evaluation and Policy Project, Australian National University. Forthcoming.

# Appendix: Translation of ISI Subject Categories to RFCD Subfields

*210000 SCIENCE GENERAL*

*21000X Multidisciplinary*

Multidisciplinary sciences, Acoustics

*21000Y Interdisciplinary life sciences*

Marine & freshwater biology; Developmental biology; Virology; Mycology; Reproductive biology

*270000 BIOLOGICAL SCIENCES*

*270100 Biochemistry and cell biology*

Biochemistry and molecular biology; Cell biology

*270200 Genetics*

Genetics & heredity

*270300 Microbiology*

Microbiology

*270800 Biotechnology*

Biotechnology and applied microbiology; Biochemical research methods

*320000 MEDICAL AND HEALTH SCIENCES*

*320200 Immunology*

Allergy; Immunology

*320300 Medical biochemistry and clinical chemistry*

Chemistry, medicinal

*320400 Medical microbiology*

No corresponding ISI category

*320500 Pharmacology and pharmaceutical sciences*

Pharmacology and pharmacy; Toxicology

*320600 Medical physiology*

Anatomy and morphology; Physiology

*320700 Neurosciences*

Neurosciences

*320800 Dentistry*

Dentistry, oral surgery & medicine

*320900 Optometry*

No corresponding ISI category

*321000 Clinical Sciences*

Andrology; Anesthesiology; Cardiac & cardiovascular systems; Clinical neurology; Dermatology & venereal diseases; Emergency medicine & critical care; Endocrinology & metabolism; Gastroenterology & hepatology; Geriatrics & gerontology; Hematology; Infectious diseases; Medicine, general & internal; Obstetrics & gynecology; Oncology; Ophthalmology; Orthopedics; Otorhinolaryngology; Pathology; Pediatrics; Peripheral vascular disease; Psychiatry; Psychology (SCI only); Radiology, nucl med & med imag; Rehabilitation; Rhematology; Respiratory system; Transplantation; Surgery; Urology & nephrology; Tropical medicine

*321100 Nursing*

Nursing (SSCI)

*321200 Public health & health services*

Ergonomics (SSCI); Health care sciences & services; Health policy and services (SSCI); Medical informatics; Nutrition & dietetics; Public, environmental & occup hlth; Substance abuse; Medical ethics

*321300 Complementary/alternative medicine*

Integrative & complementary medicine

*321400 Human movements and sports sci*

Sport sciences

*329900 Other medical and health sciences*

Medical laboratory technology

*32X000 General medical & health sci*

Medicine, research and experimental